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Abstract

Using a discrete choice experiment (DCE), we analyze how social comparisons and financial information influence households' preferences and trade-offs among three sustainable electricity demand behaviors: conservation actions, efficiency investments, and purchasing a green power mix. Our results show that while a strong majority favors sustainable behaviors over inaction, both interventions significantly increase the likelihood of choosing inaction. Heterogeneity analyses reveal that this negative effect is driven by households with above-average consumption. Furthermore, our findings highlight conflicting motivational mechanisms, suggesting that financial information within normative messages may crowd out intrinsic motivation

Keywords Electricity-saving behaviors; households' preferences; social comparisons; financial information; discrete choice experiment; mixed logit (MXL) model; crowding out effect.

JEL Codes D12, D91, Q48.

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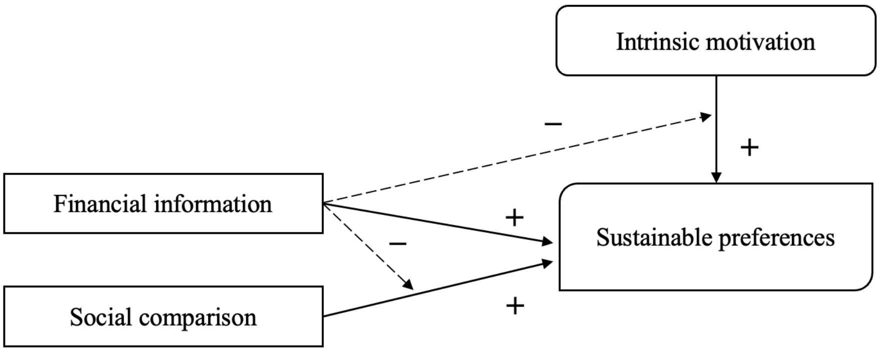
1 Introduction

There is growing interest in non-financial approaches to reduce electricity demand, with social comparisons emerging as particularly effective (Andor and Fels, 2018). People tend to benchmark their actions by looking at the behaviors of others, so that social norms may exert powerful influence on individual behavior (Allcott, 2011). This influence is further reinforced by a desire for social approval, as individuals value the esteem of their peers (Cialdini and Goldstein, 2004). When saving electricity aligns with social norms, individuals are motivated to conform, upholding a positive self-image and social standing (Laibson and List, 2015). Alongside these social influences, highlighting financial aspects remains a popular tool to influence behavior. Given the delay between electricity consumption and billing, households may not fully account for the cost at the time of use (Kempton and Layne, 1994). Bringing financial consequences to the forefront of household awareness may therefore drive behavioral changes (Bordalo et al., 2013).

However, psychologists have long theorized that external rewards, such as financial incentives, can undermine intrinsic motivation, which was labeled the hidden costs of rewards (Deci, 1971) or the overjustification hypothesis (Frey and Jegen, 2001). These theories suggest that when individuals accept an external reward, they may come to view it as the primary driver of their motivation, thus reducing the value they place on their intrinsic interest (Ryan and Deci, 2000). Financial information may not improve motivation as expected; rather, it may reduce it, a phenomenon later termed motivational crowding out. Financial information provides an egoistic motive to conserve electricity. Therefore, on the one hand, intrinsic motivations, such as environmental concerns, could be undermined as individuals no longer perceive themselves to act for these reasons. On the other hand, social comparisons can be undermined as the desire for social approval drives individuals to adjust their behavior to avoid being perceived as motivated by financial gain (Steinhorst et al., 2015). In other words, financial information can threaten self-image and social standing (Delmas et al., 2013). This study aims at shedding light on these opposing effects on sustainable preferences in the context of residential electricity consumption (Schwartz, 2019).

Although these conflicting effects have been experimentally studied on electricity consumption (Dolan and Metcalfe, 2015; Ito et al., 2018; Holladay et al., 2019), little research has focused on their impact on the various strategies to achieve sustainable electricity consumption. In fact, households can adopt various approaches to achieve more efficient electricity usage. However, such behaviors are not easily observable. To address this, we designed a discrete choice experiment (DCE) that captures different as-

Figure 1: Conceptual framework



pects of sustainable electricity use. Specifically, the experimental design considers the trade-off between engaging in conservation actions, investing in efficient appliances, and contracting a green electricity supply. Subsequently, by systematically varying the information provided to participants — one group receives a social comparison framed in electricity consumed (kWh), another group receives a social comparison using its monetary value (CHF[1]), and a control group receives no normative information — we estimate the causal effect of combining social comparisons and financial information on household sustainable preferences. We model preferences using an indirect utility function and estimate treatment effects on choice probabilities with Mixed Logit (MXL) models.

This paper investigates the direct effect and interactions of two interventions (social comparisons and financial information) on preferences. As illustrated in Figure 1, we hypothesize that financial information and social comparisons positively impact sustainable preferences. In addition, intrinsic motivation, such as concerns about the environment or energy security, also enhances sustainable preferences. Concurrently, financial information can undermine intrinsic motivation as well as social comparisons. Therefore, the overall effects on household preferences remain uncertain, which is the central focus of this study. Shedding lights on these hypothetical paths requires testing different effects. First, we estimate the impact of electricity comparisons (kWh) and financial comparisons (CHF) on household preferences. Next, we identify key components of intrinsic motivation and assess their influence. Finally, we compute the difference between both treatment and, therefore, evaluating the inclusion of financial information into a normative message.

Households' electricity consumption is a crucial factor, defining whether the social comparisons

[1] The Swiss franc is the currency and legal tender of Switzerland. CHF/USD: 1,1118 USD (24^{th} of February 2025).

indicate that their electricity consumption is below or above the comparison group. Adapting to the norm means opposing effects for the two groups as the former would increase their consumption while the latter would decrease it. Therefore, we conduct subsample analyses to estimate the effects of social comparisons and financial information separately for these two groups. Households with above-average consumption are the priority target of such policy intervention since they have the largest potential for reduction. However, it is crucial to assess that households with below-average consumption maintain their preferences for conserving electricity.

Our first results provide unexpected evidence on the effect of social comparisons. Quantitatively, our analysis shows that participants exposed to electricity comparisons (kWh) show a decrease in their preferences for *efficiency investment* by 2.6% and an increase in their preferences for *no action* by 4%, which means that social comparisons do not improve sustainable preferences. We do not observe significant effects on the other alternatives. For participants treated with financial comparison (CHF), we note an increase for *no action* by 5.7%. In general, both treatments cause adverse effects on preferences.

Therefore, we continue our analysis by separately estimating households with below- and above-baseline electricity consumption. Starting with low-consumers, we observe no statistically significant effect. This result suggests that both social comparisons (kWh and CHF) do not backfire. Interestingly, the effects differ for high-consumers, who have the greatest potential for energy savings. However, we find a significant adverse effect from both treatments, as participants show increased preferences for *no action*, rising by 13.1% among those who receive electricity comparisons (kWh) and by 7.0% among those who receive financial comparisons (CHF). This segment of consumers may not like to be compared with other households or consider high consumption desirable. We also note that financial information reduces the adverse effect by 46,6%. This is consistent with the hypothesis that households with above-average consumption lack intrinsic motivation to save electricity, making financial information particularly effective for them.

Individuals can be intrinsically motivated to save electricity based on moral or ethical considerations and supported by prior personal beliefs. The literature identifies key antecedents of intrinsic motivation to conserve electricity, namely attitude toward the environment and awareness of the relationship between natural resources and energy consumption. Subsequently, to assess the potential motivational crowding out, we conduct moderation analyses by adding interaction terms to the main specification. We show that financial comparisons (CHF) significantly reduces the preferences of intrinsically motivated for two of the sustainable alternatives, while electricity comparison (kWh) have no effect on them. However, the difference between both treatments is not significant, providing only limited evidence that financial information undermines intrinsic motivation.

This paper represents a novel application of choice models to evaluate the effects of social comparisons and financial information. Our study resonates with two field studies conducted by Dolan and Metcalfe (2015), which demonstrate that incentivizing households with large financial rewards yields significant reductions in electricity usage, averaging 8%. This is consistent with standard economic theory, in which households respond to changes in relative prices. In particular, the observed reduction in consumption persists even after the withdrawal of financial incentives, suggesting that there is no crowding out of intrinsic motivation. However, introducing social comparisons annihilates this effect, indicating that the two instruments do not work together. Based on our framework, we interpret this finding as revealing that information on social norms increases the salience of socially desirable behavior. Consequently, financial incentives threaten household social standing by signaling a egoistic motivation for electricity conservation (Steinhorst et al., 2015).

Ito et al. (2018) provide similar evidence that focuses on peak-hour electricity consumption using a random control trial (RCT). They find that financial incentives do not crowd out intrinsic motivation as households show no sign of habituation, indicating no unintended long-term effect. Moreover, our analysis is closely related to the work of Pellerano et al. (2017), which has the specificity to study low-consumers in a developing country. Their analysis aligns with our findings, showing an opposing effect between intrinsic motivation and financial incentives. Lastly, the policy treatment studied by Holladay et al. (2019) is the closest to our experiment, as the social comparisons emphasize different aspects (financial or environmental). They show no crowding out of intrinsic motivation to register for an audit program, although adding financial incentives does not strengthen the normative intervention and may reduce it. When assessing the effect on the purchase of durable goods, they find no effect for both treatments.

Our study also builds on existing research on the impact of social comparisons on different energy-saving strategies or between different consumer segments. Komatsu and Nishio (2015) demonstrate that social comparisons encourage conservation efforts, a conclusion that our research does not support. Similarly, Holladay et al. (2019) show a positive impact on investment, suggesting that social comparisons can drive immediate behavioral changes and also translate into long-term investment in energy efficiency. In contrast, Schultz et al. (2007) show that norm-based interventions can adversely affect households with below-average consumption, leading to a boomerang effect in which these households increase their consumption to match the norm. Our findings do not corroborate this, as we observe no negative impact on below-average consumers.

The remainder of this paper is structured as follows. Section 2 describes the experimental framework and the identification strategy. Section 3 provides descriptive statistics. Section 4 discusses the results and policy implications. Section 5 summarizes and concludes.

2 Methods

2.1 Experimental procedure

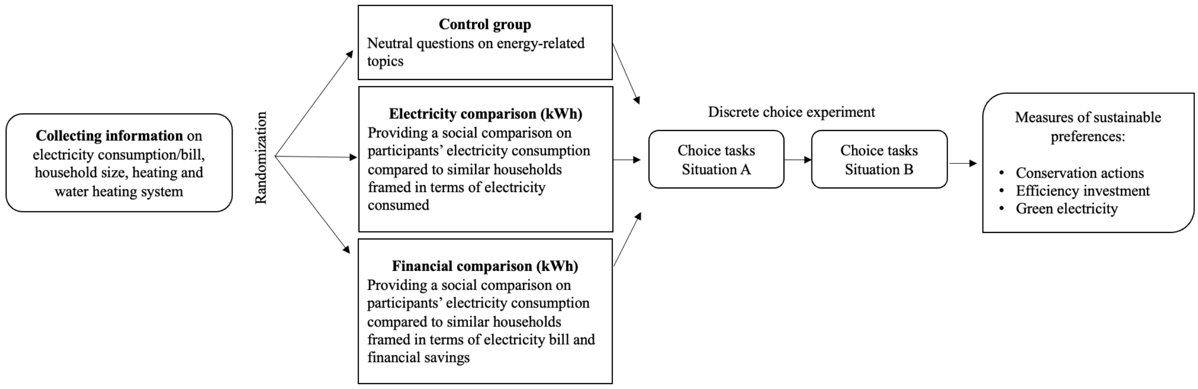
Preference analysis can be divided into two types: revealed and stated preferences. Revealed preferences are based on actual market behaviors observed through real purchases However, in many cases, it is challenging or even impossible to directly observe such behaviors, especially when studying consuming behaviors within households. In these cases, experimental designs allow researchers to assess preferences using hypothetical situations. Given the absence of empirical data on how households make trade-offs between energy saving alternatives, we employ a discrete choice experiment (DCE) to elicit their preferences (Johnston et al., 2017).

As illustrated in Figure 2, the experimental procedure involves four main steps designed to estimate the interplay of social comparison and financial information on household preferences: information collection, random assignment to experimental conditions, the discrete choice experiment (DCE), and assessments of sustainable preferences. Precisely, we need to collect households' electricity consumption and bill as well as information on housing characteristics. Subsequently, we build baseline consumption levels by accounting for household size, housing type, heating system, and heating water system[2]. On this basis, we can inform participants whether their electricity consumption is below or above that of similar households[3]. This social comparison stimulates households to evaluate their actual consumption levels with others. Then, we randomly assigned participants to one of the three groups: one control group and two treatment groups. The control group does not receive any normative information. In contrast, both treated groups receive social comparisons. For the first group, the script refers to electricity

[2] Table 9 in the appendix summarizes all baseline consumption levels.

[3] An additional step is required to provide social comparisons in terms of electricity bill. Since electricity prices vary between Swiss cantons, we need to multiply baseline electricity consumptions by the price of kWh (Table 10 shows electricity prices in Switzerland).

Figure 2: Experimental procedure



consumption (kWh), while for the second group, it refers to the electricity bill (CHF)[4]. Furthermore, the choice experiment also differs between conditions: *electricity comparisons (kWh)* present electricity savings using percentage (%), while *financial comparisons (CHF)* show the equivalent in terms of financial savings (CHF), thus adding financial information[5].

2.2 Discrete choice experiment

In the choice experiment, participants are presented with two distinct situations, each offering three alternatives. Two of these alternatives are repeated across both situations, resulting in a total of four unique alternatives (see Figure 3). First, individuals can save electricity by engaging in conservation actions. This modification of their behavior requires efforts and/or comfort reduction, which entails potential disutility. Second, consumers can save electricity by investing in (more) efficient appliances, which implies a direct monetary cost. We assume that similar electricity savings can be achieved with both alternatives. Third, we consider the possibility of switching to a greener electricity mix, which varies along with the proportion of renewable energy. This option does not imply electricity savings, but can be seen as a contribution to an impure public good, as households pay a premium to consume sustainable electricity. Last, participants can also decide not to do anything (no action). The attributes defining the hypothetical scenarios are summarized in Table 1. These levels were chosen to be as realistic as possible. Participants face three times the situation A (*conservation actions, efficiency investment, no*

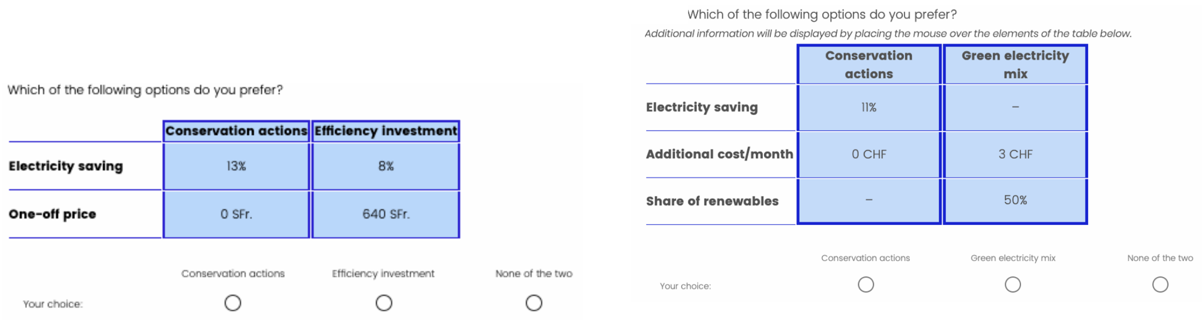
[4] For the full script, see Figures 7 and 8 in the appendix.

[5] See Figure 5 in the appendix.

Table 1: Attributes levels

Attribute	Levels
Electricity savings [%]	2; 5; 8; 11; 13; 15
One-off price [CHF]	40; 80; 160; 320; 640; 1280
Additional cost/month [CHF]	2; 4; 6; 8; 10; 12; 14
Share of renewable [%]	50; 100

Figure 3: Example choice task



Situation A | Situation B

action) and three times the situation B (*conservation actions, green electricity, no action*). The choices are gathered together in the post-experiment analyses.

In addition, we ask two sets of questions. Immediately after receiving the comparison, participants can try to identify why they are under or over-consuming compared to similar households. The objectives of the questions are twofold. First, these responses may provide valuable insight into the effects of social comparisons. Second, some participants might feel uncomfortable when being compared, and giving them the opportunity to justify their consumption could help alleviate this discomfort. The second additional set of questions appears after each decision task. When respondents choose conservation actions, they must select the precise actions they would engage in. These follow-up questions aim to raise awareness of the efforts required, bringing more realism to the hypothetical situations[6].

2.3 Econometric method

The alternatives are described with four attributes with respectively 6/6/6/2 levels (see Table 1). An efficient design procedure is applied to reduce the number of choice sets to 24. Each respondent i faces

[6] Figure 9 in the appendix presents a comprehensive representation of the experimental procedure.

six different choice tasks c covering the four alternatives j. We consider Mixed logit (MXL) choice models, which introduce random coefficients to account for variability and correlation in error terms between individuals and alternatives, thus relaxing the Independence of Irrelevant Alternatives (IIA) assumption (Hensher and Greene, 2003). The respondent's indirect utility function can be formulated as follows:

$$U_{ijc} = \alpha_{jc} + \beta_{jc}A_{jc} + \gamma_{ij}X_i + \delta_{ij}T_i + \epsilon_{ijc} \tag{1}$$

where α_{jc} represents the alternative-specific constant or intercept for alternative j in choice task c, β_{jc} is the coefficient associated with the attribute level A_{jc}, γ_j is the coefficient associated with the respondent-specific variables X_i, δ_i is the coefficient associated with the treatment T_i (T_i = 0 for the control group, T_i = 1 for electricity comparison (kWh), T_i = 2 for the financial comparison (CHF), and ϵ_{ijc} is the stochastic error term capturing unobserved factors. In the experiment, participants select the alternative they prefer, assuming that the chosen alternative maximizes their utility:

$$U_{ijc} > U_{ikc} \qquad \forall j \neq k \tag{2}$$

3 Data

3.1 Sample selection

The discrete choice experiment was implemented in wave 2023 of the Swiss Household Energy Demand Survey (SHEDS), which is a rolling panel data set of 5,000 respondents representative of the Swiss population in terms of age, sex, region (excluding Ticino), and type of residence (Farsi and Weber, 2024). This survey provides information on housing, energy-related topics, and personal characteristics. In our analyses, we include participants' sociodemographic and housing characteristics, their levels of energy literacy, as well as their environmental norms, attitudes, and awareness[7]. Two eligibility criteria needed to be satisfied to participate to the experiment. First, respondents must have referred to their last electricity bill when reporting their consumption, which ensures that the social comparison is as accurate as possible. Second, respondents must have participated in at least one former wave of SHEDS. The number of questions is larger for respondents who take part in SHEDS for the first time, so that adding a

[7] Individual characteristics that remain constant over time are collected from respondents only once. Therefore, we used data from previous waves of the SHEDS to obtain this information.

DCE would lead to potential problems of survey fatigue. 606 households participated in the DCE, each one facing six choice tasks. Our final dataset contains 3,636 choices[8].

3.2 Descriptive statistics

Table 2 presents descriptive statistics of sociodemographics. The sample consists of 606 households, with a relatively balanced gender distribution (44% female, 56% male). The age of the participants ranges between 24 and 89 years, with an average of 54, which is older than the general adult population (49.8 years)[9]. The lack of participants between 18 and 23 years of age explains the difference. Otherwise, the sample is close to the general population is terms of their level of education and income, as well as, household size, residential type, and property status[10]. Furthermore, following the literature, we include personal characteristics that have been shown to be important in understanding preferences for electricity consumption. Participants' energy literacy is likely to influence how they consume electricity and apprehend efficiency investments (Blasch et al., 2021). Similarly, subjective environmental norms—individuals' perceptions of how environmentally friendly their acquaintances behave—are expected to affect sustainable preferences (Schwartz, 2019). In addition, two beliefs are included that underlie the intrinsic motivation for resource conservation: positive environmental attitudes and awareness of the relationship between the environment and natural resources (Gatersleben et al., 2014). Finally, self-reported electricity consumption and bill are presented[11].

Before reviewing the results, it is important to present the descriptive statistics of the participants' choices to evaluate the understanding of experimental design. Table 3 shows the choice pattern statistics, assessing whether participants trade off between alternatives. We note that no alternative emerges as a dominant or dominated choice, suggesting a relevant experimental design. However, 29,5% of the participants do not trade between the alternatives, indicating that they either strongly prefer one alternative over the others or did not pay attention to the experiment. This proportion is higher in Situation B, possibly due to less interest in the second scenario or respondent fatigue (Lavrakas, 2008). To ensure

[8] To ensure a balanced dataset, we excluded 14 participants who did not complete one or more choice tasks.

[9] https://www.bfs.admin.ch/bfs/fr/home/statistiques/population/effectif-evolution/age.assetdetail.32229031.html

[10] Table 8 in the appendix shows that the three experimental groups are comparable in terms of demographics, with differences in *Female*, two income groups (< *4,500* and *9,000-12,000*) and two categories of household size (*1-person* and *2-person*). This overall balance enhances the plausibility of establishing causal relationships between interventions and observed outcomes, thereby strengthening the internal validity of the study.

[11] We ask participants to read these numbers from their latest electricity invoice.

Table 2: Sample characteristics

Binary variable	Share (%)	
Female	42.7	
Age group		
24-44 y/o	30.4	
45-64 y/o	44.1	
$>$ 65 y/o	25.6	
Education level		
Vocational school	33.2	
High school	11.1	
Higher education	55.8	
Income		
$<$ 4,500	11.2	
4,500-6,000	13.2	
6,000-9,000	23.3	
9,000-12,000	24.6	
$>$ 12,000	20.5	
Household size		
1-person	26.4	
2-person	45.5	
3-person	10.7	
$>$ 4-person	17.3	
Residence type (ref: house)	36.5	
Residence status (ref: owner)	48.7	
Continuous variable	**Mean**	**S.D.**
Energy literacy	3.88	0.99
Values & norms		
Egoism	2.68	0.64
Subjective norms	3.97	0.84
Intrinsic motivation		
Attitudes	3.58	0.88
Awareness	4.16	0.95
Monthly electricity bill (CHF)	71.1	5.26
Monthly electricity consumption (kWh)	335.3	47.57

Notes: the table presents descriptive statistics for 606 households participating in the experiment. 44 participants (7.6%) did not report their income. See table 7 for additional information.

the robustness of the analysis, we re-estimate the main specification including participants who trade off between alternatives at least once[12].

4 Results and discussion

4.1 Treatment effects and preferences

Our main findings reveal unexpected effects of social comparisons on household preferences. The results are presented in Tables 4 and 5. Specifically, our analysis shows that individuals exposed to electricity comparisons (kWh) experience a 2.7% reduction in their preferences for *efficiency investments*, accom-

[12] Tables 11 and 12 in the appendix show consistent results, supporting the confidence in the experimental design.

Table 3: Statistics of choice

Choice pattern	Share
Situation A	
Always choose conservation actions	27,9%
Always choose efficiency investment	13,9%
Always choose no action	7,3%
At least one trade-off between alternatives	50,9%
Situation B	
Always choose conservation actions	35,5%
Always choose green electricity	26,2%
Always choose no action	8,6%
At least one trade-off between alternatives	29,7%
Pooled A & B	
Always choose to conserve	15,6%
Always choose to pay (efficiency or green)	7,7%
Always choose no action	6,1%
At least one trade-off between alternatives	70,5%

Note that conservation actions and no action are repeated along situation A and B, while efficiency investment and green electricity alternate and both alternative involve a financial cost to adjust electricity consumption.

panied by a 4.0% increase in their preferences for *no action*. Both effects are statistically significant at the 10% level. This suggests that social comparison does not effectively enhance sustainable preferences as anticipated. Moreover, we do not observe any significant effects on the other alternatives presented to participants.

In the case of participants subjected to financial comparisons (CHF), we observe a 4.7% increase in their preference for *no action*. Conjointly, these results indicate that both types of comparisons have adverse effects on participants' preferences for energy-saving behaviors. The increase in preferences for the *no action* alternative illustrates that households are more likely to not engage in any sustainable strategy. Our results resonate with Pellerano et al. (2017) and Dolan and Metcalfe (2015), who found that presenting social comparisons and financial incentives in the same frame leads to backfire. This raises important questions about the efficacy of social comparisons as drivers of energy conservation, suggesting that they may lead to disengagement rather than fostering the behavioral changes. Further exploration of these dynamics is essential to understand the underlying mechanisms at play.

In addition to providing evidence on the effects of policy instruments, this experiment offers valuable

Table 4: Mixed logit model

	(1)	(2)	(3)
Treatment			
Electricity comparisons (kWh)			
× Conservation actions	-0.473	0.313	-1.420**
	(0.329)	(0.466)	(0.573)
× Efficiency investment	-0.858**	-0.0703	-1.720***
	(0.383)	(0.552)	(0.641)
× Green electricity	-0.473	0.411	-1.684***
	(0.338)	(0.480)	(0.568)
Financial comparisons (CHF)			
× Conservation actions	-0.731**	-0.471	-0.901
	(0.331)	(0.433)	(0.613)
× Efficiency investment	-0.463	-0.204	-1.019
	(0.384)	(0.517)	(0.675)
× Green electricity	-0.883***	-0.685	-1.106*
	(0.342)	(0.455)	(0.607)
Attributes			
One-off price (efficiency)	-0.0023***	-0.0029***	-0.0017***
	(0.0003)	(0.0004)	(0.0004)
Monthly price (green electricity)	-0.0213	-0.0276	-0.0154
	(0.0263)	(0.0340)	(0.0433)
Share of renewable	0.126	0.225	0.00241
	(0.149)	(0.192)	(0.244)
Electricity saving (conservation)	0.0688***	0.0919***	0.0296
	(0.0144)	(0.0192)	(0.0234)
Electricity saving (efficiency)	0.143***	0.129***	0.156***
	(0.0215)	(0.0313)	(0.0318)
SD [Electricity saving (conservation)]	0.277***	0.273***	0.277***
	(0.0216)	(0.0264)	(0.0379)
SD [Electricity saving (efficiency)]	0.284***	0.324***	0.249***
	(0.0316)	(0.0475)	(0.0469)
Household characteristics			
Home owner × Conservation actions	-0.410	-0.718*	0.0962
	(0.267)	(0.381)	(0.445)
Home owner × Efficiency investment	1.079***	1.172**	1.075**
	(0.317)	(0.457)	(0.514)
Energy literacy × Conservation actions	0.249*	0.295	0.258
	(0.138)	(0.192)	(0.228)
Energy literacy × Efficiency investment	0.564***	0.388*	0.953***
	(0.162)	(0.218)	(0.266)
Subjective norms × Efficiency investment	0.318**	0.594***	-0.0389
	(0.136)	(0.181)	(0.230)
Subjective norms × Green electricity	0.450***	0.542***	0.303
	(0.118)	(0.153)	(0.197)
Constant			
Conservation actions	0.404	-0.290	1.001
	(0.649)	(0.862)	(1.104)
Efficiency investment	-2.661***	-3.019***	-2.767**
	(0.822)	(1.090)	(1.382)
Green electricity	-0.135	-0.756	-0.226
	(0.699)	(0.991)	(1.054)
N observation	3,636	2,226	1,308
N households	606	371	218

Notes: ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.10$. Robust standard errors in parentheses are adjusted for clusters (participants). No action is the baseline alternative. Specification (1) contain all participants. Specification (2) includes respondents with consumption levels below the baseline, while Specification (3) includes those above.

Table 5: Marginal effect on probabilities

	"Mixed" (1)	"Below" (2)	"Above" (3)
Electricity comparisons (kWh)			
× Conservation actions	-0.004	0.016	-0.028
	(0.028)	(0.035)	(0.048)
× Efficiency investment	-0.026*	-0.013	-0.041
	(0.015)	(0.019)	(0.026)
× Green electricity	-0.011	0.014	-0.061**
	(0.019)	(0.025)	(0.031)
× No action	0.040*	-0.017	0.131***
	(0.022)	(0.027)	(0.041)
Financial comparisons (CHF)			
× Conservation actions	-0.028	-0.015	-0.011
	(0.029)	(0.037)	(0.052)
× Efficiency investment	0.002	0.005	-0.021
	(0.016)	(0.019)	(0.027)
× Green electricity	-0.031	-0.030	-0.038
	(0.020)	(0.027)	(0.035)
× No action	0.057**	0.039	0.070**
	(0.024)	(0.033)	(0.039)
N observation	3,636	2,226	1,308
N households	606	371	218

Notes: ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.10$. Robust standard errors in parentheses are adjusted for clusters (participants). Coefficients represent the marginal change in choice probabilities and are estimated from Table 4. Specification (1) contain all participants. Specification (2) contain respondents with below baseline constructed consumption. Specification (3) contain respondents with above baseline constructed consumption.

insights into how individual characteristics shape household preferences for electricity saving strategies. Sociodemographic factors such as gender, age, education, and income are excluded from the model, as they either have no significant influence or only weakly contribute to explaining participants' choices. However, our findings reveal that homeowners are more inclined to prefer efficiency investments, while respondents with higher energy literacy exhibit a stronger propensity for both efficiency investments and conservation actions. In contrast, participants with stronger subjective norms demonstrate a greater preference for energy investments and green electricity, highlighting the role of social influences in shaping energy savings preferences. These results suggest that perceiving oneself as being surrounded by individuals who behave pro-environmentally does not necessarily lead to stronger preferences for conservation actions. Babutsidze and Chai (2018) argues that the non-visibility of electricity consumption may partly explain this disconnect. In contrast, more tangible measures—such as investing in energy-efficient appliances or opting for a greener electricity mix—may be preferred, as they provide visible and demonstrable evidence of pro-environmental behavior. This suggests that subjective norms lead individuals to prioritize actions that signal their commitment to sustainability over those with less observable outcomes.

4.2 Heterogeneity analysis

The following analyses shed light on two different consumer segments that are likely to react differently to social comparisons: below-average and above-average electricity consumption[13] (Allcott and Mullainathan, 2010). On the one hand, households with below-average electricity consumption already make great efforts or own efficient appliances. Therefore, they are not the priority target of electricity reduction policies. However, while studying the effects of norm-based instruments, it is of primary importance to assess whether this consumer segment aligns with norms by relaxing their efforts once they learn that they are performing well (Buchanan et al., 2015). As shown in Table 5, we find no significant effect of either type of social comparison (kWh or CHF) on respondents' preferences, suggesting the absence of a boomerang effect (Schultz et al., 2007). This result indicates that when households learn that their consumption habits and appliance efficiency rank among those with relatively low electricity usage, they experience a sense of satisfaction. Consequently, their preferences for electricity consumption remain unchanged.

On the other hand, households with above-average consumption have the most significant potential for reduction and, thus, are the priority target for policy interventions. For these consumers, aligning with the norm means reducing their electricity consumption. However, as shown in Table 5, electricity comparisons (kWh) have adverse effects, increasing preferences for *no action* by 13.1% and decreasing preferences for *green electricity* by 6.1%, both statistically significant at the 1% and 5% levels, respectively. High-level consumers may dislike perceived attempts to dictate their energy consumption, leading to a negative response (Allcott, 2016). Furthermore, they could identify with a social group that values high consumption (Steindl et al., 2015). Social norms within this group may reinforce the idea that high electricity consumption is acceptable or desirable. Sustainable preferences may be perceived as a threat to their image and status within their social group (Farrow et al., 2017). Therefore, we do not suspect any crowding out effect for this consumer segment. Introducing financial information does not further undermine preferences and may even have a positive effect. The adverse effect observed with electricity comparisons (kWh)—an increase in preferences for *no action*—remains statistically significant at the 5% level but is 53.4% lower when using financial comparisons (CHF).

[13] 17 participants are excluded from these analyses as they received a neutral social comparison (because their consumption was within the range +/- 5% from the baselines we had estimated). Consequently, the sample contains 381 households with below-average consumption and 223 with above-average consumption.

Table 6: Moderation analysis

Intrinsic motivation	Attitude (1)	Awareness (2)
Conservation actions	0.837***	0.625**
	(0.283)	(0.247)
Green electricity	1.135***	1.167***
	(0.296)	(0.287)
Electricity comparisons (kWh)		
× Conservation actions	-0.770	-0.772
	(0.970)	(0.522)
× Green electricity	-0.966	-0.986*
	(1.010)	(0.546)
Financial comparisons (CHF)		
× Conservation actions	-2.070***	-1.169**
	(0.775)	(0.524)
× Green electricity	-2.532***	-1.535***
	(0.825)	(0.559)
N observation	3,636	3,636
N households	606	606

Notes: ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.10$. Robust standard errors in parentheses are adjusted for clusters (participants). No action is the baseline alternative. Both specifications contain all participants and are estimated using Mixed Logit (MXL) model. Coefficients in specification (1) represent the interactions with high-level of attitude, those in specification (2) with high-level of awareness.

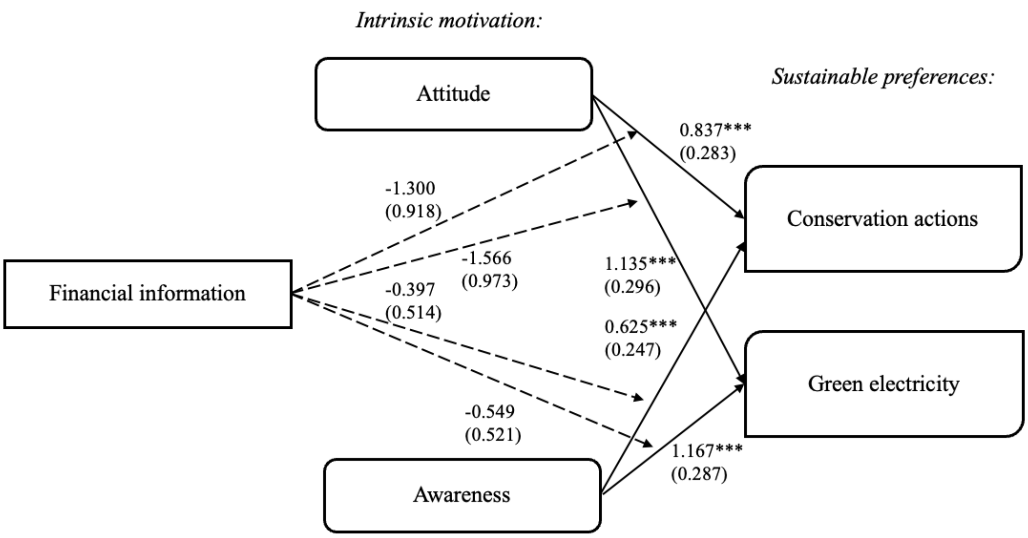


Figure 4: Crowding out

4.3 Moderation analysis

We hypothesize that extrinsic motivation can undermine intrinsic motivation and aim to shed light on this potential motivational crowding out. First, we identify two antecedents of intrinsic motivation to conserve electricity in the literature: attitude and awareness. The former refers to the predisposition to engage in environmentally friendly behaviors, even at the cost of daily inconveniences (Ajzen, 1991). The latter encompasses the belief that environmentally friendly actions contribute to the preservation of natural resources (Steg et al., 2005). Individuals with high levels of attitude and awareness inherently value the environment and recognize its connection to natural resources, thereby fostering intrinsic motivation for sustainable usage. Our results support this theory, demonstrating a strong effect between both components and sustainable preferences. Table 6 reports preferences for conservation actions and green electricity[14] and the effects of social comparisons (kWh and CHF), interacted with high levels of attitude (column 1) and awareness (column 2). The first four coefficients are positive and statistically significant at the 1% level, indicating that both components of intrinsic motivation are important drivers of sustainable preferences.

Subsequently, the remaining coefficients represent the treatment effects for the participants who receive the interventions compared to those who do not, all characterized by high levels of intrinsic motivation. Interestingly, both treatments—electricity comparisons (kWh) and financial comparisons (CHF)—reduce preferences for sustainable preferences. However, the second treatment, which includes financial information, is of greater magnitude and is statistically significant. To isolate the impact of adding financial information alongside social comparisons, we calculate the difference between the two treatments. As illustrated in Figure 4, this difference, which we labeled financial information, is negative, indicating a possible crowding out of intrinsic motivation. However, the coefficients are not statistically significant, thus providing only limited support for our hypotheses.

5 Conclusion

This research explores the impact of social comparisons and financial information on sustainable preferences in residential electricity use. Building on earlier studies, we examine the trade-offs between adopting energy-saving actions, making efficiency investments, and opting for green electricity. Special attention is given to how the effects of social comparisons vary between below-average and above-average electricity users. To uncover the underlying mechanisms, we integrate our findings into a theoretical framework that addresses the conflicting effects of financial information, social comparisons, and intrin-

[14] Efficiency investment is not reported due to the absence of a significant relationship.

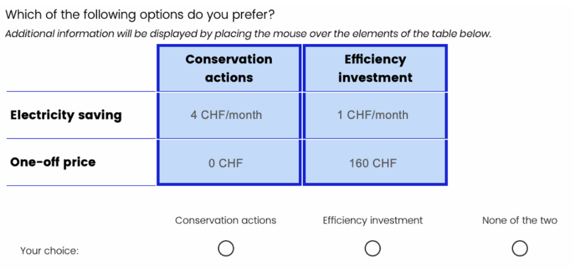
sic motivation. Using a discrete choice experiment conducted within a nationwide survey in Switzerland and employing Mixed logit (MXL) models, our results show that social comparisons are less effective than expected. They fail to enhance preferences for *conservation actions*, *efficiency investments* or *green electricity* and lead to higher preferences for *no action*.

Moreover, combining social comparisons with financial information results in further reductions in preferences for *green electricity* and increases in preferences for *no action*. These results suggest some evidence of motivational crowding out effect. However, further moderation analyses reveal no statistically significant evidence to fully support this hypothesis. While we find strong correlations between the antecedents of intrinsic motivation and preferences for sustainable electricity consumption, we do not observe a causal relationship between these preferences and the introduction of financial information.

In conclusion, this research highlights the complexity of designing interventions aimed at enhancing sustainable preferences. Encouraging households to adopt energy-saving behaviors, invest in more efficient technologies, and opt for greener energy sources is crucial for both energy security and broader environmental sustainability. However, as we demonstrate, the preferences, motivations, and drivers behind these behaviors differ across strategies and consumer segments. Policymakers should therefore tailor interventions to account for the distinct characteristics of each sustainable strategy and consumer segment thereby developing more effective approaches to promoting sustainable energy usage.

6 Appendix

Figure 5: Choice situation [Financial comparisons (CHF)]



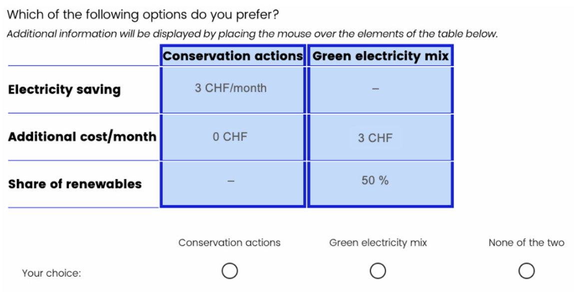
Which of the following options do you prefer?

Additional information will be displayed by placing the mouse over the elements of the table below.

	Conservation actions	Efficiency investment
Electricity saving	4 CHF/month	1 CHF/month
One-off price	0 CHF	160 CHF

	Conservation actions	Efficiency investment	None of the two
Your choice:	○	○	○

Situation (a)



Which of the following options do you prefer?

Additional information will be displayed by placing the mouse over the elements of the table below.

	Conservation actions	Green electricity mix
Electricity saving	3 CHF/month	–
Additional cost/month	0 CHF	3 CHF
Share of renewables	–	50 %

	Conservation actions	Green electricity mix	None of the two
Your choice:	○	○	○

Situation (b)

Figure 6: Control group

Control group

Q1: Can you please try to rank the following sources of electricity production in Switzerland, from the most important (1) to the least important (6)?

Hydropower
Nuclear
Solar
Waste incineration
Wind
Wood

Q2: Which of these sources do you think Switzerland should develop in priority?

Hydropower
Nuclear
Solar
Waste incineration
Wind
Wood

Q3: Why did you choose this source of electricity?

Cheapest to produce
Safest to produce
Best for the environment
Best for landscape conservation
Best trade-off between environmental, economic, and safety reasons
Other reasons

Figure 7: Electricity comparison [kWh]

Social comparison [kWh]

Q1: Can you try to rank the following 5 categories in terms of their importance in the electricity consumption of your household, from the most important (1) to the least important (5)?

Cooking
Electronics
Laundry
Lighting
Fridge and freezer

Q2: According to your previous answers, it seems that your electricity consumption is above/below the average of households similar to yours.

Q3a: In your opinion, what could be the reasons for your above-average electricity consumption?

Home office
High usage of electronic appliances
Inefficient appliances
Own a lot of electric appliances
Spend much time cooking
Spend much time cleaning
Own an electric vehicle
Other reasons

Q3b: In your opinion, what could be the reasons for your below-average electricity consumption?

Not often at home
Low usage of electronic appliances
Efficient appliances
Special attention for saving electricity
Frequent restaurant meals
Frequent cleaning of clothes at the dry cleaners
Other reasons

Figure 8: Financial comparison [CHF]

Social comparison [CHF]

Q1: Can you try to rank the following 5 categories in terms of their importance in the electricity bill of your household, from the most important (1) to the least important (5)?

Cooking
Electronics
Laundry
Lighting
Fridge and freezer

Q2: According to your previous answers, it seems that your electricity bill is above/below the average of households similar to yours.

Q3a: In your opinion, what could be the reasons for your above-average electricity bill?

Home office
High usage of electronic appliances
Inefficient appliances
Own a lot of electric appliances
Spend much time cooking
Spend much time cleaning
Own an electric vehicle
Other reasons

Q3b: In your opinion, what could be the reasons for your below-average electricity bill?

Not often at home
Low usage of electronic appliances
Efficient appliances
Special attention for saving electricity
Frequent restaurant meals
Frequent cleaning of clothes at the dry cleaners
Other reasons

Table 7: Description variables

VARIABLES	QUESTIONS	SCALE
Energy literacy	1) The biggest share of energy consumed in a Swiss household is for heating purposes. 2) CO2 emissions play a crucial role in global warming. 3) Simply lowering the heating temperature in an average household by 1°C can help to cut down the heating demand by 6%. 4) Coal is a renewable energy resource. 5) Hydroelectric power plants account for 10% of total Swiss electricity production.	True/False
Norms	*Please rate the extent to which you agree with the following statements.*	5-point scale [Totally disagree–Totally agree]
Subjective norms	I believe that most of my acquaintances behave in an environmentally friendly manner whenever it is possible.	
Intrinsic motivation	*Please rate the extent to which you agree with the following statements.*	5-point scale [Totally disagree–Totally agree]
Attitude	I will take steps to adopt environmentally friendly behaviors even if it causes daily inconveniences.	
Awareness	Acting environmentally friendly will contribute to save our natural resources.	

Table 8: Households characteristics

	(1)		**(2)**		**(3)**			
	Control		kWh		CHF		T-test	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	t	p-value
Female	0.463	0.500	0.450	0.499	0.356	0.480	2.66	0.071
Age group								
Young adults	0.339	0.475	0.303	0.461	0.260	0.440	1.46	0.232
Adults	0.417	0.494	0.431	0.496	0.480	0.501	0.84	0.434
retirees	0.243	0.430	0.265	0.443	0.260	0.440	0.15	0.861
Education level								
Vocational school	0.326	0.470	0.336	0.474	0.333	0.473	0.03	0.971
High school	0.114	0.319	0.114	0.318	0.102	0.303	0.10	0.905
Higher education	0.560	0.498	0.550	0.499	0.565	0.497	0.05	0.954
Income								
$<$ 4,500	0.138	0.345	0.128	0.335	0.062	0.242	3.21	0.041
4,500-6,000	0.138	0.345	0.147	0.355	0.107	0.310	0.70	0.496
6,000-9,000	0.202	0.404	0.246	0.432	0.254	0.437	0.92	0.399
9,000-12,000	0.271	0.446	0.185	0.388	0.288	0.454	3.35	0.036
$>$ 12,000	0.191	0.392	0.200	0.400	0.230	0.420	0.49	0.620
Household size								
1-person	0.298	0.459	0.284	0.452	0.198	0.399	2.89	0.056
2-person	0.422	0.495	0.427	0.496	0.531	0.500	2.90	0.056
3-person	0.119	0.325	0.118	0.324	0.079	0.271	1.03	0.356
$>$ 4-person	0.160	0.368	0.171	0.377	0.192	0.395	0.35	0.707
House	0.349	0.478	0.351	0.478	0.401	0.492	0.72	0.489
Home owner	0.454	0.500	0.474	0.500	0.542	0.499	1.63	0.197
Number of observations	218		211		177		606	

Table 9: Baseline electricity consumption

	Electric heating		No electric heating			
			Electric water		No electric water	
	Apartment	House	Apartment	House	Apartment	House
1-person	5400 kWh	6600 kWh	2500 kWh	3100 kWh	1800 kWh	2200 kWh
2-person	6300 kWh	8700 kWh	3000 kWh	4100 kWh	2100 kWh	2900 kWh
3-person	7800 kWh	10200 kWh	3600 kWh	4800 kWh	2600 kWh	3400 kWh
4-person	9200 kWh	12100 kWh	4300 kWh	5700 kWh	3050 kWh	4050 kWh
5-person	10200 kWh	13800 kWh	4800 kWh	6400 kWh	3400 kWh	4600 kWh
6-person	11700 kWh	15300 kWh	5400 kWh	7100 kWh	3900 kWh	5100 kWh

Notes: the table presents the constructed baseline electricity consumption based on household size, residence type, heating system, and heating water system. Electric heating implies electric water heating system. We use these reference values to determine whether participants consume more or less than similar households.

Table 10: Electricity prices

Canton	ct./kWh
Nidwald	19,56
Zurich	22,39
Genève	24,22
Schaffhouse	24,40
Fribourg	25,35
Jura	25,50
Berne	25,50
Argovie	25,87
Appenzell R.I.	26,29
Appenzell R.E.	26,72
Thrugovie	27,52
Grisons	27,56
Saint-Gall	27,72
Glaris	27,99
Tessin	28,52
Lucerne	28,85
Soleure	29,64
Obwald	29,77
Valais	29,96
Zoug	30,03
Uri	30,66
Schwytz	31,02
Bâle-Campagne	31,31
Bâle-Ville	31,73
Vaud	32,26
Neuchâtel	33,07

Notes: the table shows the average electricity prices for each of the 26 Swiss cantons in 2023.

Figure 9: Comprehensive design

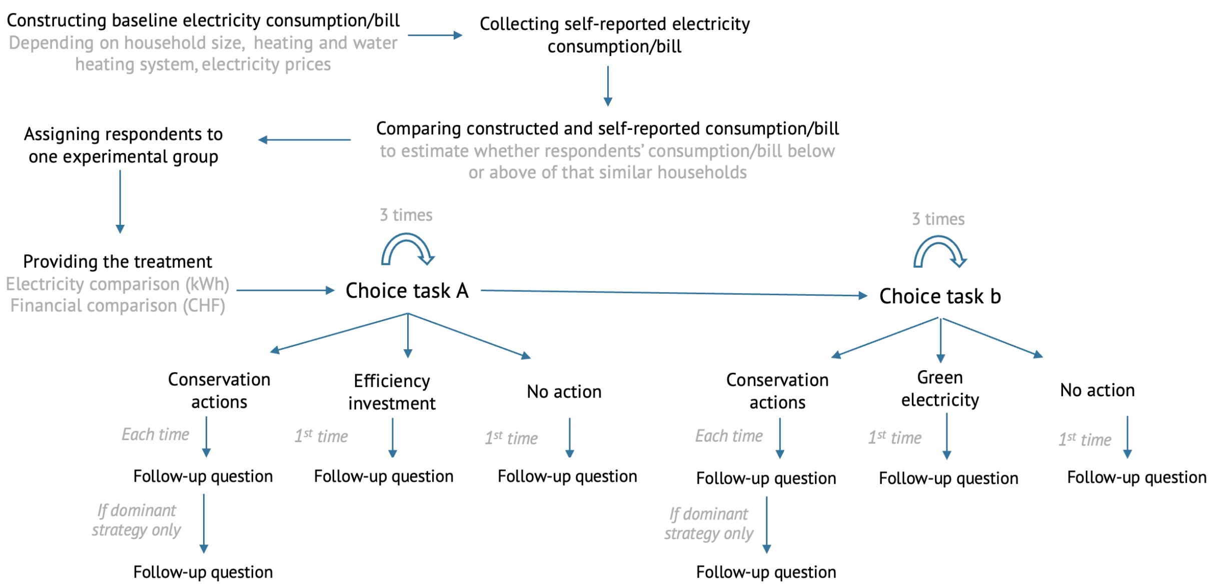


Table 11: Robustness check (MXL)

	(1)
Treatment	
Electricity comparisons (kWh)	
× Conservation actions	-0.430
	(0.309)
× Efficiency investment	-0.826**
	(0.374)
× Green electricity	-0.474
	(0.335)
Financial comparisons (CHF)	
× Conservation actions	-0.566*
	(0.308)
× Efficiency investment	-0.546
	(0.374)
× Green electricity	-1.046***
	(0.344)
Attributes	
One-off price (efficiency)	-0.00252***
	(0.000336)
Monthly price (green electricity)	-0.0332
	(0.0273)
Share of renewable	0.125
	(0.160)
Electricity saving (conservation)	0.0369***
	(0.0115)
Electricity saving (efficiency)	0.153***
	(0.0218)
SD [Electricity saving (conservation)]	0.144***
	(0.0131)
SD [Electricity saving (efficiency)]	0.211***
	(0.0279)
Household characteristics	
Home owner × Efficiency investment	0.908***
	(0.309)
Home owner × Green electricity	-0.531*
	(0.276)
Energy literacy × Conservation actions	0.335**
	(0.132)
Energy literacy × Efficiency investment	0.530***
	(0.162)
Subjective norms × Efficiency investment	0.266**
	(0.108)
Subjective norms × Green electricity	0.426***
	(0.124)
Constant	
Conservation actions	-0.961
	(0.636)
Efficiency investment	-2.257***
	(0.807)
Green electricity	0.163
	(0.726)
N observation	2,766
N households	471

Notes: ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.10$. Robust standard errors in parentheses are adjusted for clusters (participants). No action is the baseline alternative. Specification (1) includes all participants who trade off between alternatives at least once.

Table 12: Robustness check – Marginal effect

	(1)
Electricity comparisons (kWh)	
$\times$ Conservation actions	-0.003
	(0.029)
$\times$ Efficiency investment	-0.031*
	(0.016)
$\times$ Green electricity	-0.017
	(0.023)
$\times$ No action	0.052*
	(0.030)
Financial comparisons (CHF)	
$\times$ Conservation actions	-0.001
	(0.031)
$\times$ Efficiency investment	-0.010
	(0.017)
$\times$ Green electricity	-0.065***
	(0.023)
$\times$ No action	0.075**
	(0.032)
N observation	2,766
N households	471

Notes: ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.10$. Robust standard errors in parentheses are adjusted for clusters (participants). Coefficients represent the marginal change in choice probabilities and are estimated from Table 11. Specification (1) includes all participants who trade off between alternatives at least once.

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