Attitudes, preferences and intentions to participate in peer-to-peer electricity trading: The case of Southwest German households

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Abstract

While the trend towards customer-based microgeneration is at the verge from a niche towards a mass market, P2P energy trading still is rather unknown. Based on a survey among energy customers of seven German utilities, we estimated hierarchical multiple regression models to identify consumer segments, their preferences and motivations for participating in P2P electricity trading and develop implications for marketing strategies. Our results show a low importance of socio-demographics in explaining differences between consumer groups, but high explanatory power of attitudes, knowledge and likelihood to purchase further related products. The most valuable target groups for P2P electricity trading are innovators and early adopters, especially prosumers. They are well-informed about and open towards electricity sharing, highly environmentally aware and favor regional production. They ask for transparency, and tend to purchase related products (e.g. microgeneration). Their motivation is stimulated by the ability to share generation and consumption and to a lesser extent to economize. Thus, marketing strategies should first and foremost aim at these adopters and their characteristics. By contrast, gaining new, uninvolved consumers will be the far more challenging task, which is, however crucial to realize a functioning and lively P2P electricity trading community. Accordingly, marketing measures need to be extended and differentiated for both target segments. Our results indicate that the efforts should to a special degree take peer effects actively into account, as they are found to wield great influence on general openness towards and purchase intention for P2P electricity products.

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1 Motivation

The EU has set binding targets of a 40% reduction of domestic greenhouse gas emissions (compared to 1990 levels) to be reached by 2030 and a share of renewable energy of 32% (EC, 2018), which led to the implementation of manifold policies to support renewable energy on a European and national level (Kitzing et al., 2012).

In 2000 already, the German Renewable Energy Sources Act (EEG) introduced fixed feed-in tariffs for electricity from renewable sources that are guaranteed for a period of 20 years. It led to a share of renewable electricity of 36.2% in 2017 (AGEB, 2018), with a target share of renewables in the German electricity mix of 55%-60% in 2035 (RAP, 2015), and so far resulted in about 1.7 million renewable electricity producers, with 31.5% of the production capacities owned by private households (Bundesnetzagentur, 2018; TrendResearch, 2016). However, in 2021 subsidization will run out for the first renewable generation which then has to either be used entirely on site or sold independently by the producer – or shared with others. This leads to regulatory requirements that cannot be fulfilled by private consumers so far, especially regarding trading and billing, so that the support of service providers is mandatory. Accompanied by a rapidly increasing degree of digitalization (smart metering, smart grids) this opens up perspectives for new, innovative products and services (see Koirala et al., 2016), such as cooperative virtual and decentral market places for peer-to-peer (P2P) energy trading and sharing. These are moreover supported politically on a European level (EC; 2016)[1].

Recently, such P2P energy communities have started to emerge around the world, with Zhang et al. (2017) and Park and Yong (2017) reviewing and discussing some of the existing projects. Corresponding to this market development, research on P2P electricity trading increased over the last few years. It mostly focuses on the description and technological analysis of P2P or local electricity sharing market architectures, the economic evaluation of the different market and network designs from an individual and macro-economic viewpoint, and the challenges faced by prosumer communities.[2]

To the best of our knowledge, the research of Reuter and Loock (2017) is the only study focusing on socio-economic drivers and barriers for P2P electricity trading between prosumers in local electricity markets. In 2017 they conducted a survey in Germany, Switzerland, Norway and Spain with 830 respondents in total, and 206 respondents in Germany, in particular. Focusing on the results for Germany, they find that in sum, 79% of all respondents are favorable about participating in a local electricity market. They detected that socio-demographic characteristics only marginally explain respondents' willingness to participate in local electricity markets and their interest in technological applications, except for a negative influence of age. Further, their results suggest that the current number of technological devices in the household, the energy consciousness and knowledge positively influence respondents' intention to participate in local electricity markets and interest in technological applications. For German individuals, the most important reasons to participate in local electricity markets are savings on the energy bill, diffusion of renewable energy, and improvement of the local

[1] However, as Gui and MacGill (2018) point out, strong resistance from the political and economic establishment can be anticipated, delaying the required regulatory adjustments for local peer-to-peer energy markets.

[2] Among many others e.g. Zhou et al. (2018), Jogunola et al. (2017, 2018), Moret and Pinson (2018), Alam et al. (2017), Morstyn et al. (2018), Liu et al. (2017), Parag and Sovacool (2016), Giotitsas et al. (2015), Kahrobaee et al. (2014), Mengelkamp et al. (2018a, b), Chitchyan and Murkin (2018).

environment, while the least important reasons are the exchange with neighbors, expression of an innovative lifestyle, and volunteering in the local community. The most important perceived barriers are the security of energy supply, bureaucracy, coordination among neighbors and data privacy. Finally, they highlight the most prospective consumer segments and describe priority agendas to tackle marketing strategy, design, governance, and risks of local energy markets.

We expand on this research in several ways: (1) our analysis is based on a larger and more heterogeneous group of randomly chosen utility customers. The main differences are a higher share of individuals with low involvement regarding energy, i.e. a smaller share of prosumers and a six times higher share of tenants; (2) our analysis lays a stronger focus on consumer attitudes (e.g. environmental awareness, openness towards the specific technology) and purchase intentions for related products; (3) we analyze the influence of peer effects on adoption intention for P2P electricity trading, as they are found to be a key determinant in consumer adoption decisions (e.g. Palm, 2017); and (4) we quantify the impact of the explanatory variables on purchase intention and general openness towards P2P electricity trading.

Based on data from a survey carried out in April and May 2017 among customers of seven municipal utilities mainly located in Southwest Germany, the purpose of this study is: (1) to identify private energy consumer and prosumer segments and their product attribute preferences and motivations for participating in P2P electricity trading and (2) to describe the implications for marketing strategies of energy suppliers. We apply hierarchical multiple regressions to explain the intention to purchase P2P electricity trading products and to find and quantify the explanatory factors for a general openness towards P2P electricity trading.

The remainder of this article is organized as follows: Section 2 describes the research in related energy fields. In Section 3, data and methodology are outlined. On this basis, Section 4 describes the results of the two hierarchical multiple regressions for purchase intention and openness towards P2P electricity trading. In Section 5, the key results are discussed, compared with results from the literature and marketing strategies for energy suppliers are drawn. Section 6 summarizes and concludes.

2 Literature review

P2P electricity trading just recently developed and still is a niche product, so that research on the motives for participating in these systems or potential adopters' preferred product attributes' is still scarce. Thus, related streams of research are analyzed in the following to gain insights into the motivations and preferences regarding P2P sharing in general, microgeneration technologies, participation in community energy projects, and green/innovative electricity tariffs.

The findings are summarized and listed without displaying a specific order of influence on the adoption or participation decision, as the ranking and impact of the single explanatory factors often differs between studies, depending on the research objective (e.g. technology), underlying sample (size, location, time), methodology and theoretical background (e.g. number and kind of variables).

2.1 Motivation for participation in the sharing economy

Many of the new products in the sharing economy[3], especially P2P electricity trading, seem to be best described as collaborative consumption or 'pseudo-sharing' in contrast to the 'true sharing' without fees or compensation (Belk, 2014). Nonetheless, positioning and branding for emerging P2P electricity trading products stress the community feeling and sharing motive. For this reason, in the following the research on motives to participate in the sharing economy is summarized.

Results in the literature generally show that motivations to participate differ between participants (users, providers), types of shared goods, and characteristics of the underlying sharing processes of the same good (Böcker and Meelen, 2017; Balck and Cracau, 2015). Consequently, the studies unveil a wide range of drivers and motivations to participate in the sharing economy, although economic motivations (financial benefits, thriftiness) are generally found to prevail: positive attitude towards sharing, use value (possibility to use otherwise unaffordable goods), environmental and frugality motivations, idealistic orientation (anti-capitalism , anti-industry, social responsibility and generosity, social community benefits, volunteering), hedonic motivations (enjoyment and fun), knowledge/familiarity with sharing, signaling and self-perception (expression of modern lifestyle), sense of belonging to a sharing community (social experience; 'warm glow'), social norm, innovation/technical interest, product/service diversity through sharing. Barriers are found to be: low convenience and practicality, perceived independence and social prestige through ownership, loss of privacy, perceived process/product risks, resource scarcity (Bucher et al., 2016; Balck and Cracau, 2015; Hamari et al., 2015; Akbar et al., 2016; Gossen et al., 2016; Schor and Fitzmaurice, 2015; Milanova and Maas, 2017). Codagnone et al. (2016) further find that altruistic and ideological motivations seem to characterize the early not-for-profit initiatives whereas the present-day sharing economy motives are more diverse.

Socio-demographic differences are of lower importance. However, younger, higher-income and higher-educated groups living in urban areas are significantly less socially motivated but more likely to participate in the sharing economy, while women are more environmentally motivated (Balck and Cracau, 2015; Andreotti et al., 2017).

2.2 Motivation for participation in community energy projects

P2P electricity trading is often broken down on a local or regional level, as in the study of Reuter and Loock (2017), so that research on the motivation to engage in local community energy projects via investments or volunteering in local cooperatives should give usable insight to our research. It is found that general interest in and attitude toward community energy supports willingness to participate and that mainly monetary (decreasing energy costs, lucrative investment) or normative (e.g. environmental concern) considerations played a role in the participation/investment decision, with the one dominating the other depending on governance structure, goals, and energy source (Bauwens, 2016; Holstenkamp and Kahla, 2016). However, social norms, hedonic motivations, community identity (regionality), and trust determine the motivation to participate in community energy, as are the ownership of renewable generation and living in a rural community. Social and political rather than merely environmental

[3] See e.g. Codagnone et al. (2016) and Acquier et al. (2017) for the different definitions of the sharing economy.

motivations are found to be important, e.g. the wish to become independent from corporations and to achieve autarchy, as well as a green image (Seyfang et al., 2013; Dóci and Vasileiadou, 2015; Holstenkamp and Kahla, 2016; Kalkbrenner and Roosen, 2016; Kaphengst and Velten, 2014; Gamel et al., 2016; Hicks and Ison, 2018; Volz, 2012; Boon and Dieperink, 2014).

2.3 Motivation for adoption of microgeneration technologies

The main motivations for purchasing and running microgeneration technologies or battery systems found in the literature generally are economic and/or environmental reasons (e.g. Balcombe et al., 2013, 2014; Kairies et al., 2016; Kowalska-Pyzalska, 2018; Willis et al., 2011; Zhai and Williams, 2012; Ford et al., 2016; Bergek and Mignon, 2017). Simpson and Clifton (2017) and Sommerfeld et al. (2017) discover a change in motivation over time: While early adopters prioritized technical and environmental aspects, current adopters are driven by financial or social reasons. This is in line with Schelly (2014) who suggests that environmental values are neither sufficient nor mandatory to motivate PV adoption.
Further motivations to installing microgeneration are: technological awareness/interest/willingness to use or promote innovative technology, fitting personal values and lifestyle (post-materialist, status oriented), security of supply, enhanced control, self-sufficiency/independence from utility companies, social norms and peers' behavior[4], image and signaling (desire to demonstrate environmental commitment), reputation of/trust in electricity/technology companies (information, reliability, convenience, support), impact on residence (Kairies et al., 2016; Balcombe et al., 2013, 2014; Ruotsalainen et al., 2017; Shelly, 2014; Claudy et al., 2011; Wolske et al., 2017, Karakaya et al., 2015; Oberst and Madlener, 2015; Ford et al., 2016; Korcaj et al., 2015; Islam, 2014; Bernsen et al., 2014; Strupeit and Palm, 2016; Bergek and Mignon, 2017; Kastner and Matthies, 2016, Nygrén et al., 2015; Kowalska-Pyzalska, 2018; Michaels and Parag, 2016; Vasseur and Kemp, 2015; Kahma and Matschoss, 2017, Nygrén et al., 2015)

As to socio-demographic characteristics, younger individuals are typically more aware of microgeneration, less sensitive to cost related factors and intend to generate their own power. However, they install such units less frequently (Balcombe et al., 2013; Leenheer et al., 2011; Islam, 2014). Further, PV adopters are found to have a higher income, are more educated (Sigrin et al., 2015; Sardianou and Genoudi, 2013; Soskin and Squires, 2013), and retired (Shelly, 2014), either middle-aged (Sardianou and Genoudi, 2013), or younger (Sigrin et al., 2015; Willis et al., 2011), live in rural areas (Claudy et al., 2011) and larger homes, and expect to stay in their homes for longer than their non-adopting peers (Sigrin et al., 2015).[5]

[4] Palm (2017) find that peer effects are important for the adoption decision, in a sense that they confirm the reliability of the technology, with active peer effects (through direct interpersonal contact, especially existing and rather close social relationships) being more important than passive effects (observation).
[5] Kahma and Matschoss (2017) focus in their research on the exact opposite, i.e. the different reasons for non-use and summarize that disinterest is found with male and older respondents with high education and income, living in rural areas and detached houses, while lagging adoption is found with the youngest, highly educated respondents living in urban areas and in multi-person households. Mistrust towards companies is found with younger, male, highly educated respondents living in larger urban accommodations.

2.4 Motivation for choice of green electricity and time-of-use tariffs

Research reports a positive willingness to pay (WTP) for green electricity[6], and that preferences for electricity generation differ by source, i.e. individuals prefer solar over generic green and wind (Borchers et al., 2007; Sundt and Rehdanz, 2015; Ma et al., 2015, Ma and Burton, 2016; Soon and Ahmad, 2015; Kaenzig et al., 2013; Gerpott and Mahmoudova, 2010b; Yang et al., 2015; Vecchiato and Tempesta, 2015). Willingness to switch to and WTP for green electricity is significantly influenced by economic considerations (electricity consumption and cost; importance of price in supplier selection), environmental attitude, general attitude towards green electricity, social norm and peer effects, knowledge about renewables, expression of lifestyle (responsibility, 'warm glow'), being a role model, perceived own effectiveness, support for decentralized generation/specific energy sources/regional companies, dissatisfaction with/attitude towards current (conventional) supplier, experience with change of supplier (Oerlemans et al., 2016; Ma et al., 2015; Ma and Burton, 2016; Sundt and Rehdanz, 2015; Sagebiel et al., 2014; Gerpott and Mahmudova, 2010a; Litvine and Wüstenhagen, 2011; Yang et al., 2015; Tabi et al., 2014; Hartmann and Apaolaza-Ibáñez, 2012). Sagebiel et al. (2014) and Rommel et al. (2016) find a substantial WTP for transparent pricing, participation in decision making, and local suppliers, especially cooperatives or municipally-owned electricity utilities, compared to investor-owned firms.

Household income, age, household size, home ownership, and education positively influence choice of green electricity tariffs (e.g. positive influence found in Diaz-Rainey and Ashton, 2011; Tabi et al., 2014; Rommel and Mayerhoff, 2009; Yang et al., 2015).

2.5 Motivation for adoption of smart energy products

P2P electricity trading only works based on digitalized processes encompassing smart meters and smart devices in the household, enabling feedback on own electricity consumption and production and demand response options. Openness towards and adoption intention of these technologies is thus a prerequisite for participating in P2P electricity trading.

The main motivators are found to be: usefulness of the technology (e.g. improved control, improved metering/billing), economic reasons (reduced energy consumption, cost-effective tariffs), hedonic satisfaction, environmental gains, personal innovativeness/technical interest, peer effects, comfort/ease-of-use, technological reliability. The biggest barriers encompass additional costs, lack of data security/privacy, loss of control/autonomy, mistrust of energy suppliers, incompatibility with habits (Gölz and Hahnel, 2016; Forsa, 2010; PWC, 2015; Buchanan et al., 2016; van der Werff and Steg, 2016; BMWi, 2014; Gangale et al., 2013; Girod et al., 2017).

[6] In contrast, Reichmuth et al. (2014) conclude that while surveys show an increased WTP for green electricity of private households, the majority of suppliers does not expect their customers to be really willing to pay more. They conclude that a possible explanation could be the maturity of the green electricity market and the approaching of consumer segments without idealism-driven extra WTP.

2.6 Summary

Summarizing the findings of the five different streams of research and the study of Reuter and Loock (2017), we find evidence that a specific kind of consumer is open towards new, green, digitally-enhanced and community-owned energy solutions, sold or shared via decentralized market places. I.e. they have some general motivations, preferences, and expectations to purchase or participate in common, which are very comparable to those of innovators and early adopters found by Rogers (1995), the drivers of homeowners' renovation/energy efficiency decisions summarized in Wilson et al. (2015), and the reasons for general environmental behavior (e.g. Groening et al., 2018), which can be summarized as follows (see also Löbbe and Hackbarth, 2017) [7]:

- Economy: Energy cost savings or increases in payments for energy production, secure investment, acceptable payback period, and return on investment (i.e., for assets, such as PV and cogeneration), value increase of house.
- Autonomy: Self-sufficiency, independence from incumbents, possibility to (actively) participate in the energy transition.
- Community: Desire to share and to integrate into a community (democracy and codetermination).
- Ecology: Energy savings, emission mitigation, environment and resource protection (renewable energy), and possibility to promote certain energy sources.
- Regionality: Regional or local production and ownership structure of supplier (energy community, municipal utility, and power company), support of neighborhood/local community.
- Comfort and safety: Accessible, trouble-free, and time-saving service or personal assistance (all-inclusive or care-free package), reliability and trustworthiness of the supplier (transparency), data security and privacy, security of energy supply/reduced dependence on foreign energy.
- Technology: Individualized offers (mass customization), general technical interest and innovativeness (do-it-yourself), reliability and simplicity of technology (plug-and-play).
- Specific interest in, knowledge of or familiarity with the product.
- Intrinsic and extrinsic values: Ideology (anti-capitalism, moral, social responsibility, generosity), expression of modern lifestyle (self-identity, image/signaling, peer effects), 'warm glow', hedonic motivations.

Regarding socio-demographic and household characteristics, results show that the most important target group are younger, male homeowners with high income and educational level, having an above-average technical interest and good knowledge or experience with energy technologies, living in larger households in suburban and rural areas, and, to some extent, have a higher WTP for innovative or renewable products.

[7] However, Bergek and Mignon (2017), Kastner and Matthies (2016), and Nygrén et al. (2015) point out that adopters are a heterogeneous group with regard to number and combination of motives and the relevance they attach to them.

3 Data and methodology

Our analysis is based on data from a survey carried out in April and May 2017, among 100,756 customers of seven municipal utilities mainly located in Southwest Germany. 7,006 participants completed the survey that aimed at gathering information on consumer preferences regarding four energy-related products: bundle products, smart home, domestic microgeneration, and P2P electricity trading. In this study only the data concerning P2P electricity trading is analyzed. Therefore, respondents from one participating utility that decided to not interview their customers on the P2P electricity trading, were discarded. Deletion of incomplete datasets led to 4148 completed surveys available for our analysis. The purchase intention of the remaining three products is evaluated in Hackbarth et al. (2018).

Table 1: Household characteristics of the sample vs. the German population

Variable	Value	Sample (%)	Population (%)
Gender	Female	29.5	50.7
	Male	70.5	49.3
Age	Less than 18	-	13.2
	18 to 39	19.3	26.6
	40 to 59	44.6	29.8
	60 or above	36.1	27.4
Education	No form of school leaving qualification	0.3	4.0
	Still in school education	-	3.6
	Secondary general school leaving qualification	12.7	30.4
	Intermediate school leaving qualification	26.9	29.7
	Higher education entrance qualification	17.2	14.2
	University (of applied sciences) degree	42.9	17.7
Household income per month	Less than €2,000	15.7	43.2
	€2,000 to €3,999*	33.6	43.0
	€4,000* to €5,999	17.4	8.2
	€6,000 or more	5.6	5.7
	Not stated	27.7	-
Number of persons in household	1	18.4	41.8
	2	43.2	33.5
	3	17.8	12.0
	4	14.4	9.3
	5 or more	6.2	3.4
Residential location	City	51.0	29.0
	Urban district	28.5	39.0
	Rural district with urban agglomeration	18.6	17.3
	Sparsely populated rural district	1.9	14.7
Accommodation type	Rented house (single-family/two-family)	3.4	10.5
	Rented apartment	26.9	46.5
	House (single-family/two-family) ownership	57.5	33.6
	Apartment ownership	12.2	9.4
Electricity tariff	Green electricity	46.6	22.0
	Other	43.1	78.0
	Not stated	10.3	-

Note: * = €4500 in the population statistics.
Sources: Own calculations; German population shares computed on the basis of BBSR (2017), Destatis (2018), Bundesnetzagentur/Bundeskartellamt (2017).

We compare our data with the German population statistics (Table 1), as specific statistics for the population of household customers in the energy sector are not available. In our sample, respondents being male, highly educated, older, home owners, living in multi-person households in urban areas, and currently having a green electricity tariff are overrepresented,

while the low income group is slightly underrepresented.[8] These findings should be kept in mind when discussing the results.

The questionnaire was distributed in a paper-pencil version (total: 39,270; response: 4168), an online version (61,486; 3041) or both, depending on preferences and decisions of the energy utilities. The supplier-specific response rate ranged from 1.3% to 21.2% with an average of about 7% depending on the means of delivery (stand-alone vs. part of a newsletter).

The questionnaire consisted of five major parts. The first section consisted of an introduction, questions concerning impact of and support for the German energy transition, and the main sources of information on energy-related topics. The second section of the questionnaire consisted of 14 items aiming to gather information on participants' environmental attitude and behavior, technical interest, interest in specific energy-related products (electric vehicles, electricity tariffs), price consciousness, importance of independence from electric utilities, and regularity in supplier or tariff change. The third and main section of the questionnaire consisted of four subsections, i.e. the four considered energy products, each comprising an assessment of respondents' prior knowledge of the product, the importance of specific product attributes, their purchase intention in the upcoming two years, and the most preferred supplier of the specific product. Additionally, the subsection focusing on P2P electricity trading contained nine items aimed at assessing the attitude towards P2P electricity trading. The fourth section of the questionnaire asked for participants' current energy and telecommunication contracts, the perception of their current energy provider, the preferred communication channels with the utility and the willingness to participate in product development. In the final section, socio-demographic and household characteristics were assessed.

Several explanatory constructs were utilized in our survey. The items and scales for their measurement were either adopted from the literature (e.g. Kuckartz, 2000; Taylor and Todd, 1995[9]) with necessary adaptation as to content where needed and shortened to conform space restrictions, or were self-developed by the authors (see Tables 2 and 4 for more details on wording, measurement, and statistics of items, scales, and other variables).

[8] However, the group without stated household income is quite high as well which hampers final conclusions, as it can be assumed that these participants are more likely to either belong to the low or high income group (Turrell, 2000; Kim et al., 2007).

[9] All items were inspired by the decomposed Theory of Planned Behavior (TPB) of Taylor and Todd (1995), which explains behavioral intention via perceived usefulness, perceived ease-of-use, attitude, subjective norm, and perceived behavioral control. However, instead of loading on three (TPB; Ajzen, 1991) or five (decomposed TPB) different factors the eight items were influenced by just two underlying factors: a general openness towards participating in P2P electricity trading (comprising items intended to measure attitude towards the product, subjective norm, and perceived ease-of-use) and a second factor including a perceived behavioral control item and a subjective norm item.

Table 2: PCA results

No.	Component	Cronbach's Alpha	Statement	Mean	Std.dev.	Loading
1	Openness towards P2P electricity trading	0.840	My family and friends would approve if I buy a P2P electricity product.	3.03	0.973	0.818
			P2P electricity trading is innovative and modern.	3.76	0.898	0.803
			P2P electricity trading would go well with me and my lifestyle.	3.19	1.033	0.799
			P2P electricity trading is associated with more advantages than disadvantages compared to a normal electricity tariff.	3.14	0.850	0.788
			Participation in P2P electricity trading is easy.	2.96	0.825	0.662
2	Attitude towards environment, regional production and transparency	0.753	I am concerned about human behavior and its impact on the climate and the environment.	4.34	0.850	0.812
			People should live more environmentally friendly to counteract climate change.	4.39	0.803	0.794
			More detailed information about the origin and production of products is important to me.	3.91	0.956	0.667
			I always pay attention to ecological criteria when buying products and services.	3.71	0.889	0.605
			I prefer regional products and services.	4.11	0.870	0.525
3	Utility evaluation	0.887	My energy provider is customer-oriented.	3.95	0.831	0.837
			My energy provider is interested in the common good.	3.80	0.881	0.819
			My energy provider is innovative.	3.70	0.863	0.811
			My energy provider is environmentally friendly.	3.93	0.793	0.802
			My energy provider acts proactively.	3.68	0.866	0.772
			My energy provider is inexpensive.	3.41	0.886	0.733
			My energy provider is reliable.	4.38	0.689	0.647
			My energy provider is regionally connected.	4.21	0.776	0.503
4	Technical interest	0.597	I always have the latest technical products.	2.77	0.911	0.821
			I am interested in technical novelties.	3.89	1.006	0.754
5	Price and independence consciousness	0.515	I regularly change my electricity, gas or telecommunications tariff or provider.	1.78	1.001	0.746
			I want the cheapest price and would dispense with customer service in the vicinity.	2.69	1.163	0.716
			I would like to be more independent of my energy provider.	3.21	1.027	0.575
6	Knowledge and decision of P2P electricity trading	0.094	It is my sole decision whether to participate in P2P electricity trading.	4,02	1.051	0.827
			I know people who already participate in P2P electricity trading.	3.52*	0.863	0.518
7	Attitude change	-	I have changed my attitude towards energy in recent years.	3.56	1.135	0.824

Notes: Extraction method: Principal component analysis; Rotation method: Promax with Kaiser normalization; Factor loadings lower than 0.4 are suppressed; Loading = Degree of association between the statement and the factor; * = reverse-coded item.

Table 3: Correlation matrix for extracted components

	Utility evaluation	Openness towards P2P electricity trading	Attitude towards environment, regional production and transparency	Price and independence consciousness	Technical interest	Attitude change	Knowledge and decision of P2P electricity trading
Utility evaluation	1.000						
Openness towards P2P electricity trading	0.207	1.000					
Attitude towards environment, regional production and transparency	0.302	0.270	1.000				
Price and independence consciousness	-0.227	0.067	-0.089	1.000			
Technical interest	0.142	0.172	0.186	0.008	1.000		
Attitude change	-0.037	0.174	-0.134	0.140	-0.055	1.000	
Knowledge and decision of P2P electricity trading	0.057	-0.057	0.146	-0.042	-0.077	-0.113	1.000

Notes: Extraction method: Principal component analysis; Rotation method: Promax with Kaiser normalization

All items were measured based on 5-point Likert scales. Principal Component Analysis was used as method for data reduction (Table 2)[11] and revealed seven factors with eigenvalues > 1, which account for 60.25% of the overall variance. All items indicated factor loadings > 0.5 and generally loaded strongly on single factors. To test for reliability and validity of all extracted factors, a Principle Factor Analysis was conducted subsequently. The results revealed that all scales are uni-dimensional but not all are reliable (internally consistent) with the present data, as Cronbach's Alpha values ranged between 0.094 and 0.887. For instance, the extracted technical interest factor (0.597), the price and independence consciousness factor (0.515) and the knowledge and decision on P2P electricity trading factor (0.094) had Cronbach's Alpha values below the critical threshold of 0.60-0.70 (Peterson., 1994) so that the single items entered the regression models. Finally, for each reliable factor, the corresponding item scores were averaged into sum scales.

The variables used in the final models are shown in Table 4. Examining the attitudes first, the attitude towards environment, regional production and transparency obtains the highest mean score of 4.10 (ranging from 3.71-4.39 for the single items of the average sum scale), followed by the item measuring the decision control concerning the participation in P2P electricity trading (4.02), utility evaluation (3.89), attitude change (3.57), general openness towards P2P electricity trading (3.21, ranging from 2.96-3.76), the need for independence from the electric utility (3.20), price consciousness (2.68), regular provider change (1.78), and the item measuring the awareness of people who already participate in P2P electricity trading (1.47). Hence, except for the last three influencing factors the mean scores are more towards '(strongly) agree' opinions.

[11] The appropriateness of the data was assessed based on the Kaiser-Meyer-Olkin value (0.886) and Bartlett's Test of Sphericity (Chi-squared value of 34968.232 with 325 degrees of freedom; $p < 0.001$) and considered as satisfactory. Promax rotation was chosen since the attitude and behavioral constructs were expected to be correlated (Table 3).

Table 4: Variables used in the model

Variable	Definition	Mean	Std. dev.	Min	Max
Socio-demographic and household characteristics					
Middle age	1 if respondent is between 40 and 69 years old, 0 otherwise	0.62	0.485	0	1
Lower income	1 if respondent has a net household income of up to €4000, 0 otherwise	0.51	0.500	0	1
Higher education	1 if respondent has a higher education entrance qualification or university degree, 0 otherwise	0.55	0.498	0	1
Rented accommodation	1 if respondent lives in a rented accommodation (house or apartment), 0 otherwise	0.28	0.451	0	1
Residential location	4-point scale of household's residential location, ranging from '1 = central city' to '4 = rural area'	1.68	0.836	1	4
Prosumer	1 if respondent is a prosumer, 0 otherwise	0.14	0.346	0	1
Attitudes, knowledge and behavior					
Openness towards P2P electricity trading	Respondent's openness towards P2P electricity trading (average of the five 5-point Likert scale[1] item scores)	3.21	0.703	1	5
Attitude towards environment, regional production and transparency	Respondent's attitude towards the environment, regional production and transparency of products (average of the five 5-point Likert scale[1] item scores)	4.10	0.616	1	5
Utility evaluation	Respondent's evaluation of their (local) energy provider (average of the eight 5-point Likert scale[2] item scores)	3.89	0.610	1	5
Knowledge about P2P electricity trading	1 if respondent already knew about P2P electricity trading before participation in study, 0 otherwise	0.15	0.360	0	1
Decision control	Respondent's degree of accordance to the statement: 'It is my sole decision whether to participate in P2P electricity trading.' (5-point Likert scale[1])	4.02	1.048	1	5
P2P participants among acquaintances	Respondent's degree of accordance to the statement: 'I know people who already participate in P2P electricity trading.' (5-point Likert scale[1])	1.47	0.847	1	5
Attitude change	Respondent's degree of accordance to the statement: 'I have changed my attitude towards energy in recent years.' (5-point Likert scale[1])	3.57	1.124	1	5
Price consciousness	Respondent's degree of accordance to the statement: 'I want the cheapest price and would dispense with customer service in the vicinity.' (5-point Likert scale[1])	2.68	1.157	1	5
Regular provider change	Respondent's degree of accordance to the statement: 'I regularly change my electricity, gas or telecommunications tariff or provider.' (5-point Likert scale[1])	1.78	1.000	1	5
Independence from energy provider	Respondent's degree of accordance to the statement: 'I would like to be more independent of my energy provider.' (5-point Likert scale[1])	3.20	1.019	1	5
Importance of product attributes					
Shared generation and consumption	Importance of shared electricity generation and consumption in purchase decision (5-point Likert scale[3])	3.92	0.974	1	5
Transparency of electricity generation	Importance of transparency of electricity generation in purchase decision (5-point Likert scale[3])	3.88	1.023	1	5
Personal service	Importance of personal service in purchase decision (5-point Likert scale[3])	4.09	0.822	1	5
Energy costs	Importance of (reduction of) energy costs in purchase decision (5-point Likert scale[3])	4.35	0.769	1	5
Independence from energy provider	Importance of independence from energy provider in purchase decision (5-point Likert scale[3])	3.79	0.973	1	5
Easy implementation	Importance of ease of implementation in purchase decision (5-point Likert scale[3])	4.39	0.681	1	5
Telecom company	Likelihood of purchasing P2P electricity trading product from a telecom company (5-point Likert scale[4])	2.03	0.979	1	5
Purchase intention					
P2P electricity trading	Purchase probability of P2P electricity trading in the upcoming 2 years (5-point Likert scale[4])	2.15	1.035	1	5
Microgeneration	Purchase probability of microgeneration technology in the upcoming 2 years (5-point Likert scale[4])	2.33	1.167	1	5
Bundle tariff	Purchase probability of a bundle tariff in the upcoming 2 years (5-point Likert scale[4])	2.77	1.215	1	5
Time-of-use tariff	Respondent's degree of accordance to the statement: 'I want to have a time-dependent electricity tariff. Then I could at least partially transfer my consumption to the cheapest time (e.g. washing at night) and, thus, save money.' (5-point Likert scale[1])	3.02	1.282	1	5
Information and Communication					
Information: Family and friends	1 if information source on energy topics is family and friends, 0 otherwise	0.38	0.484	0	1
Communication: Social media	Importance of apps, social media and short messages as means of communication with energy provider (average of the three 5-point Likert scale[3] item scores)	2.16	1.163	0	1

Notes: 1 = The 5-point Likert scale ranges from '1 = strongly disagree' to '5 = strongly agree'; 2 = The 5-point Likert scale ranges from '1 = applies not at all' to '5 = applies fully'; 3 = The 5-point Likert scale ranges from '1 = not at all important' to '5 = very important'; 4 = The 5-point Likert scale ranges from '1 = very unlikely' to '5 = very likely'.

The attributes of a P2P electricity trading product are all valued to be important in purchase decisions, as all product characteristics entering the final model show average values above 3 (scale center value): Easy implementation (4.39), energy costs (4.35), personal service (4.09), shared generation and consumption (3.92), transparency of electricity generation (3.88), and independence from energy provider (3.79). Some product attributes were even more important from an absolute viewpoint, but evaluated equally important by interested and uninterested consumer groups, so that they did not enter the final regression model, such as climate protection (mean 4.29; standard deviation 0.845), data security (4.45; 0.821), ease-of-use (4.39;

0.693), and purchase price (4.06; 0.833). The same holds true for the companies consumers would most likely purchase the product from: energy provider (4.20; 0.815), specialized technology companies (3.45; 1.098), telecommunication companies (2.13). The latter are the only potential provider with significant differences in consumer evaluation.

The purchase intention for P2P electricity trading products has a mean of 2.15 and, thus, is more on the negative side, indicating most consumers' reluctance towards this product (1.5% of the respondents stated that they very likely, and 9.4% that they likely participate in P2P electricity trading in the upcoming two years). The purchase intention of microgeneration technologies (2.33), bundle tariffs (2.77), and time-of-use tariffs (3.02) is slightly higher, but still on the rejection/indifference side of the scales (for more details see also Hackbarth et al., 2018).

Concerning respondents' preferences for communication channels with the energy provider, social media and apps are not valued highly on average (2.16), in contrast to customer centers (3.89), web portals (3.59), or online contact forms (2.86). 38% of the respondents gather energy-related information from family and friends. Only internet in general (0.59) and information of the energy supplier (0.51) are relied more upon, while daily newspapers (0.37), internet comparison portals (0.30), and TV/radio (0.27) seem to be comparably used to gain information.

Estimations were carried out in two steps: First, multiple regression analysis was performed to detect variables with significant influence on the respective dependent variable. The retained explanatory factors were then entered in a hierarchical multiple regression model to test the incremental power of each predictor. This was done twice, first, to estimate the individual influence of the variables significantly explaining purchase intention of P2P electricity trading products; second, to detect the variables that have the greatest impact on the main influencing factor of purchase intention: openness towards P2P electricity trading.

4 Results

The results of the hierarchical multiple regression of purchase intention of P2P electricity trading products are described in section 4.1, while the results of the hierarchical multiple regression of openness towards P2P electricity trading are shown in section 4.2.

4.1 Results: Purchase intention of P2P electricity trading products

The results of the hierarchical multiple regression analysis for explaining the drivers of purchase intention of P2P electricity trading products are presented in Tables 5 and 6. All variables did not violate the assumptions of multicollinearity and homoscedasticity (Hair et al., 2010). The last column of Table 6 indicates at which step the variables were added to the four estimations (Table 5).

Socio-demographic control variables are not significant predictors of purchase intention of P2P electricity trading, except for age, which entered the first block of the hierarchical multiple regression model and explains 1.2% of variation in purchase intention for P2P electricity trading (see R^2 in Table 5). The perceived importance of product attributes and the evaluation of the telecom company as potential supplier entered the model in the second block and increased R^2

by 10.5%. In the third step, the purchase intention of microgeneration and bundle tariffs in the upcoming two years, and preference for time-of-use tariffs were added to the model, increasing R^2 by additional 21%. In the fourth and final block, scales assessing knowledge of and openness towards P2P electricity trading were entered, increasing R^2 by 11.8%. Overall, the final model explains 44.5% of the variation in consumers' intention to purchase P2P electricity trading products with all four single regression models (blocks) and the according changes in R^2 being significant at the 0.1% level.

Table 5: Hierarchical regression analysis of the four predicting blocks of purchase intention of P2P electricity trading

	R^2	ΔR^2	F change	P
Model 1	0.012	0.012	51.168	0.000
Model 2	0.117	0.105	70.135	0.000
Model 3	0.327	0.210	429.307	0.000
Model 4	0.445	0.118	440.926	0.000

Table 6: Hierarchical multiple regression results: Purchase intention of P2P electricity trading

	Unstandardized coefficients		Standardized coefficients			Collinearity statistics		
	B	Std. err.	β	T	P	Tolerance	VIF	Added in model
Constant	-0.667	0.100		-6.669	0.000			1
Middle age	0.093	0.025	0.043	3.710	0.000	0.978	1.023	1
Shared generation and consumption	0.055	0.016	0.052	3.468	0.001	0.598	1.672	2
Transparency of electricity generation	0.029	0.014	0.028	2.072	0.038	0.716	1.398	2
Personal service	-0.069	0.018	-0.055	-3.913	0.000	0.674	1.483	2
Energy costs	-0.091	0.019	-0.067	-4.855	0.000	0.698	1.433	2
Independence from energy provider	-0.056	0.014	-0.052	-3.848	0.000	0.725	1.380	2
Easy implementation	0.060	0.022	0.039	2.704	0.007	0.634	1.578	2
Telecom company	0.053	0.012	0.050	4.262	0.000	0.961	1.040	2
Time-of-use tariff	0.036	0.010	0.044	3.691	0.000	0.925	1.081	3
Bundle tariff	0.090	0.010	0.106	8.690	0.000	0.898	1.114	3
Microgeneration	0.289	0.011	0.327	26.176	0.000	0.863	1.159	3
Knowledge about P2P electricity trading	0.188	0.034	0.065	5.522	0.000	0.971	1.030	4
Openness towards P2P electricity trading	0.589	0.021	0.400	28.632	0.000	0.687	1.455	4
Estimation statistics								
F			254.983*					
dfs			13, 4134					
R^2			0.445					
Adjusted R^2			0.443					
N			4148					

Notes: * = significant at the $p < 0.001$ level; VIF = Variance inflation factor.

The standardized coefficients β in Table 6 show the impact of the 13 individual predictors on the purchase intention of P2P electricity trading and can be compared by arranging them in the following descending order (β values in parentheses): openness towards P2P electricity trading (0.400), purchase intention of microgeneration (0.327), purchase intention of a bundle tariff (0.106), importance of energy costs (-0.067), knowledge about P2P electricity trading (0.065), importance of personal service (-0.055), importance of shared generation and consumption (0.052), importance of independence from energy supplier (-0.052), telecom company (0.050), time-of-use tariff (0.044), middle age (0.043), importance of easy implementation (0.039), importance of transparency of electricity generation (0.028). As can be seen, openness towards

P2P electricity trading has the greatest influence on purchase intention, followed by the purchase intention of related products. Product attributes and age have the smallest impact on purchase intention.

In a next step, the results for the unstandardized coefficients are explored, as they display the change in purchase intention for P2P electricity trading, when the different individual independent variables are changed by one unit, keeping all other variables unchanged (elasticity). The B values in Table 6 confirm the relatively marginal influence of socio-demographic variables and product attributes on the behavioral intention. Being between 40-69 years old increases the intention to participate in P2P electricity trading only by 0.093 points (on the 5-point Likert scale of purchase likelihood). The impact of the single significant product attributes is comparable, i.e. increasing the perceived importance of the product features by 1 point, changes the intention to participate in P2P electricity trading by the following point values (in parentheses): Shared generation and consumption (0.055 points), transparency of electricity generation (0.029 points), personal service (-0.069 points), energy costs (-0.091 points), independence from energy provider (-0.056 points), easy implementation (0.060 points), and telecom company (0.053 points). An increase in the stated purchase intention for the two new tariff schemes by 1 point shows a similarly small influence on purchase intention: Time-of-use tariff (0.036 points) and bundle tariff (0.090 points). Increasing the purchase intention for microgeneration technologies by 1 point, on the other hand, has a much greater impact on the intention to participate in P2P electricity trading, as it results in an increase of 0.289 points. Prior knowledge about P2P electricity trading also displays a considerable influence on purchase intention (0.188 points), while the by far greatest impact is caused by respondents' general openness towards P2P electricity trading: A 1-point increase in respondents' openness towards P2P electricity trading increases their purchase intention for P2P electricity trading by 0.589 points. That is, having sympathy for the idea of and being open towards P2P electricity trading is a prerequisite and the main explanatory factor for the willingness to actively participate in this market activity.

4.2 Results: Openness towards P2P electricity trading products

As a reminder (Table 2), openness towards P2P electricity trading is a scale composed of items intended to assess respondents' attitude towards the product, subjective norm, and perceived ease-of-use, which, however, can all be explained by just one underlying factor.

Tables 7 and 8 present the results of the hierarchical multiple regression analysis for explaining the drivers of openness towards P2P electricity trading. Again, none of the variables violated the assumptions of multicollinearity and homoscedasticity.

Table 7: Hierarchical regression analysis of the four predicting blocks of openness towards P2P electricity trading

	R^2	ΔR^2	F change	P
Model 1	0.030	0.030	19.945	0.000
Model 2	0.078	0.048	68.522	0.000
Model 3	0.126	0.048	71.452	0.000
Model 4	0.217	0.092	91.618	0.000

Table 8: Hierarchical multiple regression results: Openness towards P2P electricity trading

	Unstandardized coefficients		Standardized coefficients			Collinearity statistics		
	B	**Std. err.**	**β**	**T**	**P**	**Tolerance**	**VIF**	**Added in model**
Constant	0.382	0.102		3.746	0.000			1
Middle age	0.079	0.021	0.054	3.719	0.000	0.942	1.062	1
Higher education	0.072	0.021	0.051	3.456	0.001	0.917	1.091	1
Lower Income	0.064	0.021	0.045	3.055	0.002	0.912	1.096	1
Prosumer	0.130	0.030	0.064	4.318	0.000	0.910	1.099	1
Rented accommodation	0.131	0.024	0.084	5.528	0.000	0.874	1.144	1
Residential location	-0.030	0.012	-0.036	-2.426	0.015	0.919	1.088	1
Information: Family and friends	0.061	0.021	0.042	2.921	0.004	0.986	1.014	2
Communication: Social media	0.041	0.009	0.068	4.711	0.000	0.968	1.033	2
Utility evaluation	0.134	0.018	0.116	7.325	0.000	0.799	1.252	2
Knowledge about P2P electricity	0.130	0.029	0.066	4.457	0.000	0.902	1.108	3
Decision control	0.039	0.010	0.058	4.089	0.000	0.988	1.012	3
P2P participants among acquaintances	0.141	0.012	0.169	11.326	0.000	0.893	1.120	3
Attitude towards environment, regional production and transparency	0.315	0.018	0.275	17.119	0.000	0.774	1.291	4
Attitude change	0.033	0.009	0.053	3.554	0.000	0.887	1.127	4
Price consciousness	0.029	0.009	0.047	3.051	0.002	0.831	1.204	4
Regular provider change	0.023	0.011	0.033	2.116	0.034	0.840	1.191	4
Independence from energy provider	0.056	0.011	0.080	5.228	0.000	0.845	1.184	4
Estimation statistics								
F			63.933*					
dfs			17, 3915					
R^2			0.217					
Adjusted R^2			0.214					
N			3933					

Notes: * = significant at the p < 0.001 level; VIF = Variance inflation factor.

Demographic variables together with household characteristics were included as control variables. Except for age, education, income, residential location, home ownership, and ownership of a microgeneration technology, these variables are not found to be significant predictors of a positive attitude towards P2P electricity trading. Entering these six remaining variables into the regression equation in the first step led to a R^2 value of 0.03 (Table 7), indicating that 3% of openness towards P2P electricity trading is explained by these demographic and household variables. Three variables were entered in the second block of the estimation dealing with respondents' preferred information and communication channels and the evaluation of their current energy provider, which increased R^2 by 4.8%. In the third step, knowledge about P2P electricity trading, respondents' perceived decision control regarding the participation in P2P electricity trading, and the presence of P2P participants among acquaintances were entered in the model, which increased R^2 again by 4.8%. In the final block, the scales assessing respondents' attitude towards the environment, regional production and transparency, the strength of respondents' attitudinal change in the near past, their degree of price consciousness and regularity of provider change were added to the regression equation, which increased R^2 by 9.2%, so that the final model explains 21.7% of the variation in consumers' openness towards P2P electricity products. All four individual models and the changes in R^2 were significant at the 0.1% level.

The standardized coefficients β in Table 8 display the impact of the 17 individual predictors on the openness towards P2P electricity trading and can be arranged in the following descending order of influence (β values in parentheses): Attitude towards environment, regional production,

and transparency (0.275), P2P participants among acquaintances (0.169), utility evaluation (0.116), rented accommodation (0.084), independence from energy provider (0.080), social media as communication channel with the utility (0.068), knowledge about P2P electricity trading (0.066), prosumer (0.064), decision control (0.058), middle age (0.054), attitude change (0.053), higher education (0.051), price consciousness (0.047), lower income (0.045), family and friends as main energy-related information source (0.042), residential location (-0.036), and regular provider change (0.033). So, environmental attitude and peer effects have the greatest, and socio-demographic and household characteristics have the smallest influence on respondents' openness towards P2P electricity trading, respectively.

Again, the results for the unstandardized coefficients (B values in Table 8) are explored in a second step to display the elasticity of openness towards P2P electricity trading, when the different individual independent variables are varied. The relatively minor influence of socio-demographic and household characteristics is confirmed. Being between 40-69 years old, higher educated or having a lower income increases the openness towards P2P electricity trading only by 0.079, 0.072, and 0.064 points, respectively. The household characteristics show a slightly larger impact on the attitude towards the product: increasing the rusticity of the residential location decreases openness towards P2P electricity trading (-0.030 points), while already being a prosumer (0.130 points) or living in a rented accommodation (0.131 points) has a positive influence. Respondents' preferred information and communication channels again only show a small impact on their openness towards P2P electricity trading: if the main information source is family and friends (0.061 points) or if social media as communication channel with the electricity supplier is preferred (0.041 points), attitude towards P2P electricity trading is slightly increased. Increasing utility evaluation by one point increases respondents' attitude towards the new product by 0.134 points, while knowledge about P2P electricity trading increases openness towards it by 0.130 points. Having P2P participants among acquaintances shows a comparable impact (0.141 points), while having decision control concerning participation in P2P electricity trading does not influence the openness towards it that much (0.039 points). Having changed the attitude towards energy in recent years (0.033 points), being price conscious (0.029 points), a regular changer of providers or tariffs (0.023 points), or wanting to be more independent from energy providers (0.056 points) shows a similarly small impact. Contrarily, increasing the attitude towards environment, regional production and transparency by 1 point leads to an increase in respondents' openness towards P2P electricity trading by 0.315 points, revealing a great influence.

5 Discussion

Building on the results of the literature review (section 2) and our estimation results (section 4), we summarize our findings and discuss the implications of this analysis for marketing strategies regarding P2P electricity trading products.

5.1 Discussion of results

First and foremost, our results indicate that openness towards P2P electricity trading is by far the greatest influencing factor of purchase intention and explains a considerable amount of

variance. This finding is in line with the TPB (Ajzen, 1991) and literature from related energy fields, where attitudes are consistently found to be an important predictor and precursor of behavioral intention. Knowledge of and familiarity with the product also shows a great impact in predicting participation intention for P2P electricity trading, which is again in line with the results found by related studies. For instance, Islam and Meade (2013) show that technology awareness has a significant effect on the adoption probability of PV systems. Moreover, it is in line with general consumer research (e.g. Baker et al., 2002). Further, our finding that interest in a specific product (P2P electricity trading) goes hand in hand with interest in other related technological products (in our case: microgeneration, bundle tariffs, time-of-use tariffs) supports the results found in Rai et al. (2016) and Reuter and Loock (2017). This could be the manifestation of a more general underlying technological interest, which, however, was not significant in our estimations, but is moderately correlated to the three mentioned products.

Second, the perceived product attributes influence respondents' purchase intentions. Our results show that consumers intending to purchase a P2P electricity trading product value the possibility to share generation and consumption, obtain greater transparency about electricity generation, and easy implementation higher as well as energy costs lower than their uninterested counterparts. This finding supports the results from the literature (e.g. Simpson and Clifton, 2017; Sommerfeld et al., 2017) that innovators and early adopters are to a greater part driven by ideological commitment compared to monetary reasons. However, financial motivators (as well as data security, ease-of-use, and climate protection) remain key in all groups, as displayed by their high average importance ratings (see section 3), and often are a prerequisite for consumer acceptance. This result is in line with previous research (e.g. Goncalves da Silva et al., 2012). Our results extend the research of Reuter and Loock (2017) by clarifying that although the potential to exchange with neighbors is dominated by the importance of economic, comfort and data security aspects in the decision to participate in P2P electricity trading, it is a motivation that distinguishes the interested from uninterested consumer segments – a fact that should be embraced in marketing strategies. Finally, the importance of personal service and independence from energy providers reduces purchase intention, which seems to be contrary to the findings in related literature. However, the former effect could be explained by individuals' willingness to dispense with customer service for cheaper prices (which is a predictor of openness towards P2P electricity sharing), which in turn would be in line with prior research. The latter effect seems to be an expression of the pronounced satisfaction with the energy suppliers (expressed in the highly positive utility evaluation rates) found in our sample.

Third, the most likely provider consumers would purchase from is the (municipal) utility, followed by specialized technology companies. Differences between interested and uninterested customer segments are only found regarding the higher likelihood of telecom companies as focal point for purchase, although it remains the least chosen option. This finding supports the results of Rommel et al. (2016) and Reuter and Loock (2017), who detect that telecommunication companies are the least preferred providers, while cooperatives and municipalities being the most preferred ones.

Finally, considering socio-demographic and household characteristics our results mostly point into similar directions as the related literature: they are of limited importance in predicting purchase intention, compared with the intra-person variables described below. In our final models they only explain about 3% of the purchase intention of and openness towards P2P electricity trading. Our results show that it is not the younger consumer group that is more likely

to potentially adopt the new product, as suggested in most studies for other green or innovative energy technologies, but respondents from 40-69 years of age. This finding, however, is in line with the results of Sardianou and Genoudi (2013), and also partially supports the results of Reuter and Loock (2017), who find that individuals in their 20s and 50s are more likely to be interested in participating in local energy markets. A possible reason might be that participation in P2P electricity trading usually is aimed at (and sometimes even requires, depending on the product offered) current owners or potential buyers of microgeneration technologies (especially PV systems with battery storage), i.e. house owners, with house ownership rate being highest in the middle age group.

Openness towards P2P electricity trading not only has a great direct effect on the intention to purchase a P2P product, but it also acts as a moderator for several other influencing factors (see Tables 6 and 8). Especially age and product knowledge impact purchase intention not only directly, but also indirectly through their explanatory effect on the attitude towards P2P electricity trading. However, while all other socio-demographic and household characteristics showed no significant influence on the purchase intention of P2P electricity trading, openness towards this product can to a small extent be explained by further socio-demographic and household variables.

First, our finding that higher educated individuals and prosumers (higher energy-related involvement) are more open towards the new technological product supports prior research. Interestingly, and opposed to prior research, our results indicate that individuals living in rented accommodations are more open towards P2P electricity trading than home owners. This may be attributed to two reasons: (1) prior research mostly focused on microgeneration which is not directly accessible for tenants (e.g. Claudy et al., 2011), unlike the P2P electricity trading product, and (2) respondents living in urban areas where the home ownership rate is lower are overrepresented in our sample. Accordingly, our results show that respondents living in urban areas are more likely to have a positive attitude towards P2P electricity trading. While Reuter and Loock (2017) do not find significant effects of residential location on intention to participate in local energy markets, our result is in line with research on sharing economy participation, which shows that sharing mainly is an urban phenomenon (Andreotti et al., 2017). Our finding that lower income households are more open towards P2P electricity trading also is in line with findings from the sharing economy research (Balck and Cracau, 2015), but stands in opposition to most research in related energy fields, which find higher income levels to go hand in hand with greater openness towards technological innovations.

Second, our finding that price consciousness and regular provider change (which is mainly done for economic reasons) positively affect openness towards P2P electricity trading is in line with the vast majority of studies, which find economic motivations besides environmental reasons to be the major driver in consumer attitudes and behavioral intentions towards new energy technologies.

Third, unsurprisingly, attitude towards environmental, regional production and transparency is the single largest predictor of openness towards P2P electricity trading in our estimations, which is in line with related literature, where environmental attitudes are positively and significantly related to attitudes towards green technologies and local/regional support and transparency is found to predict participation in community energy or sharing economy. Furthermore, our result that environmental awareness (and other attitudes) is not significantly influencing purchase intention directly, but is mediated through openness towards P2P electricity trading, supports

the findings of Hamari et al. (2015) who indicate that sustainability is not directly associated with participation in the sharing economy unless it is at the same time also associated with positive attitudes towards sharing. Our result that the motivation to increase independence from an energy provider drives attitude towards P2P electricity trading supports many previous studies, as P2P electricity trading has the potential to enable independence/autarchy. Recent attitude changes concerning energy (energy consciousness) are positively related to openness towards P2P electricity trading, which is in line with the results of Reuter and Loock (2017).

Third, our results show that having decision control regarding the behavior/purchase and especially having P2P participants among acquaintances (peer effects) explains a more positive attitude towards P2P electricity trading. Further, relying on friends and family as main information sources for energy-related topics also positively affects openness towards P2P electricity trading. All these effects are in line with the literature on related energy topics (e.g. Palm, 2017). The positive relationship between consumers' preference for digital communication and openness towards P2P electricity trading indicates that consumers who are more interested in technology and potentially also younger are also more open-minded towards P2P electricity trading. This supports the findings of Reuter and Loock (2017) concerning interest in technological applications as explanatory factor for participation in local energy markets.

Finally, our results show that respondents who evaluate their current electricity provider more positively are open towards P2P electricity trading, which supports our finding that the most likely supplier of the product would be the utility. Interestingly, the desire to be more independent from energy providers on the one hand positively influences openness towards P2P trading, but on the other hand the importance of this independence as product attribute influences purchase intention negatively. The same holds true for price consciousness and energy costs. Possibly, this is due to the different concreteness of the variables' underlying origin, i.e. a general, undifferentiated evaluation of desire for independence or price consciousness compared to a specific evaluation of importance of these attributes in an adoption decision.

5.2 Implications for marketing strategies

A marketing strategy (product, price, distribution, communication) is based on the company objectives and strategy and covers the definition of targets (e.g. positioning, market share, growth rates) to be realized regarding specific consumer target groups to be addressed. Regarding the company strategy, we assume an incumbent publicly-owned utility targeting customer retention and acquisition primarily on a regional level. To achieve this, a market launch strategy for a P2P electricity trading product has to be developed. As our results concerning the utility evaluation indicate, this type of municipal utility is in a good position as the target consumer group sees them very positively and would also choose it as principal supplier for P2P electricity trading[12]. Additionally, for those customers who are seeking for more independence or are willing to purchase the product from a telecommunication company, different business models (degree of service; outsourcing P2P energy trading into joint ventures

[12] However, they are also more likely to purchase from a telecommunication company, compared to uninterested consumers.

etc.) could address barriers associated with adoption differently and, hence, unlock different segments of potential adopters. This is in line with the conclusions drawn by Rai et al. (2016).

Generally, 11% of the respondents declared they would probably purchase P2P electricity trading in the following two years. The most promising target groups are innovators or early adopters, in broad accordance with our findings and results in prior research on related topics (see section 2 and Rogers, 1995). Our results show that members of this segment are middle aged, higher educated, having lower income, live in (sub-)urban areas and are either home owners (prosumers, interest in the installation of microgeneration technologies in upcoming two years) or living in rented accommodations. They have a greater openness towards P2P electricity trading, recently changed their attitude towards energy, have a high environmental awareness and attitude towards regional production and transparency, and a higher preference for independence from energy suppliers, which, however, is not as decisive as product attribute. They are mainly motivated by the ability to share generation and consumption and the additional transparency in the energy market and to a lesser extent by economic reasons.

Additionally, younger, urban and environmentally aware consumer segments with preferences for digital communication channels should be targeted as promising participants in P2P electricity trading since the product is very compatible to their innovative lifestyle and would perfectly fit image/signaling purposes, further providing them with a ‘warm glow’.

This target group must be differentiated into consumers buying electricity in the community and prosumers sharing their production, consuming residual energy from the community, and gaining access to commercialization of their surplus production. Especially the former group of pure consumers should be in the center of attention as the existing P2P electricity trading products in the market suffer from sufficient demand, i.e. participating electricity consumers without own generation. Especially tenants could be attracted with the promise that P2P electricity trading offers them a chance to actively take part in the German energy transition. However, to be successful, the P2P electricity trading products must offer specific benefits for prosumers and consumers alike, with the overall and melding gain being the sharing. In general, the benefits for both sides should be conceived as comprehensibly as possible - i.e., despite the high involvement of early adopters, the inherent complexity of the product should not be transferred to the consumer. As our results indicate, this incorporates features such as ease-of-use, transparency, but also data security. Per definition, the product is environmentally friendly, thus covering the high importance households lay on this product characteristic. Further important product features from related markets should be adopted (see section 2).

Moreover, our findings indicate that P2P electricity trading could be sold as part of a product bundle, as interested consumers are found to be also more interested in other related new technological options (microgeneration, bundle tariffs, and time-of-use tariffs). Some battery (e.g. Sonnen) and microgeneration providers do so already, for instance by selling their batteries with discount if buyers also participate in their energy community. Thus, bundles with other products are promising, e.g. an offer in combination with electric mobility (correlation coefficient $r = 0.234$), potentially supported by a fitting tariff structure. This is also in line with the findings of Rai et al. (2016), who describe that 82% of solar adopters co-adopt an energy-related product (energy efficiency, electric vehicle, etc.).

Pricing of a P2P electricity trading product needs to build several bridges. On the one hand, upfront cost of constructing the trading platform are high, on the other hand our results show

that the target group is price conscious. Finding an optimal and competitive solution which satisfies both sides is challenging, especially as from a consumer's point of view, the price structure needs to be comprehensible to be chosen, although from the supplier's point of view the complexity of price components and cost structure is high. I.e. the simpler the price structure (e.g. via flat rates), the lower the reservation of consumers, but the higher the risk for the provider.

Considerations regarding distribution and communication should focus on the presumed involvement of the target group. In general, P2P electricity trading is comparably unknown – in our sample, only 15% of all respondents had already heard of this product before. However, innovators and early adopters generally are more involved – i.e. show greater technical interest or openness towards technical change, familiarity with the product, have the ability to adopt the product, and have regularly switched their provider or tariff in the past. Therefore, in their communication strategy providers should give (understandable) information to attract this group. To address further consumers to prepare the market development on a broader scale, the product has to be explained very comprehensibly. Depending on market share targets, education campaigns might be envisioned, in line with the political goals. This information-based communication should be framed emotionally. To do so, peer effects are found to be very influential, as they greatly increase openness towards and purchase intention for P2P electricity trading. It is therefore important to develop peer-group distribution and communication channels – directly or via social media – and use innovators as change agents (Matschoss et al., 2015). This is also in line with the results of Rai et al. (2016) who find that peers (installers, neighbors with PV systems) are directly responsible for about 13% of the adoption decision. Further, our results show that 51% of the respondents gather energy-related information from their energy supplier, 20% from installers, and 11% from energy advisers, which makes them extremely important actors in the information gathering, decision making and adoption process. This is again in line with the results of Rai et al. (2016) who emphasize that direct marketing has a chilling effect on adopters' tendency to reach out to information from neighbors and acquaintances. Further, this finding is valuable for energy suppliers, as the positive evaluation and confidence found in our sample can be used to support their information based communication (safety, reliability, known partner).

Regarding positioning of the product, we remind that purchase intention can be based on economic (price consciousness) and ideological reasons and further added values (transparency, sharing possibility, environmental concern, support of local production). Thus, theoretically, communication could be based on either motives and address them accordingly and differently. However, this would foil a clear positioning and branding. Moreover, the cost structure regularly prohibits low-price strategies in the field. Consequently, the added values should be addressed, based on an impression of fair pricing. This is supported by the finding of Bomberg and MacEwen (2012) that the use of symbolic resources, such as shared identity or desire for self-reliant communities, was highly effective in aiding mobilization for participation on community energy projects, and by the results of Reuter and Loock (2017) who indicate that marketing strategies should inform about the local origin of electricity and highlight the benefits to the local community.

6 Conclusions

Political efforts are undertaken to enhance decentralized energy markets. This assigns a new, more active role to the consumer. While the trend towards customer-based microgeneration is at the verge from a niche towards a mass market, P2P energy trading still is a rather unknown product for many potential customers. Therefore, based on data from a survey carried out in April and May 2017 among customers of seven German utilities and hierarchical multiple regressions, we identified the most prospective customer segments, their preferences and motivations for participating in P2P electricity trading and described implications for marketing strategies.. Our results show a low importance of socio-demographics in explaining differences between consumer groups, but a high explanatory power of attitudes, knowledge and likelihood to purchase further products. The most valuable target groups for P2P electricity trading are innovators and early adopters. They are well informed about and open towards electricity sharing, highly environmentally aware and favor regional production. They ask for transparency, and tend to purchase related products (e.g. microgeneration). Their motivation is stimulated by the ability to share generation and consumption and to a lesser extent to economize.

Regarding marketing strategies, the acquisition of prosumers tends to be the easier task, given the German market environment, with first renewable generation falling out of the subsidization scheme in the near future, and their generally higher involvement and innovativeness concerning energy-related issues. By contrast, gaining new, uninvolved consumers will be the far more challenging task, which is, however a crucial one in order to realize a functioning and lively P2P electricity trading community. Marketing efforts thus should aim at both target segments focusing on linking digitalized services with at least the look and feel of personalized and P2P-based distribution and tailored communication approaches for prosumers and for consumers. Our results indicate that the efforts should take peer effects actively into account, as they are found to wield great influence on general openness towards and purchase intention for P2P electricity products.

However, shortcomings of our study have to be mentioned: First, the assessment of the P2P electricity trading product was only one of several topics covered in our survey, so that several interesting questions had to be skipped and scales to be shortened. This might be a reason why the items measuring openness towards P2P electricity trading, which were derived from decomposed TPB, did not load on three or five distinguishable factors but on only two factors. Second, as the product is new and was relatively unknown to the majority of our respondents beforehand, misunderstandings might have occurred, resulting in biased results. Third, we integrated potential prosumers as well as consumers in the sample, thereby implicitly inquiring the attitudes, preferences and intentions of tenants. In 2017, a German law on the promotion of tenant electricity entered into force, incentivizing direct sale of decentralized production from landlords to tenants. Therefore, a more differentiated study for P2P markets regarding attitudes, intentions, of consumers on the one hand and of prosumers on the other hand assessed via a specialized follow-up survey with in-depth questions represents a valuable and important topic for future research to better address these different groups and deduce marketing strategies

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