INFER
INTERNATIONAL NETWORK FOR ECONOMIC RESEARCH

Working Paper 2015.07

Prosumer Preferences Regarding the Adoption of Micro-Generation Technologies: Empirical Evidence for German Homeowners

by

Christian A. Oberst

(RWTH Aachen University, Germany)

&

Reinhard Madlener

(RWTH Aachen University, Germany)

www.infer-research.net

Prosumer Preferences Regarding the Adoption of Micro-Generation Technologies: Empirical Evidence for German Homeowners

Christian A. Oberst and Reinhard Madlener

Institute for Future Energy Consumer Needs and Behavior (FCN), School of Business and Economics /
E.ON Energy Research Center, RWTH Aachen University, Mathieustraße 10, 52074 Aachen, Germany.
e-mail: COberst@eonerc.rwth-aachen.de, RMadlener@eonerc.rwth-aachen.de

September 2015[1]

Abstract

This paper investigates the preferences of homeowners in Germany regarding the adoption of renewable energy-based micro-generation technologies using data from a survey with a discrete choice experiment. In the German policy debate, private households, in their possible joint roles as electricity producers and consumers, are discussed as potential key actors for the transition of the energy system towards a decentralized energy market based on renewable energies. In our study, we address the relevance of investment and usage characteristics as well as the perceived importance of both private and social costs and benefits behind prosumer preferences for the adoption of generic electricity micro-generation technologies. The empirical investigation is based on a conditional logit model. The results show the perceived usefulness of electricity self-supply, indicating that the motivation for electricity "prosuming" is about more than just using green electricity and undertaking a profitable (energy) investment. Policy makers should not rely on the intrinsic motivation of households to contribute towards climate protection but instead take social effects more strongly into account in their policies which aim to foster the energy system transition (*"Energiewende"*). Further, both energy policies and business models should avoid the introduction of overly complex measures which might be too demanding on households.

Key words: Prosumer, micro-generation technologies, choice experiment, renewable energy, energy transition, policy

JEL Classification Nos.: C25, D12, O33, Q20

---

[1] This working paper is also published in the FCN Working Paper Series, No. 22/2014, see http://www.fcn.eonerc.rwth-aachen.de/cms/E_ON_ERC_FCN/Forschung/~emvl/Arbeitspapiere/lidx/1/.

1. Introduction

The term "prosumer" (pro-ducer and con-sumer) of energy or electricity is often used in the German debate to describe the new role of private households in the future (decentralized) energy market. Despite its investigation over several decades in academic circles (cf. Toffler 1980), the role of energy prosumer households is constantly evolving due to technological advancements in related products, services, and business opportunities as well as the consequent behavioral responses (e.g. the demand for own residential energy generation, self-consumption, and green electricity). The role of residential energy generation has evolved particularly dynamically over the last decade due to the market diffusion of micro-generation technologies (MGT) for producing and storing electricity and heat. However, the diffusion process of electricity generation based on renewable energy sources (RES) in general, and residential MGT in particular, relies heavily on government incentive schemes in the form of feed-in-tariff regulation, rebates and other forms of subsidies. However, these have faced declining political support in recent years (cf. EPIA, 2014 and Grösche and Schröder, 2011). In Germany, where the government has set ambitious goals[2] for an energy turnaround ("*Energiewende*") by means of a nuclear phase-out, the increasing of the share of RES, and the reduction of greenhouse gas (GHG) emissions and energy consumption, the adoption of MGT is especially encouraged by the Renewable Energy Sources Act (EEG), which came into force in 2000 with guaranteed feed-in tariffs, preferential dispatch, and connection requirement.[3]

To our knowledge, no official statistics are available on residential prosumer households' electricity supply and self-consumption; the following figures give a rough outline of today's relevance of private households and MGT on the German electricity market. Private households account for about 23% of electricity consumption (137 and 138.4 billion kWh in 2012 and 2013, respectively).[4] Individual owners account for about 25% (18 MW, in 2012) of RES generation capacity (= 73 MW, in 2012) and provide about 46% (15 MW, in 2012) of the capacity via photovoltaic (PV) systems. According to the asset data of the electrical grid operators in Germany (for 2013, see table 1) about 54.5% account for MGT systems (≤10 kWp) among the number of installed RES generation systems. Of these almost 800,000 renewable energy-based MGT systems are 99.7% solar systems. These shares are relatively stable across the four grid providers, with only Tennet having a notably lower share of MGT systems (49.6%). In the data sample collected for our investigation, and which we consider to be roughly representative of homeowners in

---

[2] For example, the German Federal Government's energy concept from September 2010 states that GHG emissions are to be reduced by 40% by 2020 (80% by 2050) compared to 1990 levels, the share of RES should reach a level of 18% by 2020 (30% by 2030, 60% by 2050), and by 2020 primary energy consumption is to be 20% lower than in 2008, and 50% lower by 2050 (see www.bundesregierung.de).

[3] Similar policy measures were taken in other countries, e.g. in Italy with the feed-in scheme of "Conto Energia" in Italy from 2005 to 2013. For an overview of promotion measures for RES and green electricity in Europe, see for example EPIA (2014) and Cansino et al. (2010). For more detailed discussions on policy measures in Germany on the promotion of green electricity, RES, and sustainable development, including social aspects, see for example, Pegels and Lütkenhorst (2014), Schlör, Fischer and Hake (2013), Grösche and Schröder (2011), and Frondel et al. (2010), among others.

[4] Cf. AGEB (2013, p. 30, table 13) and BDEW (2015).

Germany, 16% of the respondents' state that they have their own energy generation system. The majority of these households have installed a PV system (84%). Significantly fewer owners of an MGT system have installed biogas (8%), wind (7%), geothermal (6%), or micro-CHP (combined heat and power) electricity generation systems, and 2% state that they have an emergency generator based on gasoline or diesel. Summaries of our sample's socio-demographics, housing characteristics, and energy and financial matters are given in the appendix.

Table 1: Entries of MGT systems in the EEG system data of electrical grid operators[5]

Type	Total		TransnetBW		50Hertz		Tennet		Amprion	
Entries (up to 2013)	1,458,570		251,242		134,285		639,589		433,454	
Solar	1,412,064	96.8%	246,949	98.3%	121,760	90.7%	618,483	96.7%	424,872	98.0%
Wind	24,013	1.6%	449	0.2%	9,082	6.8%	10,382	1.6%	4,100	0.9%
Biomass	14,306	1.0%	2,010	0.8%	2,661	2.0%	6,727	1.1%	2,908	0.7%
Micro-Systems	795,322	54.5%	148,852	59.2%	77,712	57.9%	317,220	49.6%	251,538	58.0%
M.Solar	792,956	99.7%	148,383	99.7%	77,533	99.8%	315,879	99.6%	251,161	99.9%
M.Wind	491	0.1%	47	0.0%	66	0.1%	313	0.1%	65	0.0%
M.Biomass	724	0.1%	209	0.1%	52	0.1%	318	0.1%	145	0.1%

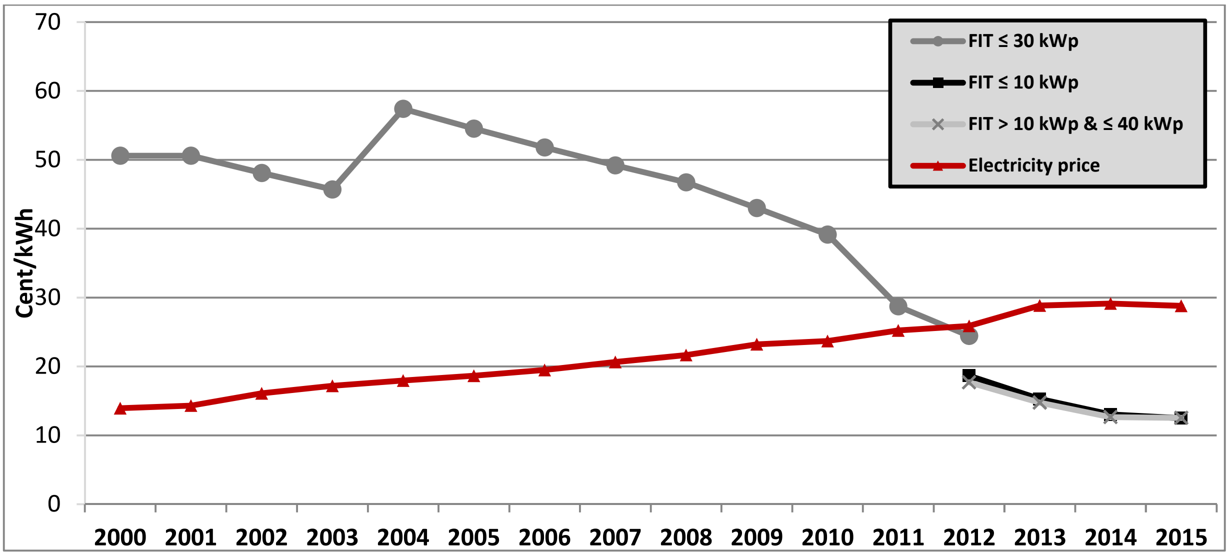

Figure 1: Development of electricity prices for private households and feed-in tariffs in Germany (in €-ct/kWh)[6]

Bardt et al. (2014) estimate that in the time period 2008 to 2012, electricity self-supply in the German residential sector (prosumer households) rose from 0.0% to 1.3%. The simulation study by Bardt et al. (2014) is based on EEG remuneration for PV systems, which seems reasonable in light of the high share of PV systems in MGT systems. However, until 2012 the price structure of

---

[5] M stands for MGT systems (10 kWp and smaller). Only entries up to 2013 were considered, because data for 2014 were not available for all grid operators. The colors in table 1 indicate the reference values, so the shares in the first column (on technology type) refer to all entries (green), while the shares in the second column only refer to MGT systems smaller than or equal to 10 kWp (orange). TransnetBW is located mainly in the south-west of Germany, 50Hertz in the east and in Hamburg, Tennet in the north-west, central, and south-east, and Amprion is located in the west and a part in the central south.

[6] Note that in April 2012 the feed-in tariff scheme changed. Since then, the tariffs are set to decrease monthly instead of annually. The exact development of energy prices is more complex, volatile, and heterogeneous, and depends on several factors including generation, transport, and other supply costs, electricity tax, VAT, and apportionment costs (e.g. under the EEG and the CHP Acts).

electricity had not incentivized prosumer households to consume self-generated electricity,[7] because the price of electricity from the grid was lower than the guaranteed feed-in tariffs (see figure 1). Therefore, residential self-consumption was economically irrelevant due to prohibitively high opportunity costs. This price-relation only reversed in 2012 when the guaranteed feed-in tariffs for new MGT systems fell below the average electricity price. With decreasing feed-in tariffs incorporated in the EEG and the previously discussed declining public support for RES subsidies, it seems unlikely that feed-in tariffs will exceed electricity prices again in the near future.

In order to evaluate the potential of energy prosumer households for the transition process of the energy system and the future energy market, we conduct an empirical investigation among homeowners in Germany[8] that is based on a large-scale (N=1,030), nationwide online survey with a discrete choice experiment pursued in November 2014. Choice experiments are an attribute-based stated preference method used in various research areas, including energy and environmental economics (see e.g. Hoyos (2010) or Hanley, Mourato, and Wright (2001)).

The objective of our study is to provide empirical insights on homeowners' preferences regarding their adoption and usage of MGT. Therefore, we analyze the perceived importance of both individually and socially underlying benefits and costs of MGT. Technology-wise, we focus on electricity generation with MGT, in particular on the degree of electricity self-supply in which the joint roles of prosumer households as electricity producers and consumers manifests itself. Thereby, we regard generic MGT systems and focus on the underlying characteristics of MGT (e.g. degree of electricity self-supply, net electricity costs, and environmental benefits).

The paper proceeds as follows. Section 2 discusses the methodology and research approach, including the empirical model in the form of a conditional logit (CL) model and the attributes. Section 3 reports the results mainly for the overall group and to a limited extent for group-specific differentiation relevant to extend a macroeconomic energy model simulating the residential sector. Section 4 concludes and formulates the main policy recommendations.

---

[7] MGT can mainly generate benefits either by the feed-in of electricity into the grid and the receiving of a remuneration (for current systems in Germany, most likely FIT), or on-site usage (electricity self-supply) with imputed benefits in form of the saved expenses on purchased costs for electricity from the public grid. On-site usage is profitable if the generation costs, often suggested to be calculated as levelized cost of energy (LCOE), are lower than the purchasing costs form the grid. However, it is of upmost importance to take opportunity costs into account in such calculations. Further, cost-effectiveness itself does not guarantee commercial competitiveness, cf. Yang (2010). The objective of this study is to analyze other factors influencing the adoption decision of potential prosumer households for MGT, including non-monetary characteristics.

[8] Including 16% owners of MGT systems.

2. Methodology and Research Approach

2.1 Discrete choice experiment on micro-generation technologies

In order to elicit homeowners' preferences concerning MGT, we conducted a discrete choice experiment as part of a nationwide online survey distributed in November 2014 among homeowners in Germany (N = 1,030). Choice experiments are an attribute-based stated preference elicitation method that relates to the random utility theory by Thurstone (1927) for its derivation of choice probabilities and the assumption of utility-maximizing behavior by the decision maker (see e.g. Train, 2010). Choice experiments can take inter-linked behaviors into account and are consistent with economic demand theory.[9] The advantages of choice experiments to analyze preferences are that the researcher has full information about the chosen and non-chosen alternatives, can vary attribute levels independently, and is able to elicit WTP measures for non-market goods, including potential future technologies and market frameworks. Therefore, choice experiments overcome possible drawbacks of revealed preference data (cf. Louviere, Hensher and Swait, 2000). With the choice experiment approach we are able to study a household's valuation of underlying characteristics of MGT systems, including relevant characteristics of future technologies, business models, and market regulations (e.g. storage technology and high degrees of electricity self-supply, local energy auctions or clusters of private households, and no governmental support).

The question about the external validity of choice experiments, meaning the extent to which these hypothetical statements of respondents are good predictors of field behavior, cannot be answered in this study. However, Carlsson and Martinsson (2001) provide some evidence on this matter by testing for "*both external and internal validity of a choice experiment with donations to environmental projects*". They conclude that overall choice experiments seem to be a valid method for eliciting individuals' preferences for public goods. Related to the internal validity of choice experiment results are problems of strategic behavior, inconsistencies of respondents' answers (e.g. due to learning effects), risk of compliance bias[10], as well as framing, choice set complexity, and respondents' (lack of) understanding of the task.

The challenge in designing the choice experiment to elicit prosumer preferences is the complexity of the adoption decision on MGT. Adopting an MGT is unlikely to be a repeated choice decision in contrast to a daily occurring choice situation, as for example selecting a mode of transport or purchasing food. This results in a lack of information and awareness of product characteristics of MGT. In addition, the adoption decision comprises – from a household perspective – both the investment (acquisition) and usage of the MGT, which multiplies the number of possible attributes to be considered. In other words, the household usually has to make both an

---

[9] For details see e.g. Louviere, Flynn and Carson (2010), Hoyos (2010), Train (2009), McFadden and Train (2000). The following empirical investigation of the choice experiment data is based on a conditional logit model, cf. McFadden (1974), Wooldridge (2010): p. 646, and Aizaki and Nishimura (2008).

[10] "in the sense that respondents wish to be consistent throughout the experiments", Carlsson and Martinsson (2001) p. 188.

investment decision and a consumption decision on the electricity supply mix. At the same time, the appropriate number of attributes to describe the alternatives in a choice experiment is limited. Carlsson and Martinsson (2008b) point out that the number of attributes has a detrimental effect on the ability to choose among alternatives. Also, an adoption decision of an MGT will usually not be taken within a few minutes (unlike in the survey), but rather over a longer period. In order to address this challenge, we extensively discussed the selection of relevant attributes of interest in expert discussion rounds with representatives from utility providers, governmental agencies, the consumer advice center, as well as with researchers who employ energy economic models to simulate the residential sector. In the accompanying survey, we also inquire the importance of other relevant attributes not considered in the choice experiment.

2.2 Study focus

We use homeowners as a survey group, and technology-wise we focus on electricity generation with generic MGT. The focus on homeowners seems natural for a study on the adoption decision of MGT, because homeowners are able to actually undertake the adoption decision and use the self-produced electricity in their own households. Compared to tenants, there is no landlord-tenant (principal-agent) problem regarding incentives for energy consumption and investment[11], or other legal problems, and also house-type limitations are less likely. Homeowners are a common survey group in choice experiment studies and other stated preference approaches on MGT and similar household energy contexts, see for example Achtnicht (2011), Scarpa and Willis (2010), Claudy, Michelsen and O'Driscoll (2011), Mahapatra and Gustavsson (2008), or Sopha et al. (2010), even though these studies predominantly focus on heating. Oberst and Madlener (2014) employ a regional economic evaluation on installed MGT systems in Germany and conclude that home-ownership constitutes an important precondition for households to adopt MGT. In a country like Germany, which is well known for its low home-ownership rate of 43%, (cf. Lerbs and Oberst 2014), this low rate is an important factor to consider when evaluating the potential and limitations of prosumer households.

With regard to generic MGT, we focus on the underlying characteristics of those technologies that should be abstracted from today's political incentive schemes, technology limitations, and specific attitudes towards certain technology types (solar, biomass, etc.). Specific political incentive schemes are likely to be valid only for a short time, as the frequency in Germany of amendments to the EEG in 2004, 2008, 2011, 2012, and 2014 with accompanying policy discussions and expectations indicate. Likewise, the relative cost structure of technology types can quickly change through innovations, and even attitudes towards certain technology types may change in the short term. A prominent example is the impact of the 2011 accident in Fukushima on the acceptance of nuclear power (cf. Siegrist and Visschers, 2013). Therefore, it seems useful to focus in our empirical investigation on preferences for underlying characteristics

---

[11] See for example Gillingham, Harding and Rapson (2012) for split incentives in residential energy consumption.

of MGT. The idea is that the results on underlying characteristics should have higher universal validity and time stability, compared to results on some specific technology and policy characteristics, within the limitations of a one-time survey. In particular the attribute "degree of electricity self-supply" has a crucial role, in which the joint role of prosumer households as electricity producers and consumers manifests itself.

2.3 Choice task structure and attributes

In each choice task, respondents can choose between two alternatives and "neither". The “neither” option is considered to enable respondents to state that there would be no adoption of an MGT system in such a choice situation. It could also be labeled as “none” or “status-quo” option and is an obvious element of choice in the adoption decision concerning MGT systems.[12] However, such “neither” options should be omitted in choice decisions on basic household equipment, as for example the choice of the primary heating system in Scarpa and Willis (2010). In each question, the two options for electricity MGT systems were described by a bundle of relevant attributes affecting the adoption decision. The respondents – who are individuals – answer representatively for the rest of their household as the decision-maker on energy matters.

We control for the effect of the choice set complexity by randomly assigning respondents to two different treatments. Respondents assigned to treatment A (N = 499) had to choose in fifteen “complex” choice tasks between generation devices described by both investment and usage attributes. Treatment A takes the characteristic of the adoption decision on MGT into account that for private households it is normally both an investment and usage decision. In treatment A, the choice tasks are described by seven attributes. In treatment B (N = 531) the respondents first had to choose ten times between MGT systems described by a reduced choice set with emphasis on the usage character (B1, four attributes), and in the second step the respondent had to choose fourteen times between systems whose description focus is on investment characteristics (B2, six attributes). With the two treatments, we can obtain some evidence on the effect that the choice task complexity has on the selection. Additionally, in the accompanying survey, we asked for comprehensibility, importance, and unimportance, as we were searching for different perceptions between the two treatments.

Table 1 provides an overview of the attributes considered in the choice experiment, their levels and main decision sphere (usage vs. investment, individual vs. social benefits), as well as the treatment group (A or B1/B2), with which we control for choice set complexity. Note that the selected attributes for a choice experiment should be relevant in the respondent’s decision process, substitutable with each other, independent in their utility, modest in number, and realistic in the specification of attribute levels (at least within the given scenario). With our focus on the future potential of MGT, we consider also very high degrees of electricity self-supply,

---

[12] See for example Bergmann et al. (2006) for an application, and Louviere, Flynn and Carson (2010) for theoretical details.

although they cannot be achieved yet at given (reasonable) costs with today's standard of technology.

Table 2: Attributes used in the choice experiment[13]

Attributes			Levels	Treat-ment
Individual	Investment & Usage	**Degree of electricity self-supply** Proportion of the used electricity that can be produced with the installed system throughout the year and does not need to be purchased from the grid. The degree of self-supply can be increased in particular through installing a storage device and/or advanced energy management measures.	**0, 20, 50, 80, 100%** (none, low, middle, high, self-provider)	**A** **B1** **B2**
Social		**CO_2 reduction** (contribution to climate protection) Based on the CO_2 emission of the current electricity procurement. With the system, CO_2 emissions can be reduced that are related to electricity. Through the feed-in of renewable electricity into the grid, the CO_2 emission can be reduced by more than 100%. **Social Impacts** Assessment of other social impacts, e.g. if through distributional effect the electricity costs for other private households increase/decrease.	**0, 50, 100, 200%** **Negative, neutral, positive**	**A** **B1** **B2**
Individual	Usage	**Net electricity costs** $\frac{total\ costs}{lifetime} + elec.procurement\ costs - elec.revenues$ Total costs cover investment, operating, financing costs and taxes. Electricity procurement costs may still apply for not self-supplied electricity consumption, and electricity revenues may arise from electricity feed-in and other savings.	**60, 80, 100, 120%** of stated household electricity costs	**A** **B1**
	Investment	**Initial investment costs** Including public or private investment subsidies **Payback period** Number of years after which the acquisition will turn out to be profitable **Investment risks** (loss probability) Expert assessment of the investment risks in three categories: (1) Speculative investments with high risk (10.0%): with deteriorating markets, losses are likely (as with stocks) (2) Investments with medium risks (1.0%): with deteriorating markets, revenues losses are likely, and losses are possible but highly unlikely (as with low-risk financial assets) (3) Safe investments with low risks (0.1%): where revenue losses and risk of loss are negligible in the long term, e.g. due to government guarantees.	**5,000 10,000 20,000 Euros** **5, 10, 20 years** **High, middle, low** (10%, 1.0%, 0.1%)	**A** **B2**

To describe our experimental design in comparison to the related literature, we provide a summary of selected related choice experiment studies in table 5. Further, we refer to Balcombe, Rigby and Azapagic (2013): In their comprehensive literature review (predominantly on studies for the UK), they assign motivation and adoption barriers to five categories: (i) financial, (ii) environmental, (iii) security of supply, (iv) uncertainty and trust, and (v) inconvenience and impact of residence.

---

[13] Overviews of attributes displayed to the respondents in the survey for both treatment A and treatment B in German are given in tables A1 and A2.

Table 3: Summary of selected choice experiment studies carried out with regard to the adoption of MGT

Study	Key findings	Choice task	Attributes considered	Sample	Model
Achtnicht (2011)	Environmental benefits have a significant impact on choices of heating systems, but not in terms of insulation choices. People are aware of their responsibility and are willing to contribute to climate protection. (p. 2198).	Heating system or improved thermal insulation	**Acquisition costs** (incl. public and/or private funding). Annual **energy-saving potential** at current energy prices; **payback period**; **CO_2 savings**; o**pinion** of an independent **energy adviser** [*sic*]; Public and/or private **funding**; period of **guarantee**, (p.2193).	Germany, June 2009 (p.2194). 400 sampled owner-occupiers of single-family, detached houses, semi-detached houses and row houses (p.2192).	Mixed logit model (pp. 2192, 2194).
Amador et al. (2013)	Customers who have experienced more serious outages in the past tend to show a higher WTP to reduce the outage frequency. Highly-educated respondents, those who state a great concern for the greenhouse gases (GHG) emissions, and those who carry out energy saving actions exhibit a larger WTP for RES. (p. 953).	Electricity supplier with electric attributes	Monthly household **electricity bill** in Euros; **no.** of non-scheduled **outages** per year; average **length of outages** in minutes; electricity generated from **RES in %**; **energy audit**, (p.955).	Canary Island Tenerife, Nov. and Dec. 2010. 376 valid surveys from a stratified random sample of households (p.958).	Fixed parameter conditional logit model, panel mixed logit model (p.958).
Bergmann et al. (2008) & Bergmann et al. (2006)[14]	Rural and urban households are shown to have different preferences (which are dependent on the type of RES technology and on the scale of project under consideration). (p. 616). Income groups do not differ in their preferences RES. General support for the expansion of RES projects, in spite of the existence of heterogeneous preferences with regard to the potential costs and benefits of these projects. (p. 624). Significant importance is assigned to impacts on wildlife and avoidance of high impact on landscape. Increases in prices reduce consumer utility.	Policy plans on the deployment of RE projects	Impact on **landscape**; impact on w**ildlife** impact; impacts on **air pollution**, **jobs**, **electricity price**, (p.619 in 2008 & p. 1008 in 2006).	Scotland, Sept. 2003; 547 survey of general public (pp. 509, 621).	Random parameter logit model (p.620), conditional logit models (p.1004)
Banfi et al. (2008)[15] & Farsi (2010)	Benefits of the energy-saving attributes are significantly valued by the consumers (incl. both individual energy savings and environmental benefits as well as comfort benefits, i.e., thermal comfort, air quality, and noise protection).Banfi et al. 2008, p.503. Results reject the risk-neutrality hypothesis. Risk considerations remain a central issue in dealing with energy efficiency in residential buildings. Farsi 2010, (p. 3087).	Energy saving measures	**Windows** (e.g. enhanced insulation); **façade; ventilation; price**, (p. 506).	Switzerland, Summer 2003 163 apartment tenants and 142 house owners (p. 503, 509).	Binomial logit model with individual fixed effects (p.505).
Borchers et al. (2007)	Positive WTP for green energy electricity. Individuals have a preference for solar over a generic green energy source and wind. Biomass and farm methane least preferred sources. (p. 3327).	Green energy electricity programs	Source (wind, solar, biomass, farm methane, generic), quantity (% **green energy**), cost (add. cost on monthly **electric bill**), (p.3329).	Apr./May 2006. 128 surveys, with individuals who were renewing drivers´ licenses in Delaware, USA (pp.3328ff).	Nested logit model (p.3328).
Carlsson/ Martinsson (2008a)	The marginal WTP to avoid outages increases with the duration, and is higher if they occur during weekends and winter months. Significant unobserved heterogeneity in some of the outage attributes. Given that households have negative welfare effects from outages, it is important that policy makers consider these negative impacts on household utility when regulating the electricity market. (p. 1232).	Alternatives of unplanned power outages	7 attributes that display **number, duration and weekday of outages** and the **connection fee**.	Sweden, 2004. 1200 sent surveys (473 returned, 425 available for the analyses) (p.1238).	Random parameter logit model (p.1232)
Lizin et al. (2012)	Measures point towards organic PV (OPV) being able to reach considerable market share in the long run, bearing in mind that efforts are first needed to elevate OPVs. Efficiency and lifetime determine most consumers' preferences. Price is found to be the least important product characteristic for OPV solar cells to be incorporated in consumer electronics devices. We therefore warn against generalizing attributes' importance across the boundaries of market segments. (p. 1).	Generic consumer electronics with solar cells as power source	**Price, efficiency, lifetime, esthetics, integratability** (p.4).	Flemish Region, Belgium, 2011, 300 individuals (train-travelers) (pp. 1,5).	Multinominal model (MNL) (p.5).
Lüthi/ Wüstenhagen (2012)	Risk does matter in PV policy design, and a "price tag" can be attached to specific policy risks, such as the duration of administrative processes or uncertainty induced by an approaching capacity cap. (p. 1001).	Policy frameworks for PV investments	**Level of FIT, duration of FIT, existence of a cap**, duration of the **administrative process**, and **policy instability**, (p.1003).	European PV project developers, by 63 investors, Oct./Nov. 2008 (p. 1005).	HB estimation model (p.1004).
Longo et al. (2008)	Respondents are in favor of a policy for RES. Consumers are willing to pay a higher price for electricity in order to internalize the external costs (energy security, climate change, and air pollution) caused by the production of electricity. (p. 140).	Policies for RES	Annual percentage **reduction GHG**; length of **shortages** of energy supply;no. of persons **employed** in the energy sector; **electricity bill**, (p.143).	Bath, England, July/Aug. 2005 300 respondents (in central areas, e.g. shopping malls) (p.144).	Conditional logit model (p.146).
Scarpa/Willis (2010): WTP for RES:	RES is significantly valued by households; this value is not sufficiently large for the vast majority of households to cover the higher capital costs of micro-generation energy technologies, and in relation of annual savings in energy running costs" (p.135). Results suggest that the government will have to give substantially larger grants than those currently available (in 2009) if it is to induce significantly more households to install MGT; or conversely the price of the technologies will have to fall substantially. (p.135).	Primary heating systems & labeled MGT	**Source labeled:** wind, solar, biomass, farm methane & thermal, heat pumps, pellet stoves), quantity (% monthly electrical usage) ~ "**electricity self-supply**" (=); **capital cost**(=); **energy bill** (=); **maintenance cost (-)**, **recommendation (-)**, **contract length** (-), **inconvenience** of the system (-), (p.132).	UK (England, Wales, and Scotland), 2007 (p.133). 1,241 households, (p.133f).	Multinominal logit estimates (p.133).
Present study on prosumer preferences	The perceived usefulness of electricity self-supply with all other conditions being equal indicates that prosuming is about more than just a profitable (energy) investment and using green electricity. Policy makers should not rely on intrinsic motivation of households to contribute towards climate protection and should take other social effects more strongly into account in their policies on the energy transition. Market regulation (incl. support schemes) and business models should avoid overly complex measures which might be too demanding on households.	Generic elect. MGT systems	Source unlabeled**, electricity self-supply, CO_2 reduction,** assessment of other **social impacts,** net **electricity costs,** Initial **investment costs, payback period, investment risk** (loss probability).	Germany, Nov. 2014, 1,030 valid online surveys of homeowners	(Fixed parameter) Conditional logit model

---

[14] See similar study by Ku and Yoo (2010) for renewable energy investment in Korea.

[15] See similar study by Kwak et al. (2010) on energy saving measures in residential buildings in Korea.

In our study, we are particularly interested in the role that the degree of electricity self-supply has for the adoption decision of private households on MGT systems. The attribute "electricity self-supply" is embedded in a choice experiment, in which we model several trade-offs between individual and social costs/benefits of adopting an MGT (see table 2). We consider "electricity self-supply" and financial attributes ("net electricity costs", "initial investment costs", "payback period", and "investment risk") to be individual costs/benefits. Further, we evaluate two forms of social features relevant for the adoption decision of MGT: for environmental benefits we consider "CO_2 reduction" as a contribution to climate protection and, as a trade-off, we consider the assessment of other social impacts. By including two forms of social benefits/costs, respondents have to evaluate a trade-off between social features, in addition to the common trade-offs in choice experiment studies between individual and social features. "Electricity self-supply" and the social features are considered to be relevant for both the investment and the usage decisions. Of the financial attributes, we consider the calculative "net electricity costs" to be more related to the usage decision (electricity supply), while "investment risk", expected "payback period", and "initial investment costs" are more related to the investment decision. Although an unambiguous assignment of these attributes to each decision sphere is neither possible nor necessary, the assignment to each decision sphere (individual vs. social, and usage vs. investment) is used here to illustrate the considered trade-offs before the attributes are discussed in more detail hereafter.

The "degree of electricity self-supply" is the proportion of the consumed electricity that could be produced by the household with the shown MGT system throughout the year. The difference between the consumed electricity and self-supplied electricity needs to be purchased from the grid. It can be increased through installation of storage and/or the application of advanced energy management measures. Storages could have a beneficial effect beyond the individual increase of electricity self-supply, e.g., for stabilizing the power grid by providing the necessary flexibilization of energy supply based on renewable sources, and enabling new business models and market forms, cf. Rosen and Madlener (2013). However, (de-)stabilizing the local public grid by the MGT system is assumed to be an externality, depicted in the attribute "social impacts". The "degree of electricity self-supply" reflects the joint roles of prosumer households as electricity producers and consumers. It can hardly be assigned in the classification by Balcombe et al. (2013) and, to the best of our knowledge, there is no comparable choice experiment study that regards this "prosuming" attribute. It might be partly related to the share of electricity supplied with RES in Amador et al. (2013) or Borchers et al. (2007). Our hypothesis is that households have a higher preference for MGT that enable them to obtain a higher degree of electricity self-supply, other things being equal. The preference for a higher degree of electricity self-supply may also be interpreted as a preference for consuming self-generated electricity instead of electricity provided by others, although the electricity itself is equally useful. Of particular interest is the attribute level of 100% electricity self-supply, which is shown to respondents with the label "self-provider". 100% electricity self-supply constitutes one condition for household energy autarky. Note that with today's standard of technology, such a high degree of electricity self-supply cannot be achieved yet at reasonable costs. However, given our focus on the future potential of MGT, it is of interest to know if there might be a potential demand.

Environmental benefits appear to be a significant motivation for installing MGT systems, but there is doubt as to whether consumers are willing to pay extra for it, cf. Balcombe et al. (2013). In contrast, results by Longo et al. (2008) "*suggest that consumers are willing to pay a higher price for electricity in order to internalize the external costs in terms of energy security, climate change and air pollution caused by the production of electricity*". Likewise, Zhai and Williams (2012) find evidence that environmental concerns play an important role for the consumer acceptance of PV besides costs. Leenheer, de Nooij, and Sheikh (2011) even find that environmental concerns are the most important driver for the intention to generate one's own power. Achtnicht (2011) finds that environmental benefits have a significant impact on the choice of a heating system, but not in terms of insulation choice. These contrary findings on the role of environmental benefits in the literature might to some extent be explained by the year and location of the survey, the regarded good or service, and the evaluation methodology. Note at this point the observation by Longo et al. (2008) that *"studies that employ the WTP methodology and use a demand curve approach, find estimates for the values of CO_2 emissions much higher than those based on the damage cost method"*. On the related topic of electricity supply, Grösche and Schröder (2011) argue that *"albeit people's WTP for a certain fuel mix in electricity generation is positively correlated to the renewable fuel share, our results imply that the current surcharge effectively exhausts the financial scope for subsidizing renewable fuels."* An argumentation that we hypothesize also applies to environmental effects. Our choice experiment approach can be characterized as a demand curve approach and is similar to the attribute "annual reduction of GHG emission" in Achtnicht (2011). We assume that attributes reflecting the share of RES in the electricity mix and environmental benefits are, in the context of adopting MGT, largely interchangeable. Therefore, the share of RES on the consumed electricity mix was not explicitly considered in our choice experiment.[16]

The attribute of "social impacts" is the second social feature, illustrated to respondents by the example of distributional effects that can result in increasing (decreasing) electricity costs for other private households. Critical factors for these financially illustrated social impacts are certainly the side-effects of governmental support schemes and the stabilizing (or destabilizing) impact on the power grid. The primary use of "social impacts" is to model a tradeoff with environmental benefits and thereby take the policy debate on eroding solidarity of energy prosumer households and distributional effects of the energy transition into account. The attribute is described in the survey as an assessment of "other social impacts" and can be positive,

---

[16] 23% of the respondents stated after the choice experiment that the share of RES would have been a relevant attribute for them, see table A8.

neutral, or negative. However, it cannot be completely ruled out that respondents may have understood the attribute to incorporate impacts of various other social impacts. These other forms of social impacts range from employment effects (Bergmann et al. 2006), over neighbor concerns (Claudy et al. 2011, who also refer to it as “social risk”), to the protection of wildlife (Ku and Yoo, 2010) and landscape (Bergmann et al. 2006, Hanley, Wright and Adamowicz 1998). The protection of wildlife and landscape may also be classified as local environmental effects (in contrast to globally effective CO_2 emissions). What all these factors have in common is that they illustrate some kind of externality (in addition to the explicitly mentioned global environmental effect as "CO_2 reduction"), but they are more specific in comparison to our generalized, and financially illustrated, other social impacts.

While “electricity self-supply” and the two social features are included in all treatment groups, the considered financial attributes differ between treatments. In treatment groups A and B1 “net electricity costs” are used as a proxy attribute for the usage of the MGT system, summarizing the overall calculative electricity costs of the household per time period.[17] “Net electricity costs” were equal to 60, 80, 100 and 120% of the stated household electricity costs. The net costs are assumed to result from total costs divided by the expected lifetime of the system, plus periodical procurement costs and minus periodical potential revenues. Total costs cover investment, operating, and financing costs, and taxes. Electricity procurement costs are associated with consumed electricity provided by the public grid and revenues that arise from electricity feed-in and other savings associated with the MGT system. The definition of the net cost-benefit variable “net electricity costs” is similar to many periodical cost attributes in the related literature, in particular the “energy-saving potential at current prices” in Achtnicht (2011) and the “energy bill per month (year)” on primary heating in Scarpa and Willis (2010). However, in our case, the levels for the attribute on periodically electricity costs include cost savings (60 and 80%), the status quo (100%), and increasing costs (120%). Respondents were shown both relative cost changes in percentages and in absolute values for the new bill in Euros.[18]

In treatment groups A and B2 we regard the investment features of the adoption decision in more detail. Therefore, we consider “initial investment costs”, “payback period”, and an expert assessment on “investment risk”. For the “initial investment costs” (including one-time public or private funding), we consider the levels of 5,000, 10,000, and 20,000 Euros. The attribute is labeled “capital costs” in Scarpa and Willis (2010), “acquisition costs” in Achtnicht (2011), and “selling price” in Lizin et al. (2012), although the content covers essentially the same. The “payback period” displays the number of years after which the acquisition will turn out to be profitable, an attribute similarly used in Achtnicht (2011). The expert assessment on “investment risks” can take on three values with a loss probability given in brackets. First, speculative

---

[17] The time period can be either per month or per year, depending on how the respondents stated their electricity costs beforehand in the survey.

[18] Note that for the empirical analysis, this gives us the option to use the same values for each respondent (60, 80, 100, 120%) in percentage terms, or in different price levels in Euros.

investments with high risk (10.0%), where in deteriorating market conditions losses are likely (as with stocks). Second, investments with medium risks (1.0%), where with deteriorating market conditions revenue losses are likely and overall losses are possible, but assumed to be highly unlikely (comparable to low-risk financial assets). Third, investments with low risk (0.1%), for which revenue losses and the risk of overall losses are negligible in the long term, e.g. due to government guarantees. The perceived “investment risk”, besides “investment costs” and “payback period”, is a central factor in any investment decision, but usually neglected in choice experiment studies. Farsi (2010) proposes a methodological framework to assess risk-averse behavior towards energy-efficient technologies that might be partly transferrable to the case of MGT. Farsi (2010) refers to theoretical literature that highlights the importance of risk and uncertainty in investment and consumption decisions regarding environmental commodities (e.g. Howard 2009, Newell and Pizer 2003, Gollier 2002). The role of risk for the adoption of MGT systems may also be illustrated by the fact that so far the EEG tariff scheme in Germany, with its guaranteed feed-in tariffs, essentially eliminated investment risks (on the revenue side). The investment risk comprises policy risks on the investment, as analyzed in Lüthi and Wüstenhagen (2012) with a choice experiment among European PV project developers. They find that risk does matter, and that adopters are likely to attach a “price tag” to specific policy risks. We hypothesize that private households in general possess a lower WTP for risky investments.

Note that the three economic variables “investment costs”, “net electricity costs”, and “payback period” cannot necessarily be added up in a steady-state calculation. While the “net electricity costs” are based on current energy prices, the “payback period” includes expected energy price developments. A similar approach was adopted in Achtnicht (2011). Respondents were given this information in the introduction to the experiment. While “investment costs”, “net electricity costs”, “payback period”, and “CO_2 reduction” are relatively common attributes in choice experiment studies, the “degree of electricity self-supply”, the “investment risks”, and “social impacts” are rather unique attributes of our choice experiment study (cf. table 2). The “degree of electricity self-supply” is in the focus of this study, while the “investment risk” and “social impacts” are proxies for more complex, yet highly relevant, factors for the adoption decision of MGT, which are often neglected in the related literature.

To gain at least a basic understanding on the importance of attributes not considered in our choice experiment, we asked the respondents (after completion of the choice experiment) to state which other attributes would have been important for their decision (multiple selections possible). The most frequently selected options, which more than one in three respondents stated, are warranty period (52%), expected operating life (52%), space requirements (44%), public and/or private funding (39%), ownership structure (34%), and minimum contract period (33%). In the appendix, table A8 gives an overview of the stated importance and related literature that regards those characteristics that are not considered in our choice experiment.

2.4 Empirical model

For our empirical investigation of the choice data, we estimated the conditional logit model, which is a probabilistic choice model related to the random utility theory by Thurstone (1927), cf. McFadden (1974), Wooldridge (2010, p. 646ff), and Aizaki and Nishimura (2008).[19] The idea behind these models of choice data is to estimate a predictor function based on a set of importance weights that are associated with the explanatory variables (attributes of the discrete choice experiment, DCE).

In our model specification, the household's utility level from each MGT system is explained by the attribute levels. However, since utility levels are unobservable for the hypothetical generation system in the choice experiment (like, indeed, for real-life adoption decisions), the actually observed choices (*y*) in the experiments are used as a proxy variable of the unobservable utility. Thus, the applied conditional logit model is a binary response model, in which our interest primarily lies in the response or selection probability *P*(*i*). The respondent either selects the shown generation system (*y*=1) or does not select it (*y*=0), which is explained by a bundle of characteristics (*X*, the attribute levels).

The probability (*P*) that a respondent will select alternative *i* = {1,2} from a choice set *C* with attribute levels *k* is specified as:

$$P(i) = \frac{exp(V_{i,n})}{\sum_{j \in C_n} \exp(V_{j,n})} \quad with \quad V_{i,n} = \sum_{k=1}^{K} \beta_{i,k} X_{i,k} \quad and \; P(y_i = j|X)$$

n = respondent, *i* = alternative {1 or 2}, *j* = set of alternatives {1 and 2},
k = attribute, *K* = number of explanatory variables

To analyze the respondents' valuation of attributes in their adoption decision, we focus on the systematic component of the utility (*V*), which is assumed to be a linear additive function of the explanatory variables *X* with the associated vector of coefficients β. β reflects the impact of changes in *X* on the probability of selection. Alternative specific constants for each respondent, or in other words individual fixed effect terms, are included in X to depict the unobservable tastes of respondents (based on the respondent's ID variable). The systematic component of utility for the "neither" option is normalized to zero, meaning that when this option is chosen, the selection variable *y* is set to zero for both shown alternatives, reflecting a zero value for the systematic component. To capture heterogeneous or group-specific effects on $V_{i,n}$ (e.g. gender, age, income or treatment group) interaction terms of group-membership vectors with the basic explanatory variables *X* can be included in the model. The vectors for group membership take the value of 1

---

[19] For differences from other common models used in choice experimental studies, in particular the multinomial logit model (MNL), see e.g. Wooldridge (2010, p. 647): "*The [conditional logit] model is intended specifically for problems where the choices are at least partly based on observable attributes of each alternative*" contrary to the MNL model "*where conditioning variables do not change across alternatives*" which "*is appropriate for problems where characteristics of the alternatives are unimportant or ... simply not available*". For more detailed discussions on choice modeling and conditional logit models, see e.g. Loureiro and Umberger (2007), or Scarpa and Willis (2010).

if respondents belong to the considered group, and 0 otherwise. We estimate the model with a maximum likelihood estimation procedure.[20]

3. Empirical Analysis

3.1 Sample

The analysis is based on 1,030 completed interviews from an internet-based survey that is assumed to be largely representative of German homeowners. Sample summaries are provided in tables A1 to A4. The survey was conducted in November 2014.[21] The respondents stated that they live in their dwellings as owners and decide on energy matters for their household (56% on equal terms with their spouse/partner, 44% decide alone). To qualify, respondents had to be able to state their electricity costs. Although adoption decisions on MGT are made for the household as a whole, which is the scenario for the choice task, the choice experiment was answered by individuals. Therefore, notice that obtained preferences and derived WTP are those of individuals, which can differ from those of the households, as discussed in Munro (2009), among others.

Table 4 provides a descriptive overview of the treatment groups. Treatment group A contains 14,970 observations based on 4,548 choice tasks answered by 499 respondents. Respondents of A had to choose in 15 choice tasks between 2 systems described by 7 attributes (usage & investment decision). Treatment groups B1 and B2 were answered successively by 531 respondents. First, respondents answered to 10 choice tasks, focusing on the usage decision with 4 attributes (B1). This results in 3,865 tasks and 10,618 observations. In a second step, the respondents answered to 14 additional tasks described by 6 attributes, resulting in 4,688 tasks and 14,868 observations (B2). Respondents should have no *ex ante* preference for either option A or B, due to the random assignment, which is proven true for our sample. It is notable that for the simplest choice set, B1, which focuses solely on the usage decision, the “neither” option is less frequently chosen. After the choice experiment, we showed respondents randomly one system which they had selected in the experimental choice task and asked them if they would really buy it. The fact that the most frequent response was “maybe” indicates that our choice experiment does capture a basic motivation (a “gut feeling”) of private households to adopt MGT systems with certain features, rather than the actual willingness-to-pay (WTP). Therefore, we illustrate our results later in section 3.3 with scenario-based selection properties instead of the marginal WTP for attributes.[22]

Table 4: Overview treatment groups

Treatment	A	B1	B2
Observation	14,970	10,618	14,868
Choice tasks (events)	4,648	3,865	4,688

---

[20] The applied estimation procedure is implemented in R by Therneau (2014), and based on Gail, Lubin, Rubinstein (1980). Thereby, we follow the estimation approach described in Aizaki (2012) and Aizaki and Nishimura (2008), respectively.

[21] MAIX Market Research & Consulting, Aachen was entrusted with the technical implementation.

[22] MWTP calculations for the basic and reduced models (1.i and 2.i) based on investment costs are provided in the appendix, table A 8.

Respondents		499	531	
Option A		30%	36%	31%
Option B		32%	37%	32%
Neither		38%	27%	37%
Would you really buy it?	Yes	20%	25%	31%
	Maybe	56%	52%	49%
	No	17%	14%	14%
	Don’t know	7%	8%	6%

3.2 Estimation results

First, the fixed-parameter conditional logit models, including only attributes coded on an ordinal scale, are estimated for the three treatment groups (A, B1, B2) without group-differentiation, in order to provide basic insights on the observed data. We refer to these models as "basic models", with the empirical specification given in eq. (1). Table 5 reports results on these basic models. Model 1.0 is based on data from treatment group A, model 1.1 on B1, and model 1.2 on B2. Ordinal scaled attributes require fewer assumptions on the functional form, in contrast to using (quasi-) numerical scales. It seems unlikely that respondents grasp the corresponding numerical scale of each attribute in the survey, or even in real world decision-making. Therefore, we consider the ordinal scale to be a more appropriate representation of the respondents’ understanding of attribute levels in our choice situation. For details, see Tversky’s (1974) theory of choice, showing that scalability in most probabilistic analyses of choice is inadequate on both theoretical and experimental grounds.

The coefficients shown in table 5 indicate the impact, or weight, an attribute level has on the theoretical systematic utility component V, which in turn determines the adoption probability $P(i)$. Negative signs imply that respondents have a lower preference for MGT systems featuring these characteristics. While coefficients for attributes coded on quasi-numerical scales cannot be directly interpreted and compared when they are based on different scales, we can compare in our case, with ordinal coded attributes, the different impacts of characteristics on the preference within the model (but not between).[23] The exponential value of β can be interpreted as the multiplication factor on the adoption probability $P(i)$ similar to odd ratios.

All coefficients on the basic models are shown to be statistically significant at least at the 5% level (*), except for the coefficient of a CO_2 reduction of 50% in model 1.0, which is only statistically significant on the 10% level. The estimated coefficients exhibit the intuitively expected signs, indicating a certain preference for a higher degree of electricity self-supply, higher CO_2 reduction, lower costs, shorter payback period, and avoiding high investment risks and negative social impacts. According to the magnitude of the coefficients, a high degree of electricity self-supply (in our study 80% and more) has the heaviest weight in the estimated utility functions and can thereby be seen as the most important one for the adoption decision (within our modeled choice task). It is followed by the importance on attributes for a sharp decline in net electricity cost (60%),

---

[23] We cannot compare the estimated coefficients between treatments, because besides the $exp(V)$ also the $\sum exp(V)$ changes. Concluding from this it is not surprising that the attributes in the shorter choice sets consist of coefficients with a larger magnitude.

avoiding high investment risks, long payback periods and high initial investment costs. In general, social features are shown to be of less importance for a household adoption decision than individual features. Notice that this does not necessarily mean that households are less environmentally friendly, but it might indicate that respondents perceive the promotion of environmental quality as a public duty rather than as an individual task, as findings by Menges and Traub (2009) corroborate. From all regarded social features, the negative social impacts are given the highest importance (in A, B1), followed by a CO_2 reduction of 200% (highest in B2), and a 100% CO_2 reduction. A CO_2 reduction of 50% and positive social impacts are perceived to be less important by respondents, and the impacts are comparable to the degree of electricity self-supply of 20%. All impacts are evaluated against the respective baseline.

The results indicate a symmetric (linear) pattern for the degree of electricity self-supply and payback period, and approximately for net electricity and investment costs. Only for model 1.1 (focus on usage decision) do the coefficients indicate diminishing marginal returns for reducing net electricity costs and investment costs. We cannot find evidence that a 100% electricity self-supply, labeled as “self-provider”, has a noticeable additional value for households above the linear combination on degrees of partial self-provision (either due to the fact that there is no additional perceived utility for this, or that respondents (correctly) assumed that even 100% self-provision does not imply electricity autarky). The observation that only 10% of respondents assign importance to the attribute “island operation – independence from the grid" in the question on the relevance of other attributes, indicates that a 100% self-supply has no disproportionate additional utility. However, there is also no evidence for diminishing marginal utility for degrees of self-supply. An asymmetric (non-linear) pattern and diminishing marginal utility can be found for attributes of CO_2 reduction, social impacts, and investment risk, which are all more pronounced for treatment B. A closer look at the coefficients for CO_2 reduction shows that up to the level of 100%, the effects could approximately be described as linear (1.0, 1.2). It also indicates, however, that a CO_2 reduction of 200% compared to 100% has little to no additional perceived utility for respondents. In the following estimations, we therefore combine both levels to a level "100% and more" in order to reduce the number of estimation coefficients. The avoidance of negative social impacts and high investment risks have both a disproportionately higher weight on respondent’s adoption decision than positive social impacts and low investment risk. The relation between attribute levels of investment risk could also be described with a logarithmic function that is based on the levels of loss probability.

The measures to evaluate the goodness-of-fit of the estimated models (pseudo R^2, AIC, BIC) indicate a better model fit for the two models based on data of treatment B. Although we can interpret the Pseudo R^2 as in standard OLS estimation, it is important to note that values tend to be considerably lower due to the binary selection decision. The observed pseudo R^2 values are in line with the literature.[24]

Table 5: Estimation results basic model (ordinal scaled attributes, no group differentiation)

Attribute	Level	**Model 1.0 (A)** Coef. (SE)	**Model 1.1 (B1)** Coef. (SE)	**Model 1.2 (B2)** Coef. (SE)
Degree of electricity self-supply (cf. 0%)	20%	**0.25***** (0.068)	**0.22**** (0.076)	**0.32*****(0.069)
	50%	**0.75***** (0.066)	**0.64***** (0.074)	**0.76***** (0.067)
	80%	**1.08***** (0.066)	**1.02***** (0.074)	**1.18***** (0.066)
	100%	**1.32***** (0.066)	**1.23***** (0.074)	**1.45***** (0.066)
CO$_2$ reduction (cf. 0%)	50%	**0.16**** (0.058)	**0.41***** (0.066)	**0.18**** (0.058)
	100%	**0.33***** (0.057)	**0.56***** (0.065)	**0.32***** (0.057)
	200%	**0.31***** (0.057)	**0.60***** (0.065)	**0.42***** (0.057)
Social impacts (cf. neutral)	Negative	**-0.39***** (0.050)	**-0.70***** (0.057)	**-0.35***** (0.050)
	Positive	**0.23***** (0.048)	**0.18***** (0.054)	**0.21***** (0.048)
Net electricity costs (cf. 100%)	60%	**0.56***** (0.056)	**1.09***** (0.063)	
	80%	**0.25***** (0.056)	**0.58***** (0.062)	
	120%	**-0.36***** (0.059)	**-0.88***** (0.070)	
Investment costs (cf. 10,000 Euros)	5,000 Euro	**0.42***** (0.048)		**0.50***** (0.048)
	20,000 Euro	**-0.48***** (0.050)		**-0.63***** (0.051)
Payback period (cf. 10 years)	5 years	**0.26***** (0.048)		**0.32***** (0.048)
	20 years	**-0.50***** (0.050)		**-0.47***** (0.050)
Investment risks (loss probability, cf. middle 1.0%)	Low (0.1%)	**0.27***** (0.048)		**0.38***** (0.048)
	High (10.0%)	**-0.48***** (0.050)		**-0.76***** (0.051)
Pseudo-R^2 (adj. R^2)		0.121 (0.118)	0.152 (0.150)	0.140 (0.138)
AIC (BIC)		12,806 (12,922)	9,397 (9,472)	12,660 (12,757)

Signif. codes: 0 ‘***’, 0.001 ‘**’, 0.01 ‘*’ , 0.1

From the results of the basic models (table 4) we derive that the attributes “electricity self-supply”, “net electricity costs”, “investment costs”, and “payback period” can be approximately modeled on a linear scale. Therefore, we incorporate them in a reduced model with quasi-numerical scaled attributes. For this reduced model, we also combine the CO$_2$ reduction of “100%” and “200%” to one level “100% and more”. Table 6 reports the estimation results obtained for the reduced models. These also indicate that the estimations based on treatment B have a better fit. Specifically, the fitness of the reduced models for treatment B is (negligibly) lower than for the basic model, and for treatment A slightly better. Note that the comparisons

---

[24] For example, Scarpa and Willis (2010) obtain for their estimations on primary heating choices pseudo-R²s that range from about 0.12 to 0.14. They refer to Breffle and Rowe (2002), stating that pseudo-R² of 0.12 is typical for cross-sectional data in this setting. For estimations based on quasi-numerical coded attribute levels, whenever possible and suitable, we obtain comparable but slightly lower goodness-of-fit measures.

across models are still not straightforward since the selection probability also depends on the alternative option.

Table 6: Estimation results reduced basic model (ordinal and numerically scaled attributes, no group differentiation)

Attribute	**Level**	**Model 2.0** Coef. (SE)	**Model 2.1** Coef. (SE)	**Model 2.2** Coef. (SE)
Degree of electricity self-supply	in %	**0.01***** (0.001)	**0.01***** (0.001)	**0.01***** (0.001)
CO$_2$ reduction (cf. 0%)	50%	**0.15*** (0.058)	**0.41***** (0.066)	**0.19*** (0.058)
	100% or more	**0.32***** (0.050)	**0.58***** (0.057)	**0.37***** (0.050)
Social impacts (cf. neutral)	Negative	**-0.39***** (0.050)	**-0.70***** (0.057)	**-0.35***** (0.050)
	Positive	**0.23***** (0.048)	**0.18**** (0.054)	**0.21***** (0.048)
Net electricity costs	in %	**-0.02***** (0.001)	**-0.03***** (0.001)	
Investment costs	in 1,000 Euros	**-0.06***** (0.003)		**-0.07***** (0.003)
Payback period	in years	**-0.05***** (0.003)		**-0.05***** (0.003)
Investment risks (loss probability, cf. middle 1.0%)	Low (0.1%)	**-0.48***** (0.050)		**-0.75***** (0.051)
	High (10.0%)	**0.27***** (0.048)		**0.38***** (0.047)
Pseudo-R^2 (adj. R^2)		0.120 (0.119)	0.151 (0.150)	0.139 (0.138)
AIC (BIC)		12,803 (12,867)	9,402 (9,440)	12,662 (12,720)

Signif. codes: 0 '***', 0.001 '**', 0.01 '*' , 0.1

3.3. Scenario analysis

Next, we build scenarios by calculating the probability that a respondent will select alternative *i*, P(*i*). In the following description and discussion, the focus is on the scenario based on the comprehensive model 2.0 (A). In scenario 1, homeowners only decide between adopting an MGT and the *status quo*. In scenario 2, households decide between four options, an MGT as in scenario 1, an MGT with an eco-friendly electricity tariff, only an eco-friendly electricity tariff, and the *status quo*. The two scenarios are illustrated in tables 7 and 8 (scenario 2 is only presented for treatment A).

We assume a typical MGT, with an achievable degree of electricity self-supply of 20%, CO$_2$ reduction of 50% (because with the feed-in of electricity CO$_2$, emissions should be reduced beyond self-consumption), negative social impacts (due to distributive income effects of the current EEG regulation discussed before), lower net electricity costs (90%), investment costs of 10,000 Euros, a payback period of 20 years, and a low investment risk (because of the guaranteed feed-in tariff). The alternative represented by the *status quo* consists of no electricity self-supply, no CO$_2$ reduction, neutral social impacts, constant electricity costs (100%), no investment costs or payback period, and medium investment risk (in particular with regard to the last decade with the global financial crisis of 2008, and the subsequent European sovereign-debt crisis, in which private energy investments might have been perceived to be less risky than financial investments). Within this scenario, the selection probability to adopt the MGT system is 18%, while for the *status quo* it is 82%. For scenario 2, we assume additionally that the possibility to combine the adoption of an MGT system with an eco-friendly electricity tariff (MGT Eco-Tariff) is given, and also the option to solely choose an Eco-Tariff. The Eco-Tariff is assumed to have 10% higher net electricity costs and a CO_2 reduction of 100% or more, and is otherwise like the *status quo*. The MGT Eco-Tariff is assumed to have 6% higher net electricity costs, and a CO_2 reduction of 100% or more and is otherwise identical to the MGT. For scenario 2, the selection probability of an MGT is 17% (9% without Eco-Tariff and 8% with Eco-Tariff). The probability of remaining a consumer household is 84%, 45% with the Eco-Tariff, and 38% without.

Table 7: Scenario 1

Attribute	Scenario 1 - A				Scenario 1 - B1				Scenario 1 - B2			
	MGT		Status quo		MGT		Status quo		MGT		Status quo	
Degree of electricity self-supply	**20**	0.265	**0**	0.000	**20**	0.250	**0**	0.000	**20**	0.288	**0**	0.000
CO_2 reduction	**50**	0.153	**0**	0.000	**50**	0.409	**0**	0.000	**50**	0.185	**0**	0.000
Social impacts	**Negative**	-0.392	**Neutral**	0.000	**Negative**	-0.696	**Neutral**	0.000	**Negative**	-0.345	**Neutral**	0.000
Net electricity costs	**90**	-1.353	**100**	-1.504	**90**	-2.864	**100**	-3.182				
Investment costs	**20**	-1.169	**0**	0.000					**20**	-1.477	**0**	0.000
Payback period	**10**	-0.498	**0**	0.000					**10**	-0.520	**0**	0.000
Investment risk	**low**	0.268	**low**	0.268					**low**	0.384	**low**	0.384
Selection probability	**18%**		**82%**		**57%**		**43%**		**13%**		**87%**	
V_i / exp(V_i)	-2.726	0.065	-1.236	0.291	-2.902	0.055	-3.182	0.041	-1.486	0.226	0.384	1.467
Sum(V_i)	0.36				0.10				1.69			
Sample distribution	16%		84%		16%		84%		16%		84%	

Table 8: Scenario 2

Attribute	Scenario 2 - A							
	MGT		MGT + Eco-Tariff		Eco-Tariff		Status quo	
Degree of electricity self-supply	**90**	-1.353	**106**	-1.594	**110**	-1.654	**100**	-1.504
CO_2 reduction	**20**	0.265	**20**	0.265	**0**	0.000	**0**	0.000
Social impacts	**50**	0.153	**100**	0.319	**100**	0.319	**0**	0.000
Net electricity costs	**Negative**	-0.392	**Negative**	-0.392	**Neutral**	0.000	**Neutral**	0.000
Investment costs	**20000**	-1.169	**20000**	-1.169	**0**	0.000	**0**	0.000
Payback period	**10**	-0.498	**10**	-0.498	**0**	0.000	**0**	0.000
Investment risk	**low**	0.268	**low**	0.268	**low**	0.268	**low**	0.268
Selection probability	9%		8%		45%		38%	
	17%				**87%**			
V_i / exp(Vi)	-2.73	0.07	-2.80	0.06	-1.07	0.34	-1.24	0.29
Sum(V_i)	0.76							
Sample distribution	9%		7%		22%		62%	
	16%				84%			

These selection probabilities are close to the sample distribution of 16% for owners of an MGT system. Only the selection probability of the Eco-Tariff seems to be overestimated in our scenario in comparison to the sample distribution. However, in reality the conditions for MGT should have been better because, as has been discussed previously, within our choice experiment we do capture the basic motivations for adoption decisions. It is likely that, in reality, additional adoption barriers would arise for an actual adoption decision that cannot be implemented in a survey with hypothetical choice decisions.

To illustrate the sensibility of results (without providing tables), we now assume that homeowners may perceive that the adoption of MGT systems has mainly positive social benefits. In this case, the selection probability for the MGT systems increases to 30% in scenario 1 and to 27% (14% without and 13% with Eco-Tariff) in scenario 2, all other attributes being equal. If we take another future scenario, in which the expert assessment of investment risk for MGT changes from "low" to "middle" (with all other attributes as in tables 8 and 9), then the selection probability for MGT in scenario 1 is reduced to 15% and in scenario 2 to 13% (7% and 6%). A change of the risk assessment to "high" would reduce the selection probabilities of MGT to 10% and 15% (6% and 9%). Again, based on the initial scenario assumptions, a scenario of halving the investment costs to €10,000 is associated with increased selection probabilities of MGT in scenario 1 to 29%, compared to 18%, and in scenario 2 to 26% (14% and 13%), compared to (17%).

The examination of heterogeneous (or group-specific) preferences on the adoption of MGT is beyond the scope of this paper, and is left for future research. With regard to the objective to extend energy economics models that simulate the residential sector, we align ourselves exemplarily with the macroeconomic model of Panta Rhei (cf. Lehr, Lutz and Edler, 2012). Therefore, we test for differences in preferences depending on household size and income. Furthermore, the current ownership of MGT systems (16% in our sample) is of particular interest. We base the analysis of group-specific differences in preferences for the adoption of MGT on the reduced basic model 2.0 with data of the comprehensive treatment A. Estimation results for group-specific preferences (differentiated by ownership of an MGT system, income, and household size) are given in the appendix, table A.11. Based on the initial scenario assumptions illustrated in tables 7 and 8, the selection probabilities of current owners of an MGT system is in scenario 1, with 37% towards 15% of non-owners, and in scenario 2 with 33% towards 13%, considerably larger. The differences between higher- and lower-income households are less pronounced, which are, however, all homeowners (rather than tenants), with a selection probability for MGT ranging from 22% for higher income households to 17% for lower income households in scenario 1. Depending on household size, the selection probability in the given scenario 1 is 25% for 1-person households, 16% for 2-person, 18% for 3-person, 17% for 4-person, and 24% for 5- and more-person households. Controlling for respondents of 50 years and older, the selection probability is at 13% markedly lower than for respondents younger than 50 years at 23%.

4. Conclusion and Policy Implications

Within the German policy debate on the future electricity market design and the realization of the energy transition towards a more decentralized energy market based predominantly on RES, fundamental questions remain unanswered about the potentials and limitations of the future development of energy prosumer households. The goal of our study is to provide policy-makers, industry, and the scientific community with empirical insights on the motivation and preferences of potential prosumer households towards MGT and electricity self-supply.

The combined role of prosumer households as electricity producers and consumers manifests itself in our choice experiment in the attribute degree of electricity self-supply. Households attribute a significant weight in their decision process on adopting MGT towards electricity self-supply. Respondents show an even stronger preference for the level of electricity self-supply than for the environmental benefits in the hypothetical adoption decision on MGT systems. The results show the perceived usefulness of electricity self-supply and indicate that the motivation for electricity "prosuming" is about more than just using green electricity and undertaking a profitable (energy) investment.

Detached from day-to-day politics with continued discussion on new concepts on subsidies, market regulations (e.g. for the next amendment of the energy laws, in particular the EEG), we focused on the characteristics underlying MGT (e.g. degree of self-supply), assuming that these preferences are more consistent over time. Nevertheless, the observed preferences are only a snapshot of German homeowner’s motivations and preferences (as of November, 2014). Effectively, the saying “you pay your money and you take your choice” is true with regard to technology preferences in a market economy. The true WTP of market agents only manifests itself on markets and is not stated in surveys and hypothetical experiments. However, the present analysis, which is based on a choice experiment on underlying benefits of the adoption of MGT systems, can identify initial motivations and preferences of potential future prosumer households. It is important that these are taken into account when forming scenarios about the future electricity market, in particular the residential sector, and the diffusion of MGT. It also provides some valuable insights for starting points of new business models and some guidance for future energy policies.

Based on the results of our choice experiment, we suggest that policy makers should take social effects more strongly into account in their decisions concerning the steering of the energy transition process, due to the importance shown by respondents regarding social impacts, and in particular regarding the avoidance of negative social impacts. To achieve climate targets and other necessary environmental benefits, society cannot rely on the intrinsic motivation alone that households contribute towards these goals, as is indicated by the relatively low importance of environmental effects. This does not necessarily mean that households are not environmentally friendly, but rather that subjects may perceive the promotion of environmental quality to be a public duty rather than an individual task (as the findings by Menges and Traub (2009) suggest as well). Further, both energy policies and business models should avoid the introduction of overly complex measures which might be too demanding on households, as the differences on stated attribute clarity and importance between treatments indicate. This applies, of course, for surveys as well.

The presented study adds to the literature and policy debate on the socio-ecological transition of the energy system by employing data from a choice experiment with a rather unique choice set used to elicit household preferences. On the one hand, the choice experiment focuses on electricity generation with unlabeled MGT. On the other hand it includes some rather unique attributes – e.g. social impacts for a trade-off with environmental aspects, or investment risk. In future research that is independent from the employed data set, different forms of social impacts (e.g. income redistribution, landscape, jobs, grid stability and costs, as well as local and global environmental effects) and group-specific motivations should be differentiated and studied in more detail as well as the existence of possible rebound effects for energy prosumer households.

Acknowledgments

This study was conducted within the project “Private Households as Key Actors of the *Energiewende*: Recommendations for a Social-Ecological Oriented Policy Approach”, commissioned by the German Federal Ministry of Education and Research (Ref. No.: BMBF 01 UN 1209A) under the umbrella of the social-ecological research program (SOEF), in cooperation with project partners GWS (Gesellschaft für Wirtschaftliche Strukturforschung mbH, Osnabrück) and IOEW (Institut für ökologische Wirtschaftsforschung gGmbH, Berlin).

We are grateful to Mark Bost, Anett Großmann, Christina Wallraf, Veronica Galassi, Hendrik Schmitz, and participants of the seminar on AIXperimental Economics in Progress at RWTH Aachen University, in particular Marjolein Harmsen – van Hout, for their useful comments and suggestions. The authors are also grateful to C. Stibbe for carefully editing this article. The usual disclaimer applies.

References

Achtnicht M (2011). Do environmental benefits matter? Evidence from a choice experiment among house owners in Germany. Ecological Economics 70, 2191-2200.

AGEB (2013). Energieverbrauch in Deutschland. AG Energiebilanzen e.V., Arbeitsgemeinschaft Energiebilanzen e.V., Munich.

Aizaki H (2012). Basic Functions for Supporting an Implementation of Choice Experiments in R. Journal of Statistical Software 50, 1-24.

Aizaki H, Nishimura K (2008). Design and Analysis of Choice Experiments Using R: A Brief Introduction. Agricultural Information Research, 17, 86-94.

Amador F J, González R M, Ramos-Real F J (2013). Supplier choice and WTP for electricity attributes in an emerging market: The role of perceived past experience, environmental concern and energy saving behavior. Energy Economics 40, 953-966.

Balcombe P, Rigby D, Azapagic A (2013). Motivations and barriers associated with adopting microgeneration energy technologies in the UK. Renewable and Sustainable Energy Reviews, 22, 655-666.

Banfi S, Farsi M, Filippini M, Jakob M (2008). Willingness to pay for energy-saving measures in residential buildings. Energy Economics 30, 503-516.

Bardt H, Chrischilles E, Growitsch C, Hagspiel S, Schaupp L (2014). Eigenerzeugung und Selbstverbrauch von Strom – Stand, Potentiale und Trends. Zeitschrift für Energiewirtschaft, 38, 83-99.

Borchers A M, Duke J M, Parsons G R (2007). Does willingness to pay for green energy differ by source? Energy Policy 35, 3327-3334.

BDEW (2015): Energiedaten. URL: www.bdew.de/internet.nsf/id/DE_Energiedaten#-

Bergmann A, Colombo S, Hanley N (2008). Rural versus urban preferences for renewable energy developments. Ecological Economics 65, 616-625.

Bergmann A, Hanley N, Wright R (2006). Valuing the attributes of renewable energy investments. Energy Policy 34, 1004-1014.

Breffle W S, Rowe R D (2002). Comparing choice question formats for evaluating natural resource tradeoffs. Land Economics 78, 298-314.

Cansino J M, Pablo-Romero M, Román R, Yñiguez R (2010). Tax incentives to promote green electricity: An overview of EU-27 countries. Energy Policy 38, 6000-6008.

Carlsson F, Martinsson P (2001). Do hypothetical and actual marginal willingness to pay differ in choice experiments? Journal of Enviromental Economics and Management 41, 179-192.

Carlsson F, Martinsson P (2008a). Does it matter when a power outage occurs? – A choice experiment study on the willingness to pay to avoid power outages. Energy Economics 30, 1232-1245.

Carlsson F, Martinsson P (2008b). How much is too much? An investigation of the effect of the number of choice sets, context dependence and the choice of bid vectors in choice experiments. Environmental and Resource Economics 40, 165-176.

Claudy M C, Michelsen C, O'Driscoll A (2011). The diffusion of microgeneration technologies – assessing the influence of perceived product characteristics on home owners' willingness to pay. Energy Policy 39, 1459-1469.

EPIA (2014). Global market outlook for photovoltaics 2014-2018. European Photovoltaic Industry Association (EPIA), Brussels, Belgium. Available at http://www.epia.org.

Farsi M (2010). Risk aversion and willingness to pay for energy efficient systems in rental apartments. Energy Policy 38, 3078-3088.

Frondel M, Ritter N, Schmidt C M, Vance C (2010). Economic impacts from the promotion of renewable energy technologies: The German experience. Energy Policy 38, 4048-4056.

Gail M H, Lubin J H, Rubinstein L V (1980). Likelihood calculations for matched case-control studies and survival studies with tied death times. Biometrika 68, 703-707.

Galassi V, Madlener R (2014). Identifying business models for photovoltaic systems with storage in the Italian Market: A Discrete Choice Experiment, FCN Working Paper No. 19/2014, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, December.

Gillingham K, Harding M, Rapson D (2012). Split incentives in residential energy consumption. The Energy Journal 34, 37-62.

Gollier C (2002). Discounting an uncertain future. Journal of Public Economics 85, 149-166.

Grösche P, Schröder C (2011). Eliciting public support for greening the electricity mix using random parameter techniques. Energy Economics 33, 363-370.

Hanley N, Mourato S, Wright R (2001). Choice modeling approaches: A superior alternative for environmental valuation? Journal of Economic Surveys 15, 415-462.

Hanley N, Wright R E, Adamowicz V (1998). Using choice experiments to value the environment. Design issues, current experience and future prospects. Environmental and Resource Economics 11, 413-428.

Howard, R B (2009). Discounting, uncertainty, and revealed time preference. Land Economics 85, 24-40.

Hoyos (2010). The state of the art of environmental valuation with discrete choice experiments. Ecological Economics 69, 1595-1603.

Krinsky I, Robb A L (1986). On approximating the statistical properties of elasticities. The Review of Economics and Statistics 68, 715-719.

Ku S-J, Yoo S-H (2010). Willingness to pay for renewable energy investments in Korea: A choice experiment study. Renewable and Sustainable Energy Reviews 14, 2196-2201.

Kwak S-Y, Yoo S-H, Kwak S-J (2010). Valuing energy-saving measures in residential buildings: A choice experiment study. Energy Policy 38, 673-677.

Leenheer J, de Nooij M, Sheikh O (2011). Own power: Motives of having electricity without the energy company. Energy Policy 39, 5621-5629.

Lehr U, Lutz C, Edler D (2012). Green jobs? Economic impacts of renewable energy in Germany. Energy Policy 47, 258-364.

Lerbs O, Oberst C A (2014): Explaining the spatial variation in homeownership rates: results for German regions. Regional Studies, 2014, 844-865.

Lizin S, Van Passel S, De Schepper E, Vranken L (2012). The future of organic photovoltaic solar cells as a direct power source for consumer electronics. Solar Energy Materials & Solar Cells 103, 1-10.

Longo A, Markandya A, Petrucci M (2008). The internalization of externalities in the production of electricity: Willingness to pay for the attributes of a policy for renewable energy. Ecological Economics, 67, 140-152.

Loureiro M, Umberger W J (2007). A choice experiment model for beef: What US consumer responses tell us about relative preferences for food safety, country-of-origin labeling and traceability. Food Policy 32, 496–514.

Louviere J J, Flynn T N, Carson R T (2010). Discrete choice experiments are not conjoint analysis. Journal of Choice Modelling 3, 57-72.

Louviere J J, Hensher D A, Swait J D (2000). Stated Choice Methods: Analysis and Application. Cambridge University Press, Cambridge, UK.

Lüthi S, Wüstenhagen R (2012). The price of policy risk – Empirical insights from choice experiments with European photovoltaic project developers. Energy Economics 34, 1001-1011.

Mahapatra K, Gustavsson L (2008). An adopter-centric approach to analyze the diffusion patterns of innovative residential heating systems in Sweden. Energy Policy 36, 577–590.

McFadden D (1974). Conditional logit analysis of qualitative choice behavior, in P Zarembka, ed., Frontiers in Econometrics, Academic Press, New York, pp. 105– 142.

McFadden D, Train K (2000). Mixed MNL Models For Discrete Response. Journal of Applied Econometrics, 15 (15) 447-470.

Menges R, Traub S (2009): An Experimental Study on the Gap between Willingness to Pay and Willingness to Donate for Green Electricity. FinanzArchiv / Public Finance Analysis, 65, 335-357.

Munro A (2009). Introduction to the Special Issue: Things we do and don’t understand about the household and the environment. Environmental and Resource Economics 41, 1-10.

Newell R G, Pizer W A (2003). Discounting the distant future: how much do uncertain rates increase valuations? Journal of Environmental Economics and Management 46, 52-71.

Oberst C A, Madlener R (2014). Regional economic determinants for the adoption of distributed generation based on renewable energies: the case of Germany, FCN Working Paper No. 21/2014, Institute for Future Energy Consumer Needs and Behavior, RWTH Aachen University, December).

Pegels A, Lütkenhorst W (2014): Is Germany׳s energy transition a case of successful green industrial policy? Contrasting wind and solar PV. Energy Policy 74, 522-534.

Revelt D, Train K (1998): Mixed Logit with repeated choices: households' choices of appliance efficiency level. The Review of Economics and Statistics 80, 647 - 657.

Rosen C, Madlener R (2013). An auction design for local reserve energy markets, Decision Support Systems 56, 168-179.

Scarpa R, Willis K (2010). Willingness-to-pay for renewable energy: primary and discretionary choice of British households' for micro-generation technologies. Energy Economics 32, 129-136.

Schlör H, Fischer W, Hake J F (2013). Sustainable development, justice and the Atkinson index: Measuring the distributional effects of the German energy transition. Applied Energy 112, 1493-1499.

Siegrist M, Visschers V H M (2013). Acceptance of nuclear power: The Fukushima effect. Energy Policy 59 (8), 112-119.

Sopha BM, Klöckner CA, Skjevrak G, Hertwich EG (2010). Norwegian households' perception of wood pellet stove compared to air-to-air heat pump and electric heating. Energy Policy 38, 3744–3754.

Thurstone L L (1927). A law of comparative judgment. Psychological Review 34, 273-286.

Toffler A (1980). The Third Wave. William Morrow, New York.

Therneau T (2013). A Package for Survival Analysis in S_. R package version 2.37-4, <URL: http://CRAN.R-project.org/package=survival>.

Train K E (2009). Discrete Choice Methods with Simulation. 2nd edition, Cambridge University Press, Cambridge.

Tversky A (1974). Elimination by aspects: A theory of choice. Psychological Review 79, 281-299.

Wooldrige JM (2010): Econometric Analysis of Cross Section and Panel Data. 2nd edition MIT Press, Cambridge, USA.

Yang, C (2010): Reconsidering solar grid parity. Energy Policy 38, 3270-3273.

Zhai P, Williams E D (2012): Analyzing consumer acceptance of photovoltaics (PV) using fuzzy logical model. Renewable Energy 51, 350-357.

Appendix

Table A.1: Summary of the sample's socio-demographics

		All		**Prosumer**		**Consumer**	
		n	**in %**	n	**in %**	n	**in %**
Gender	Male	590	**57**	96	**59**	494	**57**
	Female	438	**43**	66	**40**	372	**43**
	Not stated	2	**0**	1	**1**	1	**0**
Family status	Married or civil partnership	790	**77**	131	**80**	659	**76**
	Married or civil partnership - separated	26	**3**	7	**4**	19	**2**
	Single	125	**12**	19	**12**	106	**12**
	Divorced	65	**6**	6	**4**	59	**7**
	Widowed	24	**2**	0	**0**	24	**3**
Age	21-25	15	**1**	5	**3**	10	**1**
	26-30	27	**3**	5	**3**	22	**3**
	31-50	449	**44**	94	**58**	355	**41**
	51-65	412	**40**	50	**31**	362	**42**
	66 and older	127	**12**	9	**6**	118	**14**
Household's monthly net income	Less than 1,300 Euros	35	**3**	3	**2**	32	**4**
	1,300 to below 2,600 Euros	227	**22**	30	**18**	197	**23**
	2,600 to below 3,600 Euros	267	**26**	30	**18**	237	**27**
	3,600 to below 5,000 Euros	252	**24**	49	**30**	203	**23**
	5,000 to below 18,000 Euros	98	**10**	28	**17**	70	**8**
	18,000 Euros and more	13	**1**	7	**4**	6	**1**
	Not stated	138	**13**	16	**10**	122	**14**
Employment status	Full-time working (more than 30 h per week)	589	**57**	110	**67**	479	**55**
	Part-time working	144	**14**	16	**10**	128	**15**
	Not working (including pensioners, unemployed, students)	246	**24**	27	**17**	219	**25**
	Others	51	**5**	10	**7**	41	**5**
Employment status partner	Full-time working (more than 30 h per week)	471	**46**	86	**53**	385	**44**
	Part-time working	135	**13**	18	**11**	117	**13**
	Not working (including pensioners, unemployed, students)	196	**19**	24	**15**	172	**20**
	Not applicable	144	**14**	22	**13**	122	**14**
	Others	84	**7**	13	**7**	71	**7**

Table A.2: Summary of the sample's housing characteristics

		All		Prosumer		Consumer	
		n	in %	n	in %	n	in %
House type	Detached 1-2 family houses	669	65%	117	72%	552	64%
	Row house or semi-detached 1-2 family house	314	30%	37	23%	277	32%
	Agricultural residential building	25	2%	5	3%	20	2%
	Other	22	2%	4	3%	18	2%
Household size	1	97	9%	19	12%	78	9%
	2	389	38%	51	31%	338	39%
	3	248	24%	40	25%	208	24%
	4	204	20%	38	23%	166	19%
	5 and more	92	9%	15	10%	77	8%
Age of building	Before 1948	217	21%	18	11%	199	23%
	1949 - 1978	265	26%	29	18%	236	27%
	1979 - 1986	103	10%	17	10%	86	10%
	1987 - 1990	62	6%	9	6%	53	6%
	1991 - 2000	174	17%	35	21%	139	16%
	2001 - 2009	147	14%	39	24%	108	12%
	2010 or later	57	6%	15	9%	42	5%
	Not stated	5	0%	1	1%	4	0%
Living in house since	Before 1949	2	0%	1	1%	1	0%
	1949 - 1978	132	13%	8	5%	124	14%
	1979 - 1986	104	10%	13	8%	91	10%
	1987 - 1990	76	7%	15	9%	61	7%
	1991 - 2000	247	24%	37	23%	210	24%
	2001 - 2009	307	30%	67	41%	240	28%
	2010 or later	162	16%	22	13%	140	16%
Living space in m^2	Smaller than 80	31	3%	3	2%	28	3%
	80 - 105	141	14%	14	9%	127	15%
	105 - 119	80	8%	15	9%	65	7%
	120 - 134	255	25%	37	23%	218	25%
	135 - 149	110	11%	22	13%	88	10%
	150 - 174	174	17%	27	17%	147	17%
	175 - 200	55	5%	9	6%	46	5%
	200 or larger	184	18%	36	22%	148	17%
Energy-efficiency condition of the house	In good condition	682	66%	129	79%	553	64%
	Partially in need of renovation	303	29%	31	19%	272	31%
	In urgent need of renovation	37	4%	2	1%	35	4%
	Don't know	8	1%	1	1%	7	1%
Cars	0	19	2%	4	2%	15	2%
	1	432	42%	62	38%	370	43%
	2	468	45%	84	52%	384	44%
	3 and more	111	10%	13	8%	98	12%
Household amenities	Washing machine	1011	98%	154	94%	857	99%
	Garden	993	96%	152	93%	841	97%
	Dish-washer	930	90%	146	90%	784	90%
	Bathtub	914	89%	142	87%	772	89%
	Balcony/terrace	881	86%	141	87%	740	85%
	Basement	770	75%	116	71%	654	75%
	Garage	750	73%	114	70%	636	73%
	Separate freezer	699	68%	110	67%	589	68%
	Dryer	698	68%	110	67%	588	68%
	Second refrigerator	463	45%	66	40%	397	46%
	Electrical garage door	350	34%	74	45%	276	32%
	Sauna	93	9%	29	18%	64	7%
	Electric bicycle/small moped	81	8%	30	18%	51	6%
	Storage heater	56	5%	18	11%	38	4%
	Single-room air conditioner	51	5%	16	10%	35	4%
	Smart home	31	3%	18	11%	13	1%
	Smart meter	29	3%	19	12%	10	1%
	Central air conditioner	28	3%	12	7%	16	2%
	Electric car	13	1%	9	6%	4	0%
	None of the above	2	0%	0	0%	2	0%

Table A.3: Summary of samples energy matters

		All		Prosumer		Consumer	
		n	in %	n	in %	n	in %
Prosumer (own energy generation)	Yes	163	16%	163	100%	0	0%
	No	867	84%	0	0%	867	100%
	Don't know [excluded from survey]	-	-	-	-	-	-
Making decisions on energy matters in household	Respondent him/herself	449	44%	77	47%	372	43%
	Respondent on equal terms with partner	581	56%	86	53%	495	57%
	Not the respondent [excluded from survey]	-	-	-	-	-	-
More familiar term for own electricity costs	Annual	259	25%	40	25%	219	25%
	Monthly	771	75%	123	75%	648	75%
	Don't know excluded	-	-	-	-	-	-
Electricity costs per month	Less than 70 Euros	227	22%	31	19%	196	23%
	70 to 95 Euros	286	28%	46	28%	240	28%
	95 to 120 Euros	212	21%	35	21%	177	20%
	120 Euros or more	305	30%	51	31%	254	29%
Eco-power tariff	Yes	**301**	29%	72	44%	229	26%
	No	593	58%	76	47%	517	60%
	Don't know	136	13%	15	9%	121	14%
Heating system*	Central heating (oil, gas)	693	67%	90	55%	603	70%
	Single stove (oil, gas, wood(pellet), coal)	354	34%	58	36%	296	34%
	Solar thermal	103	10%	54	33%	49	6%
	Heat pump	78	8%	29	18%	49	6%
	Electric heating	73	7%	20	12%	53	6%
	Connected to local or district heating network	52	5%	8	5%	44	5%
	CHP	13	1%	6	4%	7	1%
	Don't know	11	1%	0	0%	11	1%
Hot water supply*	Exclusively with primary heating system	553	54%	67	41%	486	56%
	Electrical instantaneous water heater	219	21%	36	22%	183	21%
	With solar thermal system	162	16%	70	43%	92	11%
	Gas (instantaneous water heater, boiler)	197	19%	30	18%	167	19%
	Don't know	21	2%	2	1%	19	2%

Table A.4: Summary of samples other financial and investment questions

		All		Prosumer		Consumer	
		n	in %	n	in %	n	in %
House acquisition	Purchase of the house	782	76%	130	80%	652	75%
	Inheritance, donation, or transfer	199	19%	26	16%	173	20%
	Mixed ("*Gemischte Schenkung*")	6	1%	2	1%	4	0%
	No statement	43	4%	5	3%	38	4%
Existing mortgages	Yes	550	53%	83	51%	467	54%
	No	447	43%	75	46%	372	43%
	No statement	33	3%	5	3%	28	3%
Revenues generated from rents	Yes (from apartments in self-used building)	105	10%	25	15%	80	9%
	Yes (from other properties)	125	12%	34	21%	91	10%
	No	786	76%	106	65%	680	78%
	No statement	30	3%	4	2%	26	3%
Other investments in energy generation	Yes	49	5%	30	18%	19	2%
	No, but would consider it	408	40%	59	36%	349	40%
	No statement	573	56%	74	45%	499	58%
Stocks and other securities	Yes	383	37%	80	49%	303	35%
	No, but would consider it	157	15%	29	18%	128	15%
	No, no interest	490	48%	54	33%	436	50%

Table A.5: Summary of respondents' evaluation of choice experiment attributes (by prosumer/consumer)

		All		Prosumer		Consumer	
		n	in %	n	in %	n	in %
Attribute ambiguous*	Initial investment costs	49	5%	11	7%	38	4%
	Net electricity costs	98	10%	18	11%	80	9%
	Payback period	72	7%	15	9%	57	7%
	Investment risk (loss probability)	173	17%	29	18%	144	17%
	Degree of elect. Self-supply	97	9%	24	15%	73	8%
	CO_2 reduction(climate protection)	67	7%	14	9%	53	6%
	Social impacts	263	26%	49	30%	214	25%
	All attributes were comprehensible	545	53%	77	47%	468	54%
Attribute importance* (on which attributes were your decisions mainly based?)	Initial investment costs	607	59%	78	48%	529	61%
	Net electricity costs	394	38%	62	38%	332	38%
	Payback period	463	45%	88	54%	375	43%
	Investment risk (loss probability)	379	37%	60	37%	319	37%
	Degree of elect. self-supply	499	48%	92	56%	407	47%
	CO_2 reduction(climate protection)	232	23%	47	29%	185	21%
	Social impacts	113	11%	24	15%	89	10%
	None of the attributes were important	46	4%	0	0%	46	5%
Attribute <u>un</u>importance*	Initial investment costs	106	10%	24	15%	82	9%
	Net electricity costs	85	8%	21	13%	64	7%
	Payback period	111	11%	16	10%	95	11%
	Investment risk (loss probability)	109	11%	27	17%	82	9%
	Degree of elect. self-supply	135	13%	25	15%	110	13%
	CO_2 reduction (climate protection)	244	24%	43	26%	201	23%
	Social impacts	472	46%	84	52%	388	45%
	All of the attributes were important	266	26%	30	18%	236	27%

Table A.6: Summary of respondents' evaluation of choice experiment attributes (by treatment)

		All		A		B	
		n	in %	n	in %	n	in %
Attribute ambiguous*	Initial investment costs	49	5%	24	5%	25	5%
	Net electricity costs	98	10%	45	9%	53	10%
	Payback period	72	7%	36	7%	36	7%
	Investment risk (loss probability)	173	17%	93	19%	80	15%
	Degree of elect. self-supply	97	9%	46	9%	51	10%
	CO_2 reduction(climate protection)	67	7%	30	6%	37	7%
	Social impacts	263	26%	147	29%	116	22%
	All attributes were comprehensible	545	53%	240	48%	305	57%
Attribute importance* (on which attributes were your decisions mainly based?)	Initial investment costs	607	59%	285	57%	322	61%
	Net electricity costs	394	38%	211	42%	183	34%
	Payback period	463	45%	230	46%	233	44%
	Investment risk (loss probability)	379	37%	162	32%	217	41%
	Degree of elect. self-supply	499	48%	240	48%	259	49%
	CO_2 reduction(climate protection)	232	23%	104	21%	128	24%
	Social impacts	113	11%	41	8%	72	14%
	None of the attributes were important	46	4%	28	6%	18	3%
Attribute <u>un</u>importance*	Initial investment costs	106	10%	47	9%	59	11%
	Net electricity costs	85	8%	37	7%	48	9%
	Payback period	111	11%	42	8%	69	13%
	Investment risk (loss probability)	109	11%	56	11%	53	10%
	Degree of elect. self-supply	135	13%	65	13%	70	13%
	CO_2 reduction (climate protection)	244	24%	122	24%	122	23%
	Social impacts	472	46%	231	46%	241	45%
	All of the attributes were important	266	26%	131	26%	135	25%

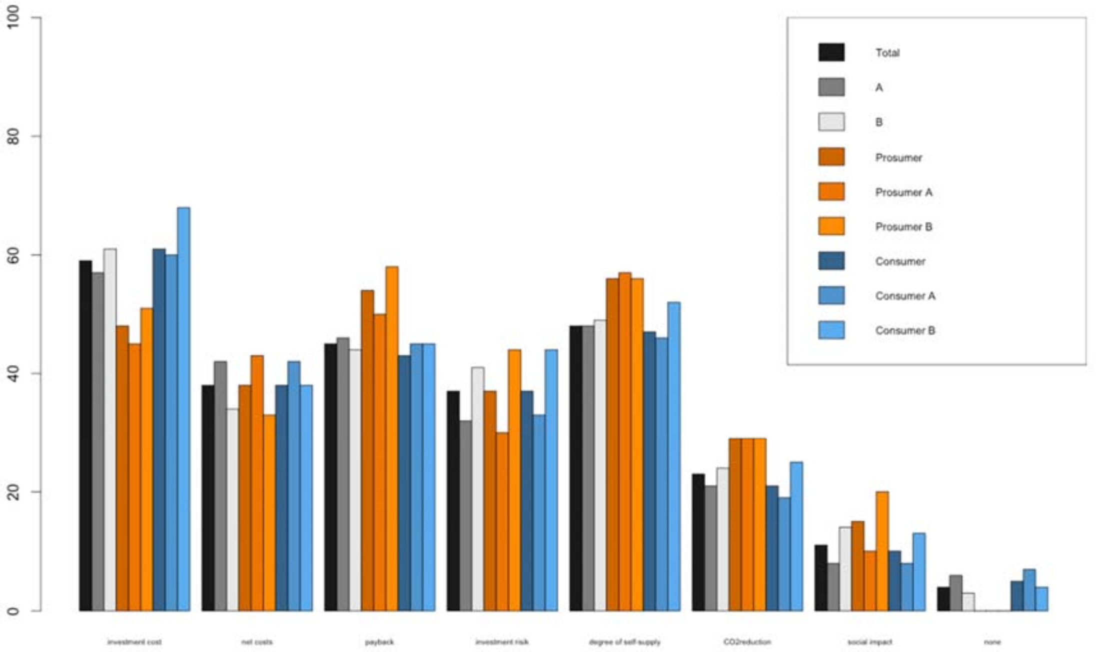

Figure A.1: Stated main relevant attributes after the choice experiment (in %, multiple options)

Figure A. 1 gives an overview of the stated attribute relevance based on the choice experiments. It shows notable differences in the attribute valuation between prosumer and consumer and between respondents in the two treatments A (complex decision) and B (simplified separate usage and investment decision). Consumers attribute a higher importance to high investment costs than prosumers, while prosumers more frequently state that the payback period, the electricity self-supply, and CO_2 reduction are main relevant attributes. Between the treatments we find that respondents in treatment B more frequently state that the investment costs, investment risks, social impacts, as well as payback period (only prosumer), electricity self-supply (only consumer), and CO_2 reduction (only consumer) are the main relevant attributes for their selection decision. The net electricity costs play a more important role in treatment A, most likely due to their summarizing character.

Table A.7: Stated relevance of other attributes that were not considered in the choice experiment

Attributes	n	%	See for example:
Period of guarantee	538	52	Achtnicht (2011)
Expected operating life	532	52	Lizin et al (2012)
Space requirement of system	456	44	~Integratability in Lizin et al (2012), ~inconvenience in Scarpa/Willis (2010).
Public and/or private funding	401	39	Achtnicht (2011)
Ownership structure (ownership, leasing or renting agreement)	351	34	Galassi/Madlener (2014)
Minimum contract period	341	33	Scarpa/Willis (2010), Galassi/Madlener (2014)
Installation of storage system (implicit in self-supply)	287	28	Galassi/Madlener (2014)
Place of manufacture (Germany, China, USA)	259	25	~Employment in Bergmann et al (2006), Bergmann et al (2008), Longo et al (2008), Ku/Yoo (2010)
Generation location (at home, neighborhood association)	255	25	None
Opinion of an independent energy advisor	252	24	Achtnicht (2011)
Share of RES on consumed electricity (e.g. 100%)	236	23	Amador et al (2013)
System extension possibilities	227	22	~Integratability in Lizin et al (2012),
Recommendation of installer	178	17	~Scarpa/Willis (2010)
Personal recommendation (e.g. friends, relatives, neighbors)	146	14	~Scarpa/Willis (2010)
Network effect (stabilizing destabilizing)	136	13	~Nearest related are the social impacts in our choice experiment
"Island operation" – independence from grid	106	10	None
All decision-relevant characteristics were given	70	7	
Other	14	1	

Table A.8: MWTP in terms of investment costs (in Euros) for basic and reduced models

Attribute	Level	Model 1.0			Model 2.0			Model 1.2			Model 2.2		
Degree of electricity self-supply	**num. in %**				**227**	199	200				**195**	174	218
	20%	**4,221**	1,918	6,525	**4,540**	3,986	4,006	**4,310**	2,481	6,184	**3,902**	3,488	4,368
	50%	**12,855**	10,327	15,582	**11,350**	9,965	10,015	**10,254**	8,367	12,250	**9,755**	8,720	10,920
	80%	**18,397**	15,658	21,601	**18,160**	15,944	16,024	**16,011**	13,933	18,329	**15,608**	13,952	17,472
	100%	**22,509**	19,493	26,041	**22,700**	19,930	20,030	**19,573**	17,352	22,077	**19,510**	17,440	21,840
CO_2 reduction	**50%**	**2,638**	707	4,612	**2,611**	707	4,562	**2,509**	976	4,041	**2,510**	993	4031
	100%	**5,667**	3,713	7,731				**4,356**	2,822	5,958			
	200%	**5,252**	3,337	7,313				**5,705**	4,116	7,303			
	100% or more				**5,459**	3,738	7,291				**5,030**	3667	6475
Social impacts	Negative	**-6,706**	-8,637	-4,933	**-6,705**	-8,653	-4,981	**-4,678**	-6,090	-3,336	**-4,670**	-6099	-3353
	Positive	**3,957**	2,334	5,688	**3,939**	2,345	5,668	**2,871**	1,580	4,220	**2,870**	1608	4193
Payback period	**num. in years**				**-853**	-1,006	-719				**-705**	-817	-604
	5 years	**4,349**	2,720	6,083	**-4,263**	-5,028	-3,595	**4,272**	2,965	5,649	**-3,524**	-4087	-3021
	10 years	**Base**			**-8,525**	-10,056	-7,190	**Base**			**-7,047**	-16346	-12082
	20 years	**-8,477**	-10,484	-6,647	**-17,050**	-20,112	-14,380	**-6,404**	-7,903	-5,019	**-14,094**	-16346	-12082
Investment risks	High	**-8,220**	-10,215	-6,407	**-8,205**	-10,219	-6,395	**-10,186**	-11,832	-8,637	**-10,173**	-11809	-8662
	Low	**4,585**	2,922	6,358	**4,580**	2,938	6,304	**5,170**	3,884	6,540	**5,193**	3863	6537
Net electricity costs	**num. in %**				**-257**	-302	-219						
	60%	**9,628**	7,638	11,828	**-15,444**	-18,120	-13,128						
	80%	**4,291**	2,393	6,337	**-20,592**	-24,160	-17,504						
	100%	**Base**			**-25,740**	-30,200	-21,880						
	120%	**-6,130**	-8,338	-4,128	**-30,888**	-36,240	-26,256						
Treatment group		A			A			B2			B2		

Table A.9: Sample distribution of respondent's household income (differentiated by prosumer status)

Income group (in Euros)			**Prosumer**		**Consumer**		**Diff.**
	n	**%**	**n**	**%**	**n**	**%**	**%-points**
≤2,600 (low)	262 (25%)	**29%**	33 (20%)	**22%**	229 (26%)	**31%**	-8%
2,600-3,600 (medium low)	267 (26%)	**30%**	30 (18%)	**20%**	237 (27%)	**32%**	-11%
3,600-5,000 (medium high)	252 (24%)	**28%**	49 (30%)	**33%**	203 (23%)	**27%**	6%
≥ 5,000 (high)	111 (11%)	**12%**	35 (24%)	**24%**	76 (9%)	**10%**	14%
All stated	892 (87%)	**100%**	147 (90%)	**100%**	745 (86%)	**100%**	0%
No indication	138 (13%)		16 (10%)		122 (14%)		
All Sample	1,030 (100%)		163 (100%)		867 (100%)		

Table A. 10: Attribute overview for respondents in treatment A (in German)

Übersicht Eigenschaften: Variante A

!Programmierhinweis monatlich oder jährlich je nach dem welches Feld in S3 Stromkosten ausgefüllt wurde

Für die Entscheidung, welche Stromerzeugungsanlage Sie kaufen möchten, stehen Ihnen folgende Informationen zur Verfügung:

Eigenschaften	Ausprägungen
Anschaffungskosten Ggf. inkl. Investitionskostenzuschüsse aus öffentlicher und/oder privater Hand.	5 000 € 10 000 € 20 000 €
Monatliche/ jährliche[25] **Nettostromkosten** $= \frac{\mathit{Gesamtkosten}}{\mathit{Nutzungsdauer}} + \mathit{Strombezugskosten} - \mathit{Stromerlöse}$ Gesamtkosten umfassen Investitions-, Betriebs-, Finanzierungskosten und Steuern, Strombezugskosten fallen ggf. für den nicht selbstgedeckten Stromverbrauch an und Stromerlöse ergeben sich ggf. aus Einnahmen für die Stromeinspeisung und sonstigen Einsparungen.	X € (60 %) X € (80 %) X € (100 %) X € (120 %)
Amortisationsdauer Die Anzahl der Jahre nach denen sich die Anschaffung der Anlage rechnet.	5 Jahre 10 Jahre 20 Jahre
Investitionsrisiko (Verlustwahrscheinlichkeit) Gutachterliche Einschätzung des Investitionsrisikos in drei Stufen: 1) Spekulative Investition mit hohem Risiko (10,0 %): bei ungünstiger Marktentwicklung ist ein Verlust wahrscheinlich (wie bei Aktien). 2) Mittel riskante Investition (1,0 %): bei Verschlechterung der Marktsituation ist mit Einnahmeverlusten zu rechnen und ein Verlust ist möglich jedoch sehr unwahrscheinlich (wie bei risikoarmen Finanzanlagen). 3) Sichere Investitionen mit niedrigem Risiko (0,1 %): bei denen Einnahmeausfälle und Verlustrisiko langfristig vernachlässigbar sind, z.B. aufgrund staatlicher Garantien.	Hoch (10,0 %) Mittel (1,0 %) Niedrig (0,1 %)
Eigenversorgungsgrad Gibt den Anteil Ihres Stromverbrauchs an, den Sie mit der Anlage über das Jahr hinweg selbst decken können und nicht mehr aus dem Netz beziehen müssen. Der Eigenversorgungsgrad kann insbesondere durch die Installation eines Speichers und moderner Energie-Managementmaßnahmen erhöht werden.	0 % (keine Eigenversorgung) 20 % (niedrig) 50 % (mittel) 80 % (hoch) 100 % (Selbstversorger)
CO_2-Verminderung (Klimaschutzbeitrag) Bezogen auf die CO_2-Emissionen des bisherigen Strombezugs. Durch die Anlage können CO_2-Emissionen, die mit dem Strombezug verbunden sind, reduziert werden. Durch die Einspeisung regenerativen Stroms ins Netz können die CO_2-Emissionen sogar über 100% reduziert werden.	0 % 50 % 100 % 200 %
Soziale Auswirkungen Einschätzung zu sonstigen sozialen Auswirkungen, z.B. wenn durch (Um-)Verteilungseffekte die Stromkosten für andere private Haushalte steigen/sinken.	Negativ Neutral Positiv

---

[25] Programmierhinweis monatlich oder jährlich je nach dem welches Feld in S3 Stromkosten ausgefüllt wurde.

Table A. 11: Both attribute overviews for respondents in treatment B (in German)

Übersicht Eigenschaften: Variante B – Teil 1

Für die Entscheidung, welche Stromerzeugungsanlage Sie kaufen möchten, stehen Ihnen folgende Informationen zur Verfügung:

Eigenschaften	Ausprägungen
Monatliche/ jährliche***Nettostromkosten** $= \frac{Gesamtkosten}{Nutzungsdauer} + Strombezugskosten - Stromerlöse$ Gesamtkosten umfassen Investitions-, Betriebs-, Finanzierungskosten und Steuern, Strombezugskosten fallen ggf. für den nicht selbstgedeckten Stromverbrauch an und Stromerlöse ergeben sich ggf. aus Einnahmen für die Stromeinspeisung und sonstigen Einsparungen.	X € (60 %) X € (80 %) X € (100 %) X € (120 %)
Eigenversorgungsgrad Gibt den Anteil Ihres Stromverbrauchs an, den Sie mit der Anlage über das Jahr hinweg selbst decken können und nicht mehr aus dem Netz beziehen müssen. Der Eigenversorgungsgrad kann insbesondere durch die Installation eines Speichers und moderner Energie-Managementmaßnahmen erhöht werden.	0 % (keine Eigenversorgung) 20 % (niedrig) 50 % (mittel) 80 % (hoch) 100 % (Selbstversorger)
CO_2-Verminderung (Klimaschutzbeitrag) Bezogen auf die CO_2-Emissionen des bisherigen Strombezugs. Durch die Anlage können CO_2-Emissionen, die mit dem Strombezug verbunden sind, reduziert werden. Durch die Einspeisung regenerativen Stroms ins Netz können die CO_2-Emissionen sogar über 100% reduziert werden.	0 % 50 % 100 % 200 %
Soziale Auswirkungen Einschätzung zu sonstigen sozialen Auswirkungen, z.B. wenn durch (Um-)Verteilungseffekte die Stromkosten für andere private Haushalte steigen/sinken.	Negativ Neutral Positiv

*Programmierhinweis monatlich oder jährlich je nach dem welches Feld in S3 Stromkosten ausgefüllt wurde.

Übersicht Eigenschaften: Variante B – Teil 2

Für die Entscheidung, welche Stromerzeugungsanlage Sie kaufen möchten, stehen Ihnen folgende Informationen zur Verfügung:

Eigenschaften	Ausprägungen
Anschaffungskosten Ggf. inkl. Investitionskostenzuschüsse aus öffentlicher und/oder privater Hand.	5 000 € 10 000 € 20 000 €
Amortisationsdauer Die Anzahl der Jahre nach denen sich die Anschaffung der Anlage rechnet.	5 Jahre 10 Jahre 20 Jahre
Investitionsrisiko (Verlustwahrscheinlichkeit) Gutachterliche Einschätzung des Investitionsrisikos in drei Stufen: 1) Spekulative Investition mit hohem Risiko (10,0 %): bei ungünstiger Marktentwicklung ist ein Verlust wahrscheinlich (wie bei Aktien). 2) Mittel riskante Investition (1,0 %): bei Verschlechterung der Marktsituation ist mit Einnahmeverlusten zu rechnen und ein Verlust ist möglich jedoch sehr unwahrscheinlich (wie bei risikoarmen Finanzanlagen). 3) Sichere Investitionen mit niedrigem Risiko (0,1 %): bei denen Einnahmeausfälle und Verlustrisiko langfristig vernachlässigbar sind, z.B. aufgrund staatlicher Garantien.	Hoch (10,0 %) Mittel (1,0 %) Niedrig (0,1 %)
CO_2-Verminderung (Klimaschutzbeitrag) Bezogen auf die CO_2-Emissionen des bisherigen Strombezugs. Durch die Anlage können CO_2-Emissionen, die mit dem Strombezug verbunden sind, reduziert werden. Durch die Einspeisung regenerativen Stroms ins Netz können die CO_2-Emissionen sogar über 100% reduziert werden.	0 % 50 % 100 % 200 %
Soziale Auswirkungen Einschätzung zu sonstigen sozialen Auswirkungen, z.B. wenn durch (Um-)Verteilungseffekte die Stromkosten für andere private Haushalte steigen/sinken.	Negativ Neutral Positiv
Eigenversorgungsgrad Gibt den Anteil Ihres Stromverbrauchs an, den Sie mit der Anlage über das Jahr hinweg selbst decken können und nicht mehr aus dem Netz beziehen müssen. Der Eigenversorgungsgrad kann insbesondere durch die Installation eines Speichers und moderner Energie-Managementmaßnahmen erhöht werden.	0 % (keine Eigenversorgung) 20 % (niedrig) 50 % (mittel) 80 % (hoch) 100 % (Selbstversorger)