



Explaining and promoting participation in demand response programs: The role of rational and moral motivations among German energy consumers

Daniel Sloot^{*}, Nico Lehmann, Armin Ardone

Karlsruhe Institute of Technology, Karlsruhe, Germany

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ABSTRACT

Demand response programs aim to increase flexibility in electricity consumption. Yet, their success hinges on a sufficient level of consumer participation, which makes it important to understand the factors that motivate participation. Though it is often assumed that consumers participate in demand response programs for the potential financial benefits, these programs can also generate collective environmental benefits, such as an increase in the share of renewable energy. Consequently, we studied potential motivations that underlie individuals' participation in demand response programs (indicated by their acceptance, interest, and intention to participate). By examining the role of specific beliefs about costs and benefits and the role of general personal motivations (i. e., financial, environmental, and innovation-seeking) for individuals' participation in quota schemes (a novel type of incentive-based demand response), we found that both financial and environmental beliefs underlie participation. Moreover, compared to a personal financial motivation, a personal environmental motivation (and, to a lesser extent, an innovation-seeking motivation) was both more strongly related to participation and better able to explain favorable beliefs about participation. Furthermore, we experimentally manipulated different benefits and modes of participation (through frame manipulation) and found that emphasizing the environmental benefits of participation leads to stronger acceptance and interest in participating among those strongly motivated by the environment. Conversely, this tailoring effect does not exist among those strongly financially motivated when the financial benefits are emphasized. Additionally, participation was generally higher when participation was described as voluntary compared to mandatory. We discuss the theoretical and practical implications arising from these findings.

1. Introduction

Mitigating the adverse effects of climate change requires a rapid transition towards a more sustainable energy system [1]. This need is being met by an increasing share of renewable energy sources and by increasing electrification in areas such as mobility and heating on the demand side. Yet, these developments pose new challenges for electric grids due to the growing fluctuation of electricity generation on the supply side (e.g., due to weather conditions) and the growing demand due to new electricity-intensive appliances (e.g., electric vehicles and heat pumps). Demand response programs are an increasingly popular policy approach to address these challenges, as they can generate demand-side flexibility during certain grid conditions [2,3]. Crucially, electricity consumers need to engage in such demand response programs in order for these programs to reach their full potential.

The first step towards successful consumer engagement with demand

response is consumers' initial participation in these programs [4,5], such as their willingness to enroll. However, little is known about consumers' willingness to participate in demand response programs and initial findings from studies or trials suggest that ensuring participation is a primary challenge for the success of demand response [5,6]. As demand response programs typically aim to change consumers' energy consumption via financial incentives, their common assumption is that informed consumers make an economically rational decision to participate in demand response programs that generate financial benefits [7,8]. Recent research from the field of social psychology has questioned the validity of this rational consumer assumption by showing that energy behavior is often not merely influenced by economically self-interested decision making but by a range of broader factors such as moral and social considerations [9–12]. Yet, insights into the factors underlying participation in demand response programs are scarce. For example, in a recent review, Parrish and colleagues [3] identified both

^{*} Corresponding author.

E-mail address: daniel.sloot@kit.edu (D. Sloot).

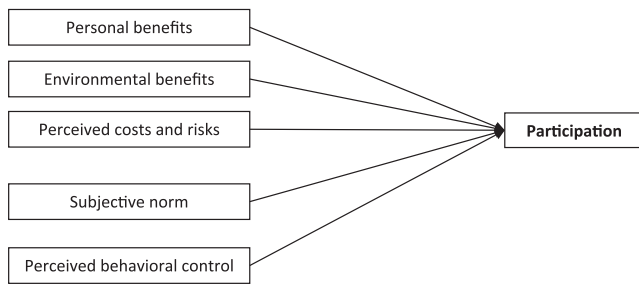


Fig. 1. Theory of planned behavior model.

financial and environmental benefits as underlying participation in demand response programs but their findings point to the need for more research on the role of environmental motivations next to financial ones.

This paper aims to investigate why consumers participate in demand response programs by addressing two related questions. First, we examine which personal motivations and beliefs can explain participation, including financial and environmental motivations. Specifically, we compare the predictive power of beliefs about participation (e.g., beliefs about personal benefits) within a theory of planned behavior framework and the predictive power of personal motivations such as individuals' environmental self-identity. By then integrating these different models of decision-making, we test which motivations can best explain consumers' participation in demand response programs and shed more light on the process of this decision-making. Second, we examine the extent to which the design and communication of demand response programs via persuasive appeals has the potential to affect participation. In particular, we experimentally manipulate the presentation of a demand response program that requires mandatory or allows voluntary participation and emphasizes financial benefits, environmental benefits, or benefits for the security of supply. We thereby explore what program design is most effective in promoting participation among consumers and test if the communicated benefits are particularly effective when tailored to pre-existing personal motivations of consumers.

In the remainder of this paper, we will first review types of demand response programs as well as behavioral theories on personal motivations and beliefs pertaining to the participation in these programs. We will then describe the research design comprising of correlational measures and an experimental manipulation, and subsequently present our empirical findings. Lastly, we discuss theoretical and practical implications arising from these findings.

2. Literature review

2.1. Types of demand response programs

Demand response programs can broadly be distinguished into two categories [8]. First, price-based programs, such as time-of-use (TOU) or critical peak pricing (CPP), aim to reduce or shift demand during peak times by imposing higher prices on electricity during these times of high consumption. Second, incentive-based programs aim to generate changes in electricity demand by rewarding consumers for their participation. For example, critical peak rebate (CPR) programs provide financial incentives for consumers to reduce their consumption by a certain margin during times of (infrequent) high demand. Moreover, demand response programs differ in whether participation is mandatory, semi-mandatory (e.g., for households with certain appliances), or voluntary e.g., [13]. Whereas some programs require mandatory participation of the target households e.g., [14], participation is often voluntary and requires households to actively sign up for these programs [5].

Quota schemes are one specific type of demand response program currently being discussed and trialed by policy makers and grid

operators in Germany. Similar to CPR programs, they aim to incentivize consumers to provide flexibility in their electricity consumption during times of infrequent high demand in a certain local grid area [15]. A distinct characteristic of quota schemes is the idea that local grid operators can issue a quota on electricity consumption to the households participating in the program, which caps the maximum consumption during certain peak times relative to a baseline. Quotas are communicated to households in a given local area on a day-ahead basis, as a result of forecasts predicting tight grid conditions on the next day. Participating households then limit their electricity consumption to a prescribed limit (e.g., 70% of the planned load) during the quota event. In return for their flexibility during the quota events, households receive a financial reward for their participation, for example through reductions in grid charges that are part of the electricity bill [16].

Participation in demand response programs offers different benefits to consumers. First, demand response programs are typically designed to generate personal benefits to those participating in the form of financial rewards [3,8]. Second, though often less emphasized to consumers, participation in demand response programs generates environmental benefits, as the reduction in peak consumption helps to avoid the activation of additional power plants (often using fossil fuels during peak hours) and therefore allows the feed-in of more renewable energy into the grid [17]. Third, by participating in demand response programs, consumers can help in overcoming potential grid congestions and thus contribute to a secure and stable local grid without technical interruptions.

2.2. Motivational factors underlying participation in demand response programs

Demand response programs typically rest on the assumption of economically rational decision-making by consumers, as the programs generally rely on consumers responding to changing electricity prices (e.g., TOU or CPP pricing) or financial rewards (e.g., CPR) [7,8]. The theory of planned behavior (TPB; [18]) offers a theoretical framework to analyze participation from such a perspective of rational decision-making. The theory is widely used in behavioral research and has been found to be predictive of a wide range of energy-related behaviors [e.g., [19–22]]. The TPB predicts that a behavior results from an intention to perform this behavior, and this intention in turn is the result of three factors reflecting perceived costs and benefits for consumers: first, attitudes towards the behavior, stemming from beliefs about the consequences of engaging in the behavior; second, a subjective norm to engage in the behavior stemming from perceived social pressure; and third, perceived behavioral control, the perception that one is able to engage in the target behavior [18]. Research that has comprehensively tested the theory of planned behavior in the context of participation in demand response programs is scarce. Based on theoretical grounds and the benefits of demand response participation introduced above, we reason that participation in demand response should be more likely when consumers perceive personal (e.g., financial) and environmental¹ benefits of their participation and perceive little costs or risks. Participation should also be more likely when consumers perceive important others to value participation and when they see themselves as able to shift their electricity consumption during peak times (see Fig. 1).

¹ In line with Wolske et al. [23], we include beliefs about collective environmental benefits next to those about personal benefits. Environmental benefits arguably do not reflect considerations of narrow self-interest, but they can nevertheless be part of a rational decision-making process by reflecting a rational evaluation of the utility of participation due to environmental benefits. As such, while we distinguish them here from factors of moral decision making, such as feelings of moral obligation captured by personal norms, beliefs about environmental benefits could also relate to dimensions of moral decision-making. We thank an anonymous reviewer for pointing to this.

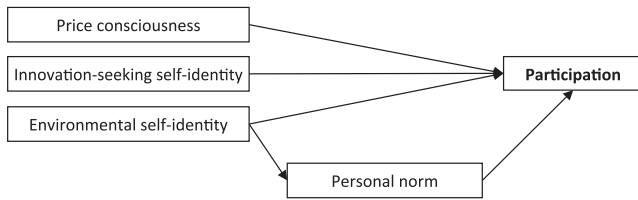


Fig. 2. Personal motivations and personal norm model.

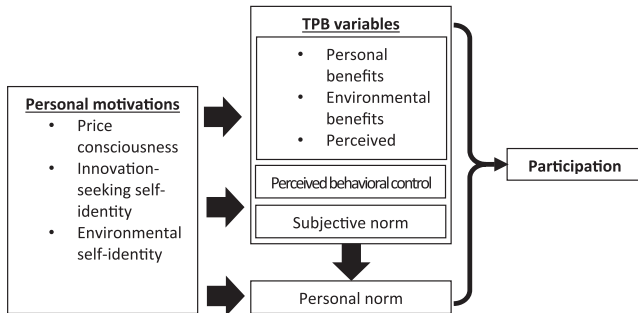


Fig. 3. Integrated model of personal motivations, beliefs, and norms.

A body of research has shown that different types of personal motivations can influence energy behavior [12,24], e.g., [25]. In contrast to the specific beliefs captured by the theory of planned behavior, general personal motivations reflect more overarching goals or identities not tied to a particular behavior. In line with the assumption that demand response participation is largely driven by the prospect of financial incentives, individuals could be more likely to participate when they are generally motivated to be price conscious, reflecting the motivation to seek out economically advantageous options when making decisions [26,27]. While a price-conscious individual would be expected to participate in demand response from a perspective of rational decision making, findings on other types of energy behavior have shown that the assumption of rational behavior is often not realistic and other motivations than narrow cost-benefit calculations may influence energy behavior [9,24,28–30]. In addition, the financial benefits of participation in demand response may be perceived as small, making it questionable if the level of price consciousness is a strong motivator of participation [8], cf. [31]. This emphasizes the need to consider other types of motivations that reflect concerns beyond narrow cost-benefit analyses.

Energy behaviors (including participation in demand response programs) can be seen as reflecting a pro-environmental behavior [cf. [32]] and research has examined these behaviors through a lens of moral decision making as well. In contrast to theories of rational decision-making, the assumption of this line of research is that individuals are often intrinsically motivated to engage in pro-environmental behavior and consider the environmental consequences of their actions [9,24]. Environmental self-identity is a key personal motivation in this reasoning, capturing the extent to which individuals see themselves as someone who acts in a pro-environmental manner [33–35]. Individuals strive to behave consistent with this self-perception, and those with a strong environmental self-identity are thus likely to engage in a broad range of pro-environmental behaviors, including sustainable energy behaviors e.g., [36–38]. Studies have further shown that environmental self-identity influences sustainable energy behaviors via increasing individuals' moral obligation (typically defined as personal norms) to engage in the behavior [37,39].

Moreover, demand response is a relatively new concept with which most consumers are not yet familiar. Therefore, a third general personal motivation potentially relevant for explaining participation could be the extent to which individuals see themselves as someone who seeks out

new products and innovations. As posited by diffusion of innovation theory, some consumers adopt new social or technological innovations sooner than others, depending on their personal propensity to seek out new innovations [40]. Recent research has shown that such novelty-seeking motivations can explain other types of innovative energy behaviors such as the uptake of photovoltaic systems [23]. Yet, it is unclear whether price consciousness, environmental, or innovation-seeking personal motivations can best explain individuals' participation in demand response programs and whether these motivations can extend the explanation of participation by a TPB model, which we will address in this research (Fig. 2).

Because personal motivations, such as one's price consciousness or environmental self-identity, reflect a more general type of motivation, they can be expected to be less influential in directly predicting participation in demand response compared to the more behavior-specific TPB variables or personal norms (the compatibility principle; [41]). We will thus test the role of personal motivations and more specific beliefs in an integrated model that proposes general personal motivations as more distant predictors underlying more concrete beliefs and norms (Fig. 3). This model builds on the reasoning of other scholars who integrated TPB variables with additional variables from moral models of decision making and other personal motivations e.g., [19,23,42]. As research has shown, the relationship between environmental self-identity and pro-environmental behavior is mediated by personal norms ([33,37]; see also Fig. 2), and past research has seen personal norms as a penultimate variable through which beliefs about benefits or subjective norms (e.g., as conceptualized in the TPB) influence intentions or behavior [42,43]. Additionally, more concrete beliefs about benefits, costs and risk may explain the effects of general personal motivations on the participation in demand response programs [44], cf. [45], although it remains an open question which personal motivations may form a motivational basis for more concrete beliefs and therefore affect demand response participation indirectly, and to what extent.

2.3. Using appeals to promote participation in demand response programs

Identifying relevant motivations and beliefs underlying participation in demand response programs is an important step towards developing strategies to promote participation. Research has investigated the effectiveness of informational appeals via persuasive messages as one potential strategy to promote energy-related behaviors [11,30]. Such appeals typically emphasize certain benefits of engaging in a behavior or participating in a program, with financial and environmental appeals having received the most attention. As persuasive appeals are likely to be effective when they address important pre-existing motivations [cf. [9]], this attention corresponds to insights that financial and environmental motivations can underlie energy behavior, as discussed in the preceding section. Some empirical findings comparing the effectiveness of financial and environmental appeals indicate that financial appeals may be less effective in promoting sustainable energy behavior compared to environmental appeals [e.g., [10,11]]. Yet, these effects are often small and other studies have found no differences between financial and environmental appeals [46,47]. To reconcile these inconclusive findings, researchers have recently suggested that appeals may need to be tailored to pre-existing personal motivations at an individual level [47–49]. Empirical findings support this idea, for example showing that environmental appeals have a stronger effect in changing environmental attitudes and behavior among those with strong environmental values [49,50]. In line with this, we propose that appeals emphasizing the financial benefits of participating in a demand response program should be more effective among individuals who are personally strongly motivated to achieve these benefits (e.g., due to a strong price consciousness) and appeals emphasizing environmental benefits should be more effective among those with a strong environmental self-identity.

3. Current research

We conducted a nationally representative online questionnaire study in October 2020 among a commercial panel of German consumers. The novelty of quota schemes, which have thus far not been implemented in practice, meant that we had to capture participation in this scheme as a hypothetical future decision. Correspondingly, we measured three indicators as proxies of participation, namely acceptance of the quota scheme, interest in participating in the scheme, and a more specific intention to participate that was expressed repeatedly after participants had rated different concepts of a quota scheme in a choice experiment [51].

In line with our reasoning above, we expected that individuals with more positive beliefs about participation in the quota scheme (as reflected by the TPB) are more likely to participate. We also expected that those with a stronger environmental self-identity and stronger personal norms are more likely to participate, suggesting that participation in demand response programs can be driven by both rational and moral concerns. Whereas we also expected that those with a stronger innovation-seeking self-identity are more likely to participate, we had no specific expectation about the role of price consciousness, as research has pointed to the financial benefits of demand response often being too small to influence participation e.g., [31]. In an integrated model with both personal motivations and concrete beliefs, we expected general personal motivations' effects on participation to diminish relative to the concrete beliefs. Yet, general personal motivations likely underlie these concrete beliefs and may thus predict participation indirectly. Additionally, we tested if beliefs may in turn predict participation via personal norms, which are often conceptualized as a penultimate factor closely related to intentions and behavior [43]. The primary goal of these analyses is thus to identify the motivations underlying individuals' decision to participate in quota schemes.

Building on this first part, we next tested whether emphasizing financial or environmental benefits in short informational messages could increase participation, as these appeals directly target the economically rational and moral motivations potentially underlying participation. Previous research has discussed the difficulty of including no-appeal control conditions in contexts where individuals may automatically associate energy behavior with certain motivations e.g., [30]. Instead of a control condition, we included an emphasis of the security of supply, which does not correspond to underlying financial or moral considerations (yet only allows relative comparisons between the appeals). In line with previous findings on the ineffectiveness of general information campaigns using appeals, we hypothesized that the effectiveness of emphasizing certain benefits of participation depends on whether these benefits corresponded to people's pre-existing personal motivations, namely their price consciousness and environmental self-identity. Next to the emphasis of one of the three benefits, the informational messages varied in whether participation in the quota scheme was described as mandatory (for all households), semi-mandatory (with households using electric vehicles or electric heat pumps), or voluntary. We primarily included this for practical purposes, to help inform current policy discussions on these different participation modes, expecting that quota schemes with voluntary participation are more accepted and also provide higher levels of interest in participating compared to quota schemes with mandatory (or semi-mandatory) participation. However, we were also interested in exploring if there would be any differences in the effectiveness of different appeals depending on the prescribed participation mode. This is an interesting question, as the collective benefits of participation can only be achieved if enough, or all, households participate in the quota scheme. For example, a stronger environmental self-identity might enhance the effects of emphasized environmental benefits more so when participation in the quota scheme is (semi-)mandatory, because in a program with voluntary participation and few participating households, the environmental benefits might be perceived as negligible.

4. Method

4.1. Participants and design

An a priori power analysis indicated that a sample of roughly 900 participants would be necessary to detect a small to medium effect ($f = 0.15$) given the number of experimental groups (specified below) and the covariates included in the model (alpha level = 0.05, power = 0.80). We thus targeted an overall sample size of 1000 participants and obtained complete responses from 1102 participants who filled out a questionnaire via a commercial online panel. The sample was representative of the German population regarding gender, age, and the level of education. Complete responses included those participants who passed two attention-check items as well as straightlining checks and did not terminate the questionnaire early. We screened this dataset and excluded an additional 68 participants for extreme response behavior. The final sample included 1034 participants (51% female, $M_{age} = 48.13$ years, $SD = 15.63$). Participants' education level and income were representative of the German population, with a median net household income of 2000–2600€. Moreover, 38% of participants owned their house or apartment, the remaining were tenants. Most participants lived in a two-person household ($M = 1.97$, $SD = 0.99$), though household size commonly varied from one to five household members, with only seven households bigger than this number. The final sample included 1034 participants. See Appendix A for a detailed comparison with German population statistics.

The experimental manipulation consisted of a 3 (Benefit: financial vs. environmental vs. security) \times 3 (Participation: mandatory vs. semi-mandatory vs. voluntary) between-subjects factorial design, thus containing nine experimental groups.

4.2. Materials and procedure

Most people are unfamiliar with the concept of demand response and quota schemes in particular, which could hamper valid ratings of beliefs and participation in such programs. Therefore, we introduced the concept to participants at the beginning of the online study via a five-minute video that explained the need for demand response programs, the basic purpose of quota schemes, and the implications of participating in an easily accessible way (see Supplementary Materials for a more detailed explanation including screenshots). Afterwards, participants took part in a discrete choice experiment (not part of this article) and rated their intention to participate in each of their chosen alternatives. Next, participants rated their agreement with a number of psychological variables. Subsequently, participants were randomly allocated to one of nine experimental groups that presented a hypothetical scenario on the introduction of the quota scheme. Specifically, participants were asked to imagine that a quota scheme would be established in their municipality in the following quarter. The text then specified that participation in this quota scheme would be either (a) mandatory for all households, (b) semi-mandatory such that only households with an electric vehicle and/or a heat pump would have to participate, or (c) voluntary (factor Participation). In addition, the text emphasized that fulfilling a quota by being flexible in one's electricity consumption (a) has financial advantages and lowers one's energy costs, (b) is beneficial for a successful energy transition, allows the feed-in of more renewable energies, and helps climate protection, or (c) is beneficial for the local grid and lowers the risk of blackouts (factor Benefit). The presentation of the scenarios was otherwise kept constant between conditions. On the next page, participants rated their agreement with the dependent variables acceptance of the quota scheme and interest to participate, followed by a manipulation check. The last part of the questionnaire contained socio-demographic variables.

Table 1
Overview of descriptive statistics and scale reliabilities for all measures.

Measure	Mean	SD	Min	Max	C's alpha	No. of items
Environmental self-identity	4.96	1.33	1	7	0.95	3
Innovativeness self-identity	3.82	1.46	1	7	0.87	3
Price sensitivity	5.30	1.39	1	7	0.90	3
Perceived personal benefits	5.07	1.26	1	7	0.84	3
Perceived environmental benefits	5.08	1.33	1	7	0.87	3
Perceived costs and risks	3.04	1.28	1	7	0.76	4
Perceived behavioral control	5.28	1.45	1	7	–	1
Personal norm	3.47	1.52	1	7	0.83	3
Subjective norm	4.13	1.16	1	7	0.86	2
Acceptance of the quota	4.78	1.68	1	7	0.96	3
Interest in participating in the program	4.95	1.67	1	7	0.88	2
Intention to participate	5.43	1.23	1	7	0.95	12

Table 2
Model comparisons based on OLS regression (N = 1,017)

Model	Predictor set	DV 1: Acceptance				DV 2: Interest				DV 3: Intention			
		Total R ²	R ² change	F change	P	Total R ²	R ² change	F change	p	Total R ²	R ² change	F change	p
Theory of planned behavior													
Step 1	Experimental conditions	0.04	0.04	5.51	< 0.001	0.02	0.03	3.16	0.002	–	–	–	–
Step 2	Socio-demographic variables	0.05	0.01	1.36	0.193	0.04	0.02	2.04	0.026	0.01	–	1.13	0.336
Step 3a	TPB variables	0.51	0.46	187.58	< 0.001	0.49	0.44	172.70	< 0.001	0.33	0.32	95.41	< 0.001
Personal motivations													
Step 1	Experimental conditions	0.04	0.04	5.51	< 0.001	0.02	0.03	3.16	0.002	–	–	–	–
Step 2	Socio-demographic variables	0.05	0.01	1.36	0.193	0.04	0.02	2.04	0.026	0.01	–	1.13	0.336
Step 3b	Personal motivations	0.19	0.14	54.41	< 0.001	0.19	0.15	60.59	< 0.001	0.10	0.09	34.03	< 0.001
Step 4b	Personal motivations (incl. personal norms)	0.41	0.23	383.69	< 0.001	0.41	0.21	357.44	< 0.001	0.20	0.11	123.43	< 0.001
Integrated model													
Step 5	Integrated model	0.57	0.06	32.32	< 0.001	0.55	0.06	31.47	< 0.001	0.35	0.02	9.50	< 0.001

*p < .05; **p < .01; ***p < 0.001; coefficients are standardized beta estimates

4.3. Measures

4.3.1. Predictor variables

Items were measured on a 7-point Likert scale from 1 (completely disagree) to 7 (completely agree) unless indicated otherwise. Compound scales were computed based on mean scores across items. See Table 1 for an overview of descriptive statistics and scale reliabilities (Appendix B provides a comprehensive list of all measured items). Socio-demographic variables (gender, age, level of education, income, house ownership, and household size) are described in detail in Appendix A.

Environmental self-identity. Three items measured the extent to which participants saw themselves as an environmentally friendly person (based on [34]).

Innovation-seeking self-identity. We adapted the environmental self-identity items to capture the extent to which participants saw themselves as someone who seeks innovation and innovative products.

Price consciousness. We measured participants' propensity to compare prices and identify the cheapest price with three items (loosely based on [52]).

Personal norm. Three items measured participants' personal norm to participate in the quota scheme (based on [37]).

Perceived personal benefits. Three items captured participants' belief that the quota scheme would generate personal benefits for them (items for this and the following four scales were adapted from [23]).

Perceived environmental benefits. Three items captured participants' belief that the quota scheme would have environmental benefits.

Perceived costs and risks. We measured participants' perception of different risks associated with the quota scheme, such as complexity or negative consequences on data protection or comfort.

Subjective norm. Two items captured the extent to which participants believed others in their neighborhood valued the energy transition and participation in the quota scheme.

Perceived behavioral control. One item captured perceived behavioral control to participate in the quota scheme.

4.3.2. Outcome variables

Acceptance of the quota scheme. Three items measured participants' level of acceptance for the quota scheme in general (e.g., "I am for the quota scheme").

Interest in participating. Two items measured to what extent participants were interested in participating in the quota scheme (e.g., "I am

interested in participating in the quota scheme").

Intention to participate. The questionnaire contained a discrete choice experiment in which participants were shown three options of a possible quota scheme that randomly varied on certain attributes (i.e., how many quotas there could be per year; how long the quota restrictions could last; at what time of the day the quotas could be in place; and how much of a monetary compensation participating households would get).² Participants had to choose their preferred option (out of the three) twelve times in a row, with varying levels of the four attributes. After each choice, participants were asked the following question: "Would you really participate in the quota scheme option you chose?" Participants answered this question on a 7-point Likert scale from 1 (certainly not) to 7 (certainly yes). Hence, participants repeatedly rated their level of intention to participate in the respective chosen option of the quota scheme and we assume that aggregating these twelve ratings reflects

² The discrete choice experiment itself is beyond the scope of this article in both its theoretical focus and methodology. Specifically, the aim of the choice experiment is to generate insights on people's preferences regarding the potential design of the quota scheme, for example regarding compensation structures etc., as opposed to examining underlying motivations that explain participation. Details on the discrete choice experiment can be requested from the corresponding author.

Table 3
Path analysis of acceptance, interest, and intention on theory of planned behavior predictors (Step 3a)

	Dependent variable		
	Acceptance of the quota scheme	Interest in participating	Intention to participate
Personal benefits	0.17***	0.17***	0.17***
Environmental benefits	0.26***	0.22***	0.10**
Perceived costs and risks	-0.15***	-0.12***	-0.22***
Subjective norm	0.14***	0.15***	0.02
Perceived behavioral control	0.16***	0.22***	0.21***
<i>N</i>	1,017	1,017	1,017
<i>R</i> ²	0.51	0.48	0.33

* $p < .05$; ** $p < .01$; *** $p < 0.001$; coefficients are standardized beta estimates

their overall propensity to participate in the quota scheme (in the choice modeling literature, this type of response format is known as certainty questions; e.g., [51]). Indeed, ratings had a very high internal consistency across the twelve choices and we thus formed a mean score for each participant. This outcome was measured before the experimental condition was administered and is thus not a dependent variable for these conditions.

5. Results

Consistent with our two research questions, we present our results in two parts. First, we investigate which factors can explain participation in the quota scheme by examining the role of different underlying beliefs and motivations. Specifically, we first test a theory of planned behavior model. Next, we examine the role of personal motivations, specifically environmental and innovation-seeking self-identities and price consciousness, and further test the moral route to participation by including personal norms in the model. We then test an integrated model containing all variables and analyze the indirect effects of personal motivations on the indicators of participation. We compute these models by conducting path analyses using the R package *lavaan* [53]. In all models, we follow the same stepwise procedure: Since acceptance and interest were measured after the experimental manipulation (which we were not focusing on in this first part), we controlled for the dummy-coded experimental conditions and their interaction terms (Step 1). Next, we added all socio-demographic variables (Step 2), and lastly added all focal variables to observe the unique variance explained by beliefs and personal motivations (Steps 3–5).³ Bivariate correlations between the tested variable are displayed in Appendix C.

Second, we investigate if certain emphasized benefits and the mode of participation affect participation by conducting multiple regression analyses for the two outcomes of acceptance and interest in participating. We included the (dummy-coded) condition variables (Step 1), the main effect of environmental self-identity and price consciousness (in separate models), and all two-way and three-way interactions between these variables (Step 2). All continuous predictor variables were mean-centered and we again controlled for the socio-demographic variables as described above.

5.1. What motivations and beliefs underlie participation in demand response programs?

Socio-demographic variables on their own explained only a very

³ Since the specific effects of socio-demographic variables were not focal to our research question, we do not display them in the main text for ease of interpretation. Appendix D presents all steps of the path analysis in full.

small proportion (about 1%) of the variance in the three outcome variables acceptance, interest, and intention (Table 2, Step 2).⁴ Only few relationships between the socio-demographic variables and the three outcomes reached statistical significance and these relationships were inconsistent across the three outcomes (detailed results are available in the online Supplementary Materials).

5.1.1. Theory of planned behavior

The theory of planned behavior variables on their own explained between 33% and 46% of additional variance in the three outcomes after socio-demographic variables were controlled for (Table 2, Step 3a). As expected, the more people perceived personal and environmental benefits, thought others in their neighborhood found it important to participate in the quota scheme, and felt able to use energy flexibly, the higher their likelihood to participate (see Table 3). Conversely, perceived costs and risks were negatively related to these outcomes. All relationships were consistent across the three outcomes (acceptance, interest, and intention to participate) with the only exception being that subjective norms were not significantly related to people's intention to participate in the quota scheme. Interestingly, while environmental benefits showed the strongest relationship with both acceptance and interest in participating relative to the other predictors, perceived costs and risks and perceived behavioral control showed the strongest (negative) relationship with intention to participate (see detailed results in Supplementary Materials for 95% confidence intervals that allow for a more in-depth comparison of estimates). This suggests that different considerations may play a role for consumers at different stages of their decision-making.

5.1.2. Personal motivations and personal norm

Environmental self-identity, innovation-seeking self-identity, and price consciousness explained between 9% and 14% of additional variance in the outcomes after controlling for socio-demographic variables (Table 2, Step 3b). Yet, the strength of the relationships differed across the variables and outcomes: environmental self-identity showed the strongest relationship with all three indicators of participation, while price consciousness was only related to the intention to participate (Table 4, Step 3b). Adding individuals' personal norms to participate to the previous model substantially increased the explained variance by an additional 11% to 23% across the outcomes (Table 2, Step 4b). Personal norms were strongly related to all three outcomes, indicating that the more strongly individuals felt morally obliged to participate in the quota scheme, the more likely they were to participate (Table 4, Step 4b). Environmental self-identity significantly predicted the extent to which people felt a personal norm in the first place and had a significant indirect effect on all three outcomes via personal norms (Table 4).

5.1.3. Testing an integrated model

When including all predictor variables in an integrated model (Fig. 3), the amount of explained variance improved further by an additional 2% to 6% across the three outcome variables (Table 2, Step 5). The theory of planned behavior variables showed similar relationships with the three outcomes in this full model compared to the previous analysis steps (Table 5). Personal norms maintained a consistent positive effect on all three outcomes that was the strongest among all predictor variables. In contrast, the relationships between the three general personal motivations and the outcomes were diminished, suggesting that their effects might be explained by other variables, such as the more proximate beliefs about benefits and risks. Indeed, the level of environmental self-identity was consistently related to all theory of planned behavior variables as well as personal norms, whereas

⁴ In the case of acceptance and interest this was the unique variance while controlling for the effects of the experimental conditions. Since these effects are the main focus of the second research questions, we return to these effects later.

Table 4
Path analysis of acceptance, interest, and intention on personal motivations

	Dependent variable						
	Personal norm	Acceptance of the quota scheme		Interest in participating		Intention to participate	
		Step 3b	Step 4b	Step 3b	Step 4b	Step 3b	Step 4b
Environmental self-identity (ESI)	0.33***	0.33***	0.15***	0.32***	0.15***	0.18***	0.06
Innovation-seeking self-identity	0.26***	0.10**	-0.05	0.13***	-0.01	0.13***	0.03
Price consciousness	-0.03	0.02	0.03	0.04	0.05	0.12***	0.13***
Personal norm			0.55***		0.53***		0.36***
Indirect effect ESI via personal norm			0.18***		0.18***		0.12***
N	1,017		1,017		1,017		1,017
R ²	0.24		0.41		0.40		0.20

p* < .05; *p* < .01; ****p* < 0.001; coefficients are standardized beta estimates

Table 5
Path analysis of acceptance, interest, and intention on all predictors (full model; Step 5)

	Dependent variable								
	Personal benefits	Environmental benefits	Perceived costs and risks	Subjective norm	Perceived behavioral control	Personal norm	Acceptance of the quota scheme	Interest in participating	Intention to participate
Environmental self-identity	0.24***	0.38***	-0.14***	0.31***	0.22***	0.13***	0.07*	0.07*	0.02
Innovation-seeking self-identity	0.16***	0.13***	-0.03	0.18***	0.09**	0.17***	-0.05	-0.05	0.04
Price consciousness	0.15***	0.06	-0.08*	0.01	0.10**	-0.08**	-0.03	-0.03	0.07*
Personal norm							0.30***	0.30***	0.30***
Personal benefits						0.15***	0.16***	0.14***	0.13**
Environmental benefits						0.22***	0.15***	0.10**	0.04
Perceived costs and risks						-0.02	-0.17***	-0.14***	-0.23***
Subjective norm						0.15***	0.06*	0.06	-0.03
Perceived behavioral control						0.14***	0.12***	0.18***	0.19***
N	1,017	1,017	1,017	1,017	1,017	1,017	1,017	1,017	1,017
R ²	0.15	0.22	0.05	0.18	0.10	0.46	0.56	0.54	0.35

p* < .05; *p* < .01; ****p* < 0.001; coefficients are standardized beta estimates for the direct effects

innovation-seeking self-identity and price consciousness showed weaker and less consistent relationships with these variables (Table 5).⁵

To further examine if general personal motivations predicted participation in quota schemes indirectly via more proximate beliefs, we estimated their indirect effects on the three outcomes (Table 6). As expected, most indirect effects of general personal motivations on acceptance, interest and intention to participate were statistically significant. Specifically, environmental self-identity predicted all three outcomes indirectly via increasing individuals' personal norms to participate, their beliefs about personal and environmental benefits, perceived costs and risks, subjective norms, and perceived behavioral control. Innovation-seeking self-identity influenced participation indirectly via increased personal (and partly environmental) benefits and perceived behavioral control. Price consciousness had an indirect effect on participation via personal benefits. Moreover, beliefs about environmental benefits and subjective norms also had an indirect effect on the outcomes via personal norms. These results suggest that the more individuals see

themselves as someone who acts pro-environmentally (and, to a lesser extent, seeks innovation) in general, the more likely they are to have positive beliefs, feel morally obliged, and, in turn, participate in the quota scheme.

5.2. Do emphasized benefits and mode of participation affect participation?

A successful manipulation check indicated that participants did indeed perceive the information emphasized by the respective persuasive appeals (see Appendix D for details). Two linear models showed no differences between the three benefit conditions on either outcome but, as expected, there were significant differences between the participation conditions (Table 8, Step 1; see Table 7 for the descriptive statistics per experimental condition). None of the two-way interactions between benefit and participation conditions reached significance. Tukey-HSD-adjusted post-hoc tests showed that the estimated marginal means for both acceptance and interest were significantly higher in the voluntary condition compared to the mandatory (*ps* < 0.001) and acceptance and interest were higher when participation was voluntary compared to semi-mandatory (*ps* < 0.001) but there was no significant difference between the mandatory and semi-mandatory condition (*ps* ≥ 0.070).

In the next step, there was a significant main effect of environmental self-identity on both acceptance and interest (Table 8, Step 2; see Supplementary Materials for the full statistical results displaying the effects of socio-demographic variables). In line with expectations, the interaction between environmental self-identity and the environmental benefit

⁵ We estimated the simultaneous model for each of the three main outcomes separately. As the effects of the general personal motivations on the theory of planned behavior variables and personal norms were very similar for all three outcomes, we only display these results in Supplementary Materials. For ease of interpretation, we estimated a separate model for the effects of general personal motivations on the TPB variables and personal norms (excluding the three outcomes of acceptance, interest, and intention) displayed in Table 6 in the main text.

Table 6
Indirect effects on acceptance, interest, and intention to participate

Indirect effect	Dependent variable		
	Acceptance of the quota scheme	Interest in participating	Intention to participate
Environmental self-identity (ESI) via personal norm	0.04***	0.04***	0.02**
ESI via personal benefits	0.04**	0.03**	0.03**
ESI via environmental benefits	0.06**	0.04*	0.02
ESI via perceived costs and risks	0.02**	0.02**	0.03**
ESI via subjective norm	0.02*	0.02*	-0.01
ESI via perceived behavioral control	0.03**	0.04***	0.04**
Innovation-seeking self-identity (ISI) via personal benefits	0.02**	0.02**	0.02*
ISI via environmental benefits	0.02*	0.01	0.01
ISI via perceived costs and risks	0.01	0.004	0.01
ISI via perceived behavioral control	0.03**	0.02*	0.02*
Price consciousness via personal benefits	0.02**	0.02**	0.02*
Environmental benefits via personal norm	0.08***	0.08***	0.04***
Subjective norm via personal norm	0.06***	0.06***	0.03**

* $p < .05$; ** $p < .01$; *** $p < 0.001$; coefficients are standardized beta estimates

frame was significant for both outcomes, indicating a tailoring effect of environmental self-identity. No other two-way or three-way interactions reached statistical significance. In the models examining price consciousness, no interaction effects were significant (all $ps > 0.050$), suggesting that the degree of price consciousness does not affect the extent to which emphasized financial benefits influence participation in quota schemes (the main effects were significant; see Supplementary Materials for all statistical results).

We probed the significant interaction effect between environmental self-identity and environmental benefit condition further (see Fig. 4a and b for the simple slopes plots; see Supplementary Materials for the simple slopes of environmental self-identity for each level of participation). For the outcome of acceptance, simple slopes analysis (Tukey-HSD-adjusted pairwise comparisons) indicated that the slope of

Table 7
Descriptive statistics for acceptance and interest per experimental group

Factor Benefit	Factor Participation	Dependent variable					
		Acceptance of the quota scheme			Interest in participating		
		Mean	SD	N	Mean	SD	N
Financial	Mandatory	4.27	1.85	125	4.65	1.76	125
	Semi-mandatory	4.77	1.50	124	4.97	1.52	124
	Voluntary	5.25	1.39	111	5.39	1.45	111
	Total	4.75	1.64	360	4.99	1.61	360
Environmental	Mandatory	4.52	1.90	103	4.82	1.88	103
	Semi-mandatory	4.59	1.64	115	4.64	1.74	115
	Voluntary	5.22	1.47	92	5.26	1.55	92
	Total	4.75	1.70	310	4.88	1.75	310
Security	Mandatory	4.42	1.81	118	4.80	1.69	118
	Semi-mandatory	4.82	1.60	122	4.82	1.67	122
	Voluntary	5.23	1.58	124	5.29	1.63	124
	Total	4.83	1.69	364	4.98	1.68	364
Total	Mandatory	4.40	1.85	346	4.75	1.77	346
	Semi-mandatory	4.73	1.58	361	4.82	1.64	361
	Voluntary	5.23	1.48	327	5.31	1.55	327
	Total	4.78	1.68	1034	4.95	1.67	1034

environmental self-identity in the environmental benefit condition was significantly greater than the slope in the financial ($p = .001$) or security benefit condition ($p = .037$), whereas there was no difference between the slopes in the financial and security benefit condition ($p = .480$). For those with a weak (-1 SD) environmental self-identity, acceptance of the quota scheme was lower in the environmental benefit condition compared the financial benefit condition ($p = .059$), whereas for those with a strong environmental self-identity, acceptance was significantly higher in the environmental benefit condition compared to the financial benefit condition ($p = .016$; all other $ps > 0.187$).

Results were similar for the outcome of interest in participating in the quota scheme. The slope of environmental self-identity in the environmental benefit condition was significantly greater than the slope in the financial ($p < .001$) or security benefit condition ($p = .017$), whereas there was no difference between the slopes in the financial and security benefit condition ($p = .486$). For those with a weak (-1 SD) environmental self-identity, acceptance of the quota scheme was significantly lower in the environmental benefit condition compared the financial benefit condition ($p = .005$), whereas for those with a strong environmental self-identity, acceptance was higher in the environmental benefit condition compared to the financial benefit condition ($p = .056$; all other $ps > 0.184$).

In summary, these results suggest that generally emphasizing certain benefits of quota schemes over others may not be effective in increasing participation in such schemes. However, the results consistently show that emphasizing the environmental benefits of participation can increase acceptance and participation among those with a relatively strong environmental self-identity while being less effective than financial appeals among those with a relatively weak environmental self-identity.

6. Discussion

This paper aims to explain why consumers participate in a novel type of demand response program and how participation can be promoted. For this purpose, we analyzed correlational data and tested an experimental intervention targeting some of the motivations assumed to underlie participation. Adopting the perspective that demand response programs often assume consumer decision-making based on financial considerations e.g., [8] but that participation can also provide environmental benefits [3], we examined the motivations underlying participation by integrating variables from different theories [cf. [54]]. Specifically, we compared the predictive power of theory of planned behavior variables (which assume a rational evaluation of expected costs and benefits, although these can include collective environmental

Table 8
Stepwise regression of acceptance and interest on benefit, participation, environmental self-identity, and their interaction

	Dependent variable			
	Acceptance of the quota scheme		Interest in participating	
	Step 1	Step 2	Step 1	Step 2
Benefit	0.09	0.09	0.07	0.06
environmental				
Benefit security	0.05	0.04	0.06	0.04
Participation semi-mandatory	0.14*	0.12*	0.09	0.07
Participation voluntary	0.27***	0.25***	0.21***	0.18**
Environmental self-identity (ESI)		0.24**		0.29***
Benefit env. × Participation semi-mand.	-0.10	-0.09	-0.11	-0.09
Benefit sec. × Participation semi-mand.	-0.03	-0.02	-0.07	-0.06
Benefit env. × Participation voluntary	-0.06	-0.06	-0.07	-0.06
Benefit sec. × Participation voluntary	-0.04	-0.03	-0.06	-0.05
Benefit env. × ESI		0.20**		0.16*
Benefit sec. × ESI		0.10		0.04
Participation semi-mand. × ESI		-0.03		-0.13
Participation voluntary × ESI		0.02		0.03
Benefit env. × Participation hybrid × ESI		-0.03		0.08
Benefit sec. × Participation hybrid × ESI		-0.04		0.02
Benefit env. × Participation voluntary × ESI		-0.05		-0.06
Benefit sec. × Participation voluntary × ESI		-0.05		-0.02
N	1,017	1,017	1,017	1,017
R ²	0.05	0.19	0.04	0.19
Adjusted R ²	0.04	0.17	0.03	0.17
F Statistic	4.00*** (df = 14; 1002)	10.33*** (df = 23; 993)	3.18*** (df = 14; 1002)	10.25*** (df = 23; 993)

*p < .05; **p < .01; ***p < 0.001; coefficients are standardized beta estimates; ESI = environmental self-identity.

benefits as well) and general personal motivations reflecting economic self-interest, moral concern, and innovation-seeking for explaining participation in quota schemes, a novel type of demand response.

6.1. Summary and theoretical implications

Our findings show that both behavior-specific beliefs and general personal motivations can explain participation in quota schemes in terms of individuals' acceptance, interest and intention to participate, whereas the explanatory power of socio-demographic variables is very low. Specifically, we find that beliefs about participation are strongly related to all three indicators of participation, with small variations between the outcomes. For example, beliefs about the environmental benefits of participation showed the strongest relationships with acceptance and interest in the quota scheme but were less strongly related to a stronger intention to participate, which was most strongly (negatively) related to perceived costs and risks of participation. These small discrepancies between the acceptance and interest to participate

on the one hand and intention to participate on the other hand are likely due to the fact that more practical concerns start playing a role in this later, and more specific stage of decision-making.⁶ Overall, people are likely to accept and participate in quota schemes when they perceive both personal and environmental benefits and low costs and risks of participating, and when they feel that they are able to be flexible in their energy use. Unsurprisingly, these behavior-specific beliefs explained more variance in the indicators of participation than the general personal motivations we tested in a separate model (the compatibility principle; see [41]). Yet, by comparing the predictive power of price consciousness, environmental self-identity, and innovation-seeking self-identity, we gained important insights into which general motivations underlie demand response participation. A stronger environmental self-identity (reflecting an intrinsic motivation to behave pro-environmentally) and (to a lesser extent) innovation-seeking self-identity (reflecting a motivation to seek out innovations) were consistently related to all three indicators of participation. Conversely, a stronger price consciousness was only related to the intention to participate but not to acceptance or interest to participate in the quota scheme. This could signify that those motivated for economic benefits do not perceive a sufficient monetary gain to affect their acceptance and participation interest e.g., [55]. This explanation would be consistent with findings from other contexts of energy behaviors suggesting that egoistic motivations, such as financial motives, do not always predict sustainable energy behavior next to individuals' intrinsic pro-environmental motivations [24,56,57]. Importantly, personal norms to participate in the quota scheme emerged as the strongest predictor in all models and also mediated the effect of environmental self-identity on the indicators of participation. This implies that a conceptualization of demand response participation as an economically rational decision is too narrow. Rather, people seem to recognize the collective environmental consequences of participation and can thus be intrinsically motivated via a moral route of decision making.

Testing personal motivations, beliefs, and norms simultaneously largely supported the relationships proposed in our integrated model (Fig. 3). The direct effects of the general personal motivations on participation were attenuated in this model compared to the direct effects of more specific beliefs and personal norms. This integrated model not only explained more variance in the outcomes compared to a TPB model, but also sheds more light on the process of individuals' decision to participate in quota schemes. General personal motivations emerged as important antecedents of more specific beliefs about participation and influenced participation indirectly via these beliefs, but to a varying extent. Specifically, those with a stronger environmental self-identity perceive both higher personal and environmental benefits of participation, perceive fewer costs and risks and feel more able to be flexible in their energy consumption (next to feeling more personally obligated to participate). Environmental self-identity was also strongly related to personal norms, which in turn strongly predicted participation. Individuals' innovation-seeking self-identity was considerably less strongly related to concrete beliefs (and not at all to perceived costs and risks), and the level of price consciousness even less so. This suggests that environmental self-identity is the most consistent general motivation underlying participation in the quota scheme. Notably, environmental self-identity reflects an intrinsic moral motivation, as individuals strive to behave in line with how they perceive themselves in order to be consistent [33,35]. Indeed, environmental self-identity is based on one's overall intrinsic environmental values [34], whereas price

⁶ We note that intention to participate was measured in a different way than the other two outcomes, and those differences in methodology could also explain the slight variations in the results. For example, participants rated their intention after choosing between three variants of the demand response program, which could have evoked perceptions of procedural fairness impacting the results.

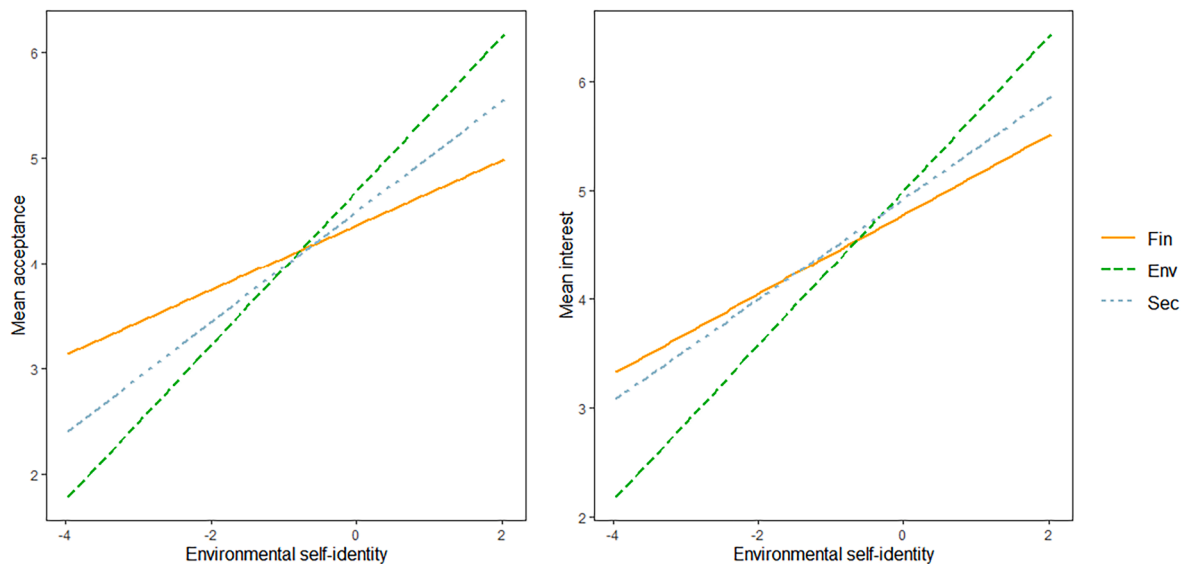


Fig. 4. a and b. Simple slopes of environmental self-identity in each benefit condition for the outcomes of acceptance (left) and interest in participating (right); effects are averaged over participation conditions for ease of interpretation.

consciousness likely reflects an egoistic motivation for financial or other personal goals [cf. [56]]. Yet, future research is needed to establish if price consciousness is closely based on an egoistic value orientation and if other motivations reflecting personal benefits (e.g., hedonic values and the importance of comfort) could be more predictive of participation in demand response programs than price consciousness.

Following up on the correlational insights into the psychological factors explaining participation in quota schemes, we examined if participation can be promoted by emphasizing financial or environmental benefits (next to benefits regarding the security of supply), particularly if these appeals are tailored to consumers' underlying personal motivations. We did not find any differences in acceptance or interest between any of the benefit frames, implying that emphasizing the financial benefits of participation is not generally more effective than emphasizing the environmental benefits, or vice versa. Some research has argued that appeals to financial benefits may undermine people's intrinsic environmental motivations to engage in a behavior, whereas environmental appeals promote behavior in line with individuals' moral self-concept and should therefore be more effective [11,30]. Other researchers suggest that one-size-fits-all campaigns are not effective but appeals instead need to be tailored to individuals' pre-existing motivations [47,49]. In line with the latter, we find that emphasizing the environmental benefits of participating in a quota scheme indeed leads to higher acceptance and interest than an emphasis on the financial benefits among those relatively strongly motivated for the environment (reflected in their environmental self-identity). Conversely, such environmental appeals are less effective compared to financial appeals among those with a relatively weak pro-environmental motivation. Interestingly, we do not find this tailoring effect for financial appeals, which are not more effective among those with a high price consciousness. These results did not depend on whether participation in the quota scheme was communicated as mandatory, semi-mandatory, or voluntary, although a voluntary participation mode was generally more accepted and caused more interest than mandatory or semi-mandatory participation modes. Interestingly, despite these differences, acceptance and interest were still slightly above the scale midpoint even for mandatory quota schemes and rose further for semi-mandatory and

voluntary participation. This suggests that people are generally open to quota schemes, at least when they come into initial contact with such programs.

6.2. Limitations and future research

Our study has the strength that it examines three different indicators of participation in demand response programs, namely acceptance, interest, and intention to participate in quota schemes. Even though these outcomes represent different stages in the decision-making process and were assessed in different ways, we find relatively consistent relationships across the three indicators, giving more confidence to our results. Nevertheless, as quota schemes are a novel type of demand response program, we were not able to assess participation directly and instead had to rely on antecedents of participation at earlier stages of the decision-making process. Future research should investigate if the role of psychological variables changes when people are actually faced with the decision to participate. This could be the case because of more practical barriers coming into play in a late stage of decision-making, and past research has suggested that the difficulty of engaging in a behavior could determine the extent to which rational or moral considerations are more relevant underlying factors (e.g., [58]).

Since the first part of the analysis was based on correlational evidence, we cannot draw firm causal conclusions about these findings. Yet, our statistical models are based on existing theory, and other research has shown that personal pro-environmental motivations (such as environmental self-identity) can causally affect pro-environmental behaviors [33,59]. Similarly, experimental evidence provided evidence that beliefs captured by the TPB can causally affect intentions ([60]; but see [61], suggesting a bi-directional causal influence between beliefs and intentions). We examined one aspect of causality by testing the effect of appeals to different personal motivations on acceptance and interest to participate in quota schemes. Due to analyzing both which predictors explain participation (in correlational models) and if appeals can promote participation (experimentally), we measured two of our outcomes after an experimental manipulation and the third prior to the manipulation. In our correlational models, we accounted for the influence of the

experimental conditions by controlling for them in the model. Besides, we find an overall similar pattern of relationships between these two outcomes and the third outcome of intention, which was measured before the manipulation. It is thus unlikely that this analysis procedure biased our estimates in the correlational models.

Since we did not include a strict no-appeal control group, we can only draw relative conclusions about the effectiveness of appeals on acceptance and interest in participating in the quota scheme. As discussed above, including a no-appeal condition may prove difficult in contexts where individuals likely generate automatic associations about certain benefits themselves [30]. Since we particularly focused on the effects of appeals tailored to personal motivations, not including a no-appeal condition seems less problematic. Yet, future research could examine if appeals can affect participation in quota schemes when compared to a no-intervention control group. Moreover, future research could examine appeals emphasizing participation as innovative, corresponding to our measure of innovation-seeking self-identity. So far, little research has investigated such appeals, but similar to environmental appeals, they could provide a fruitful basis for future interventions to increase participation. Such research could, for example, link to earlier work on the symbolic attributes of sustainable innovations [62].

Lastly, it is unclear to what extent our findings can be generalized to other types of demand response programs beyond quota schemes. As we described above, quota schemes are a novel type of demand response currently being developed and trialed. Yet, they share similarities with other existing types of programs, such as critical peak rebate (CPR) programs. Thus, it is likely that our findings about the determinants of participation will be somewhat generalizable in explaining why people decide to participate in demand response, but future research should explore potential differences in underlying motivating factors between different types of demand response further.

6.3. Practical implications and conclusion

From a policy perspective, our insights can inform strategies to increase future participation in quota schemes and possibly other types of demand response programs. We find some evidence that the perception of personal benefits is important for motivating participation, although emphasizing financial benefits via written advertisements does not seem to be superior compared to emphasizing other benefits of participation, even among those strongly motivated for financial benefits. Indeed, personal motivations to be price conscious were not consistently related to the measured indicators of participation. Nevertheless, individuals' beliefs that their participation will yield benefits (both personal and environmental) and has low costs and risks seems to be an important factor underlying their participation, which corresponds to recent research on demand response more generally [3]. Yet, our findings counter the common assumption that participation in demand response programs is primarily motivated by economic concerns. Individuals are not only more likely to participate when they believe this has environmental benefits but also out of an intrinsic moral concern, based on their environmental self-identity and personal norm to participate. Our experimental evidence shows that an emphasis on the environmental benefits of participation can indeed lead to more acceptance and interest to participate among those strongly motivated for the environment (while potentially backfiring among those with a weaker environmental motivation). This shows the importance of not only considering the reasons for which consumers may participate in demand response programs, but also which groups of consumers are most likely to participate and have positive beliefs about participation. Our findings from the integrated model have interesting implications in this respect, as they show that environmental self-identity is not only related to a stronger

personal norm or beliefs about the environmental benefits of participating, but also to stronger beliefs about personal benefits of participation, lower perceived costs and risks, and a higher ability to be flexible in one's energy consumption. Interestingly, environmental self-identity is more strongly related to these beliefs than individuals' price consciousness and slightly more strongly than their innovation-seeking self-identity. This suggests programs could target environmentally conscious consumers rather than price conscious consumers in order to effectively promote participation. Moreover, programs could target consumers high in innovation-seeking, which was also related to the indicators of participation and predicted participation indirectly via increasing beliefs about personal and environmental benefits as well as perceived behavioral control. The finding that innovation-seeking consumers are more likely to participate in demand response programs corresponds to research on other technological innovations such as residential photovoltaics [23]. This may help to identify and target those consumers and at the same time offers the potential to harness the potential of demand response (e.g., through quota schemes) where it is most needed, namely among household with other technologies of high and fluctuating electricity consumption (electric vehicles or heat pumps) or production (rooftop photovoltaics).

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Declaration of Competing Interest

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

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Appendix

Appendix A Description of socio-demographic measures

In all analyses described in the paper, we controlled for the possible influence of six socio-demographic characteristics on participation in quota schemes, as described below.

1. **Gender** was measured as binary and dummy-coded for the analysis, with men as the reference group.
2. **Age** was measured as a continuous variable and treated as such in the analysis.
3. **Education** was measured with seven categories, six of which corresponded to the Germany education system. The last category "other" allowed an open answer. Only 21 respondents provided a written answer in this last category, and we re-assigned them into the most appropriate regular category based on the text. We subsequently simplified the categories for the analysis by merging the first two and last two categories, respectively, and applying a log-normal transformation to the data. This allowed us to treat education level as a continuous variable in the analysis (and avoid the inclusion of

Table A1
Socio-demographic characteristics and comparison with the German average

	Sample (%)	German average (%)
Gender: female	51.0	50.5
Age		
18–24 years	8.4%	11.9
25–29 years	8.3%	7.2
30–39 years	16.1%	14.8
40–49 years	16.8%	15.0
50–59 years	21.5%	19.0
60 years or older	28.9%	32.1
Highest educational degree obtained		
Without school degree	0.6	4.2
Lower secondary education	36.8	30.7
Intermediate secondary education	26.2	31.0
Higher secondary education	36.5	33.7
Household income (monthly net)		
<900€	10.2	8.2
900–1500€	17.8	17.5
1500–2000€	13.7	15.4
2000–2600€	15.5	15.7
2600–3200€	15.6	11.7
3200–4500€	16.0	16.6
>4500€	11.2	14.9
Home ownership		
Owned (remaining: rented)	37.6	46.5
Household size		
1 person	32.7	41.9
2 persons	48.8	33.8
3 persons	10.7	11.9
4 persons	5.9	9.0
5 persons and more	1.8	3.4

Note. Data for the German average are based on 2018 data by the German Federal Statistical Office

multiple dummy variables in the models) with the assumption that each higher level of education provides a smaller increment than the previous one (e.g., the difference between a higher secondary degree and a university degree being smaller than the difference between a lower secondary and a higher secondary degree).

- Income** was measured with 9 categories that corresponded to the German microcensus system, with the last category being “no answer”. Respondents who chose to not disclose their income category received a follow-up question that asked them to indicate their income less specifically using categories such as “slightly below/above average” (the average household income was provided at the bottom of the page). As before, participants could opt to not disclose their income entirely. Eighty-eight respondents chose to not indicate their income in the first question, but 71 of those respondents provided an answer in the follow-up question. We merged the responses to both questions into five broader income categories and applied a log-normal transformation, assuming that each higher income category is a smaller increment compared to the previous one. Income was then treated as a continuous variable in the analysis.
- House ownership** was measured as binary and dummy-coded for the analysis, with no ownership being the reference group.
- Household size** was measured as continuous and treated as such in the analysis.

Appendix B Comprehensive list of scales and items

I Personal motivations
Environmental self-identity

1. Acting environmentally friendly is an important part of who I am
2. I am the type of person who acts environmentally friendly
3. I see myself as an environmentally friendly person

Innovation-seeking self-identity

1. Checking out innovative products and services is an important part of who I am
2. I am the type of person who seeks out information about novel products and services
3. I see myself as a novelty-seeking person

Price consciousness

1. I often compare the prices of products to get the cheapest price
2. I often engage in price comparisons of products
3. I often search for the same product at different stores to get the cheapest price

Personal norm

1. I feel morally obliged to participate in the quota scheme
2. I would feel guilty if I did not participate in the quota scheme
3. I would feel proud if I participated in the quota scheme

II Theory of planned behavior variables

Personal benefits

1. Participating in the quota scheme could save me money
2. The quota scheme could reduce my energy bills
3. The quota scheme ensures that my energy supply is secure

Environmental benefits

1. The energy quota scheme can help slow down climate change
2. If more households participate in the quota scheme, this is good for the sustainable energy transition
3. The quota scheme allows for more renewable energy sources in the system

Perceived costs and risks

1. I worry about the risks of participating in the quota scheme
2. The quota scheme is too complex to fully understand
3. Participating in the energy quota scheme would negatively affect my comfort at home
4. I would worry about privacy and data security issues when participating in the quota scheme

Subjective norm

1. Inhabitants of my community find the energy transition important
2. Inhabitants of my neighborhood would support the quota scheme

Perceived behavioral control

1. I would be able to fulfil a quota by temporarily lowering my consumption

Appendix C Bivariate correlations

Table C1
Bivariate correlations between scales

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
1. Environmental self-identity																	
2. Innovation-seeking self-identity	0.31																
3. Price consciousness	0.13	0.31															
4. Personal benefits	0.31	0.28	0.22														
5. Environmental benefits	0.43	0.26	0.15	0.70													
6. Perceived costs and risks	-0.16	-0.10	-0.10	-0.43	-0.40												
7. Perceived behavioral control	0.26	0.20	0.16	0.59	0.56	-0.46											
8. Personal norm	0.41	0.35	0.11	0.50	0.58	-0.27	0.46										
9. Subjective norm	0.37	0.30	0.11	0.45	0.50	-0.34	0.41	0.50									
10. Gender	0.12	-0.04	0.03	0.06	0.11	0.00	0.09	0.08	0.03								
11. Age	0.06	-0.07	-0.10	0.01	-0.01	-0.04	-0.08	-0.02	0.02	-0.12							
12. Education (ln)	0.09	0.05	-0.04	0.05	0.03	-0.03	0.08	-0.03	0.03	0.12	-0.21						
13. Income (ln)	0.01	0.21	0.03	0.09	0.05	-0.06	0.06	0.04	0.13	0.04	-0.02	0.28					
14. Ownership	0.03	0.10	0.03	0.03	-0.02	0.06	-0.02	0.00	0.08	-0.01	0.16	0.06	0.32				
15. Household size	0.03	0.09	0.07	0.07	0.07	0.00	0.08	0.07	0.07	0.11	-0.22	0.10	0.38	0.16			
16. Acceptance	0.37	0.22	0.10	0.58	0.61	-0.45	0.54	0.60	0.46	0.07	-0.02	0.02	0.03	-0.04	0.06		
17. Interest	0.37	0.26	0.12	0.57	0.59	-0.43	0.57	0.60	0.47	0.06	-0.03	0.07	0.10	-0.02	0.07	0.84	
18. Intention	0.24	0.22	0.18	0.47	0.44	-0.44	0.47	0.41	0.31	0.04	0.04	-0.01	0.06	-0.01	0.04	0.50	0.55

Appendix D Manipulation check

We included a manipulation check to assess if participants had indeed understood the scenario described in the experimental manipulation. For brevity reasons, we examined the success of our manipulation with four items that were answered after the dependent variables. Specifically, we asked people to rate their agreement with the following statements on a 7-point Likert scale from 1 (completely disagree) to 7 (completely agree): “According to the text ...the quota scheme offers financial benefits; ...the quota scheme offers environmental benefits; ... participation in the quota scheme is mandatory; ...participation in the quota scheme is voluntary”. The first two items assessed the success of manipulation of the first experimental factor that emphasized the financial benefits, environmental benefits, or benefits for security of supply; the last two items assessed the success of the manipulation of the second experimental factor that presented participation in the quota scheme as mandatory, semi-mandatory, or voluntary.

We examined agreement with the four manipulation check statements across the two experimental factors (comprising the nine experimental conditions). As two of the statements (i.e., financial vs. environmental benefits) referred to the first factor on the benefits of the

quota scheme, and two items referred to the second factor on participation (i.e., mandatory vs. voluntary participation), we inspected the ratings on these two factors separately across the four statements to ease interpretation. Visual inspection (Fig. D1) indicated a pattern of mean ratings on the four statements in line with expectations. Specifically, ratings on financial benefits were substantially higher in the financial conditions and ratings on environmental benefits were substantially higher in the environmental conditions compared to the respective other conditions, whereas the other reasons were rated similarly high, respectively. As expected, agreement with the two items on participation being mandatory or voluntary did not differ across the benefit conditions, and agreement with the two items on monetary or environmental benefits did not differ across the participation conditions. Yet, people in the mandatory participation conditions rated their agreement with the statement that participation was mandatory as higher than people in the other two conditions, with people in the voluntary participation conditions giving the lowest rating on this statement; the opposite pattern emerged for the statement on voluntary participation. This visual pattern was supported by a MANOVA that tested the effects of the two experimental factors (including their interaction) on the four manipulation check statements. As expected,

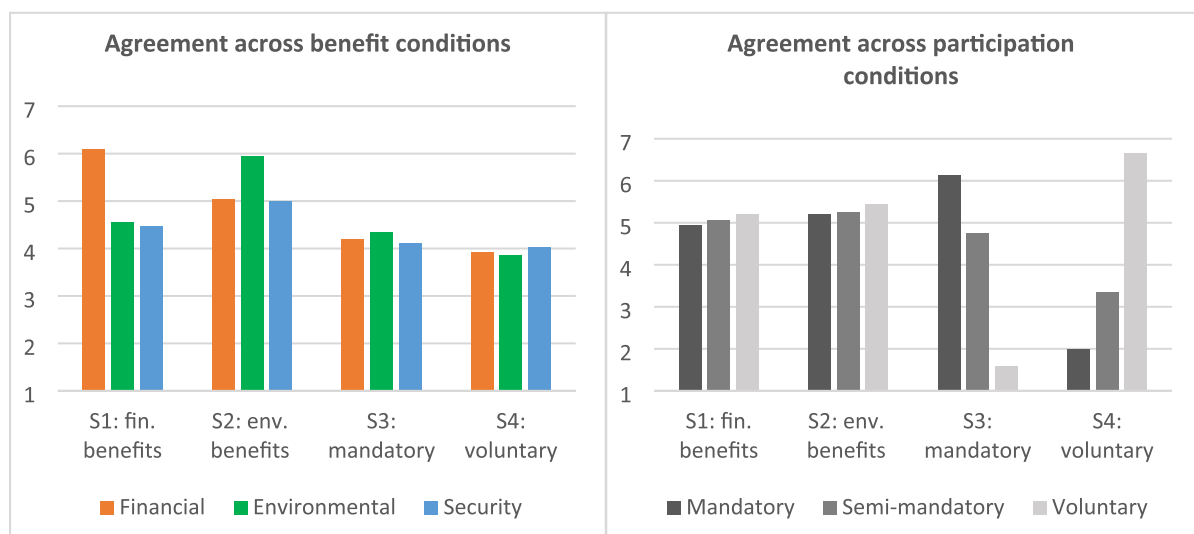


Fig. D1. Mean agreement with the manipulation check items depending on benefit condition (left) and participation condition (right).

results indicated a main effect of the factor Benefits, Pillai's trace (8, 2046) = 0.26, $p < .001$, and a main effect of the factor Participation, Pillai's trace (8, 2046) = 0.59, $p < .001$, whereas the interaction effect was non-significant, Pillai's trace (16, 4100) = 0.02, $p = .273$. Univariate results further indicated that the factor Benefits significantly affected the first two manipulation check statements and the factor Participation significantly affected the last two manipulation check statements, indicating that the manipulation was successful.

References

- [1] IPCC. Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Geneva, Switzerland: World Meteorological Organization; 2018.
- [2] T. Boßmann, E.J. Eser, Model-based assessment of demand-response measures—a comprehensive literature review, *Renew. Sustain. Energy Rev.* 57 (2016) 1637–1656, <https://doi.org/10.1016/j.rser.2015.12.031>.
- [3] B. Parrish, P. Heptonstall, R. Gross, B.K. Sovacool, A systematic review of motivations, enablers and barriers for consumer engagement with residential demand response, *Energy Policy* 138 (2020) 111221, <https://doi.org/10.1016/j.enpol.2019.111221>.
- [4] EPRI. Understanding Electric Utility Customers - Summary Report What We Know and What We Need to Know. Palo Alto, CA; 2012.
- [5] B. Parrish, R. Gross, P. Heptonstall, On demand: Can demand response live up to expectations in managing electricity systems, *Energy Res. Social Sci.* 51 (2019) 107–118.
- [6] S. Nolan, M. O'Malley, Challenges and barriers to demand response deployment and evaluation, *Appl. Energy* 152 (2015) 1–10, <https://doi.org/10.1016/j.apenergy.2015.04.083>.
- [7] M.H. Albadi, E.F. El-Saadany, A summary of demand response in electricity markets, *Electr. Power Syst. Res.* 78 (11) (2008) 1989–1996, <https://doi.org/10.1016/j.epsr.2008.04.002>.
- [8] A. Nilsson, D. Lazarevic, N. Brandt, O. Kordas, Household responsiveness to residential demand response strategies: results and policy implications from a Swedish field study, *Energy Policy* 122 (2018) 273–286, <https://doi.org/10.1016/j.enpol.2018.07.044>.
- [9] T. Dietz, Altruism, self-interest, and energy consumption, *Proc. Natl. Acad. Sci. U.S.A.* 112 (6) (2015) 1654–1655, <https://doi.org/10.1073/pnas.1423686112>.
- [10] O.I. Asensio, M.A. Delmas, Nonprice incentives and energy conservation, *Proc. Natl. Acad. Sci. U.S.A.* 112 (6) (2015) E510–E515, <https://doi.org/10.1073/pnas.1401880112>.
- [11] J.W. Bolderdijk, L. Steg, E.S. Geller, P.K. Lehman, T. Postmes, Comparing the effectiveness of monetary versus moral motives in environmental campaigning, *Nature Clim Change* 3 (4) (2013) 413–416, <https://doi.org/10.1038/nclimate1767>.
- [12] L. Steg, G. Perlaviciute, E. Van der Werff, Understanding the human dimensions of a sustainable energy transition, *Front Psychol* 6 (2015) 805, <https://doi.org/10.3389/fpsyg.2015.00805>.
- [13] A. Srivastava, S. Van Passel, E. Laes, Assessing the success of electricity demand response programs: a meta-analysis, *Energy Res. Social Sci.* 40 (2018) 110–117, <https://doi.org/10.1016/j.erss.2017.12.005>.
- [14] C.J. Midden, J.F. Meter, M.H. Weenig, H.J. Zieverink, Using feedback, reinforcement and information to reduce energy consumption in households: a field-experiment, *J. Econ. Psychol.* 3 (1) (1983) 65–86, [https://doi.org/10.1016/0167-4870\(83\)90058-2](https://doi.org/10.1016/0167-4870(83)90058-2).
- [15] BNE. Das bne-Quotenmodell für mehr Flexibilität im Verteilnetz: Vorschlag für eine kosteneffiziente und kundenfreundliche Umsetzung netzdienlicher Flexibilität; 2020.
- [16] European Smart Grids Task Force. Demand Side Flexibility: Perceived barriers and proposed recommendations; 2019.
- [17] P. Bradley, M. Leach, J. Torriti, A review of the costs and benefits of demand response for electricity in the UK, *Energy Policy* 52 (2013) 312–327, <https://doi.org/10.1016/j.enpol.2012.09.039>.
- [18] I. Ajzen, The theory of planned behavior, *Organ. Behav. Hum. Decis. Process.* 50 (2) (1991) 179–211, [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T).
- [19] N. Huijts, E. Molin, L. Steg, Psychological factors influencing sustainable energy technology acceptance: a review-based comprehensive framework, *Renewable Sustainable Energy Rev.* 16 (1) (2012) 525–531, <https://doi.org/10.1016/j.rser.2011.08.018>.
- [20] F.G. Kaiser, G. Hubner, F.X. Bogner, Contrasting the theory of planned behavior with the value-belief-norm model in explaining conservation behavior, *J. Appl. Soc. Psychol.* 35 (10) (2005) 2150–2170, <https://doi.org/10.1111/j.1559-1816.2005.tb02213.x>.
- [21] C.-S. Tan, H.-Y. Ooi, Y.-N. Goh, A moral extension of the theory of planned behavior to predict consumers' purchase intention for energy-efficient household appliances in Malaysia, *Energy Policy* 107 (2017) 459–471, <https://doi.org/10.1016/j.enpol.2017.05.027>.
- [22] A. Yuriev, M. Dahmen, P. Paillé, O. Boiral, L. Guillaumie, Pro-environmental behaviors through the lens of the theory of planned behavior: a scoping review, *Resour. Conserv. Recycl.* 155 (2020) 104660, <https://doi.org/10.1016/j.resconrec.2019.104660>.
- [23] K.S. Wolske, P.C. Stern, T. Dietz, Explaining interest in adopting residential solar photovoltaic systems in the United States: toward an integration of behavioral theories, *Energy Res. Social Sci.* 25 (2017) 134–151, <https://doi.org/10.1016/j.erss.2016.12.023>.
- [24] L. Steg, Values, norms, and intrinsic motivation to act proenvironmentally, *Annu. Rev. Environ. Resour.* 41 (1) (2016) 277–292, <https://doi.org/10.1146/annurev-environ-110615-085947>.
- [25] D. Sloot, M. Kutlaca, V. Medugorac, P. Carman, Recycling Alone or Protesting Together? Values as a basis for pro-environmental social change actions, *Front. Psychol.* 9 (2018) 1229, <https://doi.org/10.3389/fpsyg.2018.01229>.
- [26] D.R. Lichtenstein, N.M. Ridgway, R.G. Netemeyer, Price perceptions and consumer shopping behavior: a field study, *J. Mark. Res.* 30 (2) (1993) 234–245, <https://doi.org/10.1177/002224379303000208>.
- [27] B.L. Alford, A. Biswas, The effects of discount level, price consciousness and sale proneness on consumers' price perception and behavioral intention, *J. Bus. Res.* 55 (9) (2002) 775–783, [https://doi.org/10.1016/S0148-2963\(00\)00214-9](https://doi.org/10.1016/S0148-2963(00)00214-9).
- [28] W. Abrahamse, L. Steg, C. Vlek, T. Rothengatter, A review of intervention studies aimed at household energy conservation, *J. Environ. Psychol.* 25 (3) (2005) 273–291, <https://doi.org/10.1016/j.jenvp.2005.08.002>.
- [29] M.A. Delmas, M. Fischlein, O.I. Asensio, Information strategies and energy conservation behavior: a meta-analysis of experimental studies from 1975 to 2012, *Energy Policy* 61 (2013) 729–739, <https://doi.org/10.1016/j.enpol.2013.05.109>.
- [30] D. Schwartz, W. Bruine de Bruin, B. Fischhoff, L. Lave, Advertising energy saving programs: the potential environmental cost of emphasizing monetary savings, *J. Exp. Psychol. Appl.* 21 (2) (2015) 158–166, <https://doi.org/10.1037/xap0000042>.
- [31] J.-H. Kim, A. Shcherbakova, Common failures of demand response, *Energy* 36 (2) (2011) 873–880, <https://doi.org/10.1016/j.energy.2010.12.027>.
- [32] P.C. Stern, New environmental theories: toward a coherent theory of environmentally significant behavior, *J. Social Issues* 56 (3) (2000) 407–424, <https://doi.org/10.1111/0022-4537.00175>.
- [33] E. Van der Werff, L. Steg, K. Keizer, It is a moral issue: the relationship between environmental self-identity, obligation-based intrinsic motivation and pro-environmental behaviour, *Global Environ. Change* 23 (5) (2013) 1258–1265, <https://doi.org/10.1016/j.gloenvcha.2013.07.018>.
- [34] E. Van der Werff, L. Steg, K. Keizer, The value of environmental self-identity: the relationship between biospheric values, environmental self-identity and environmental preferences, intentions and behaviour, *J. Environ. Psychol.* 34 (2013) 55–63, <https://doi.org/10.1016/j.jenvp.2012.12.006>.
- [35] L. Whitmarsh, S. O'Neill, Green identity, green living? The role of pro-environmental self-identity in determining consistency across diverse pro-environmental behaviours, *J. Environ. Psychol.* 30 (3) (2010) 305–314, <https://doi.org/10.1016/j.jenvp.2010.01.003>.
- [36] D. Sloot, L. Jans, L. Steg, Can community energy initiatives motivate sustainable energy behaviours? The role of initiative involvement and personal pro-environmental motivation, *J. Environ. Psychol.* 57 (2018) 99–106, <https://doi.org/10.1016/j.jenvp.2018.06.007>.
- [37] E. Van der Werff, L. Steg, The psychology of participation and interest in smart energy systems: comparing the value-belief-norm theory and the value-identity-personal norm model, *Energy Res. Social Sci.* 22 (2016) 107–114, <https://doi.org/10.1016/j.erss.2016.08.022>.
- [38] B. Gatersleben, N. Murtagh, W. Abrahamse, Values, identity and pro-environmental behaviour, *Contemp. Soc. Sci.* 9 (4) (2014) 374–392, <https://doi.org/10.1080/21582041.2012.682086>.
- [39] A. Ruepert, K. Keizer, L. Steg, F. Maricchiolo, G. Carrus, A. Dumitru, R. García Mira, A. Stancu, D. Moza, Environmental considerations in the organizational context: a pathway to pro-environmental behaviour at work, *Energy Res. Social Sci.* 17 (2016) 59–70, <https://doi.org/10.1016/j.erss.2016.04.004>.
- [40] E.M. Rogers, *Diffusion of innovations*, Free Press, New York, London, Toronto, Sydney, 2003.
- [41] I. Ajzen, M. Fishbein, The prediction of behavior from attitudinal and normative variables, *J. Exp. Soc. Psychol.* 6 (4) (1970) 466–487, [https://doi.org/10.1016/0022-1031\(70\)90057-0](https://doi.org/10.1016/0022-1031(70)90057-0).
- [42] C.A. Klöckner, A comprehensive model of the psychology of environmental behaviour—a meta-analysis, *Global Environ. Change* 23 (5) (2013) 1028–1038, <https://doi.org/10.1016/j.gloenvcha.2013.05.014>.
- [43] N. Huijts, E. Molin, B. van Wee, Hydrogen fuel station acceptance: a structural equation model based on the technology acceptance framework, *J. Environ. Psychol.* 38 (2014) 153–166, <https://doi.org/10.1016/j.jenvp.2014.01.008>.
- [44] Sparks P. Subjective expected utility-based attitude-behavior models: The utility of self-identity. In: Terry DJ, Hogg MA, editors. *Applied social research. Attitudes, behavior, and social context: The role of norms and group membership*. Lawrence Erlbaum Associates Publishers; 2000, p. 31–46.
- [45] J. Rise, P. Sheeran, S. Hukkelberg, The role of self-identity in the theory of planned behavior: a meta-analysis, *J. Appl. Soc. Psychol.* 40 (5) (2010) 1085–1105, <https://doi.org/10.1111/j.1559-1816.2010.00611.x>.
- [46] D. Sloot, L. Jans, L. Steg, Is an appeal enough? The limited impact of financial, environmental, and communal appeals in promoting involvement in community environmental initiatives, *Sustainability* 13 (3) (2021) 1085, <https://doi.org/10.3390/su13031085>.
- [47] A. Nilsson, A. Hansla, J.M. Heiling, C.J. Bergstad, J. Martinsson, Public acceptability towards environmental policy measures: value-matching appeals, *Environ. Sci. Policy* 61 (2016) 176–184, <https://doi.org/10.1016/j.envsci.2016.04.013>.
- [48] W. Abrahamse, L. Steg, C. Vlek, T. Rothengatter, The effect of tailored information, goal setting, and tailored feedback on household energy use, energy-related

- behaviors, and behavioral antecedents, *J. Environ. Psychol.* 27 (4) (2007) 265–276, <https://doi.org/10.1016/j.jenvp.2007.08.002>.
- [49] K. Van den Broek, J.W. Bolderdijk, L. Steg, Individual differences in values determine the relative persuasiveness of biospheric, economic and combined appeals, *J. Environ. Psychol.* (2017) 145–156, <https://doi.org/10.1016/j.jenvp.2017.07.009>.
- [50] J.W. Bolderdijk, M. Gorsira, K. Keizer, L. Steg, G. Ozakinci, Values determine the (in)effectiveness of informational interventions in promoting pro-environmental behavior, *PLoS ONE* 8 (12) (2013) e83911, <https://doi.org/10.1371/journal.pone.0083911>.
- [51] S. Fifer, J. Rose, S. Greaves, Hypothetical bias in stated choice experiments: is it a problem? And if so, how do we deal with it? *Transp. Res. Part A: Policy Pract.* 61 (2014) 164–177, <https://doi.org/10.1016/j.tra.2013.12.010>.
- [52] K.L. Wakefield, J. Inman, Situational price sensitivity: the role of consumption occasion, social context and income, *J. Retail.* 79 (4) (2003) 199–212, <https://doi.org/10.1016/j.jretai.2003.09.004>.
- [53] R.Y. Lavaan, An R package for structural equation modeling and more. Version 0.5-12 (BETA), *J. Stat. Softw.* 48 (2) (2012) 1–36.
- [54] B.K. Sovacool, J. Axsen, S. Sorrell, Promoting novelty, rigor, and style in energy social science: towards codes of practice for appropriate methods and research design, *Energy Res. Social Sci.* 45 (2018) 12–42, <https://doi.org/10.1016/j.erss.2018.07.007>.
- [55] E. Dogan, J.W. Bolderdijk, L. Steg, Making small numbers count: environmental and financial feedback in promoting eco-driving behaviours, *J. Consum. Policy* 37 (3) (2014) 413–422, <https://doi.org/10.1007/s10603-014-9259-z>.
- [56] T. Dietz, Environmental value, in: T. Brosch, D. Sander (Eds.), *Oxford Handbook of Values*, Oxford University Press, Oxford, 2015, pp. 329–349.
- [57] D. Sloot, L. Jans, L. Steg, In it for the money, the environment, or the community? Motives for being involved in community energy initiatives, *Global Environ. Change* 57 (2019) 101936, <https://doi.org/10.1016/j.gloenvcha.2019.101936>.
- [58] W. Abrahamse, L. Steg, R. Gifford, C. Vlek, Factors influencing car use for commuting and the intention to reduce it: a question of self-interest or morality? *Transp. Res. Part F: Traffic Psychol. Behav.* 12 (4) (2009) 317–324, <https://doi.org/10.1016/j.trf.2009.04.004>.
- [59] J. Thøgersen, F. Ölander, Human values and the emergence of a sustainable consumption pattern: a panel study, *J. Econ. Psychol.* 23 (5) (2002) 605–630, [https://doi.org/10.1016/S0167-4870\(02\)00120-4](https://doi.org/10.1016/S0167-4870(02)00120-4).
- [60] F. Sniehotta, An experimental test of the theory of planned behavior, *Appl. Psychol.: Health Well-Being* 1 (2) (2009) 257–270, <https://doi.org/10.1111/j.1758-0854.2009.01013.x>.
- [61] R. Sussman, R. Gifford, Causality in the theory of planned behavior, *Pers. Soc. Psychol. Bull.* 45 (6) (2019) 920–933, <https://doi.org/10.1177/0146167218801363>.
- [62] E.H. Noppers, K. Keizer, J.W. Bolderdijk, L. Steg, The adoption of sustainable innovations: driven by symbolic and environmental motives, *Global Environ. Change* 25 (2014) 52–62, <https://doi.org/10.1016/j.gloenvcha.2014.01.012>.