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Do Environmental Concern and Future Orientation Predict Metered Household Electricity Use?

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Highlights

- More environmentally concerned and future-oriented persons use less electricity
- Consideration of Future Consequences is correlated to electricity use
- Subjective discount rates do not predict metered electricity use
- Metered electricity use is 23% higher for men than for women
- Results are in line with earlier research relying on self-reported behaviour

Abstract. Do individuals' environmental attitudes and future orientation predict actual energy consumption? Little is known about the answer to this fundamental question because previous research has relied on self-reported behaviour, which might be prone to social desirability. Therefore, the present study combines survey data with metered data on actual electricity use. Environmental concern is measured by attitudinal items, future orientation by a short version of the Consideration of Future Consequences (CFC) scale as well as a behaviour-based subjective discount rate. Results did not reveal any direct correlations between discount rates and electricity use but mediation analyses suggested small indirect effects. Environmental concern and CFC, however, was positively and considerably related to electricity use. Furthermore, there was a large gender difference, with women using about 23% less electricity than men. This study provides evidence that households' environmental attitudes and future orientation are correlated with actual energy consumption levels, and thus lends support to corresponding educational programmes.

Keywords: Environmental concern; future orientation; subjective discount rate; electricity use; pro-environmental behaviour; consideration of future consequences

1 Introduction

Since reducing electricity consumption plays an important role in mitigating climate change, the question as to its drivers is of utmost importance. The majority of studies looking into this topic report correlations with a number of factors, including the local climate, the type of building, floor area, appliance ownership and use, and disposable income (e.g. Bedir, Hasselaar, & Itard, 2013; Huebner, Shipworth, Hamilton, Chalabi, & Oreszczyn, 2016; Jones, Fuertes, & Lomas, 2015; Kavousian, Rajagopal, & Fischer, 2013; McLoughlin, Duffy, & Conlon, 2012). Increases in incomes have mostly been found to be related to higher home energy use (Brandon & Lewis, 1999; Brounen, Kok, & Quigley, 2012; Druckman & Jackson, 2008; Vringer & Blok, 1995). However, income elasticity is generally low (Alberini, Gans, & Velez-Lopez, 2011; Sanquist, Orr, Shui, & Bittner, 2012) and the effect may be mediated by other factors such as appliance ownership (Kavousian et al., 2013). Overall, these studies often explain around 30–40% of the variance in electricity use. Thus, although a broad range of predictors is considered, there is still a considerable amount of variance that needs explaining. A closer look at these studies reveals that they mostly neglect psychological factors such as environmental concern, locus of control and future orientation.

Studies that do focus on such factors repeatedly point to their importance in explaining consumer behaviour (for overviews see Bamberg & Möser, 2007; Hines, Hungerford, & Tomera, 1987; Liebe, 2010; Steg & Vlek, 2009; Stern, 2000). However, few of these studies analyse actual electricity use as opposed to measures of self-reported energy-saving behaviour such as frequency of curtailment behaviour (e.g. switching off lights or using a lid when cooking), or efficiency-increasing investments (e.g. buying efficient light bulbs or installing thermal insulation, Gardner & Stern, 1996). It has been argued that the relationship between psychological factors and behaviour might be weaker or even non-existent for measures of "actual" behaviour, such as metered electricity use (Van Beek, Handgraaf, & Antonides, 2017). Therefore, the present study analyses metered consumption data and takes two psychological factors into account: future orientation, i.e. the extent to which people value future benefits as opposed to present benefits, and environmental concern.

So far, only a few studies have combined measures of general environmental concern with metered electricity use. The results have been mixed: two studies report negative correlations (Cramer et al., 1985; Sapci & Considine, 2014), while most do not find any support for a relationship between environmental concern and electricity use (Huebner et al., 2016; Ohler & Billger, 2014) or combined measures of gas and electricity use (Abrahamse & Steg, 2011; Brandon & Lewis, 1999; Huebner, Hamilton, Chalabi, Shipworth, & Oreszczyn, 2015), respectively. Survey studies that run life cycle analyses to estimate (home) energy use or greenhouse gas emissions report mixed results for environmental concern (e.g. Bruderer Enzler & Diekmann, 2019; Diekmann & Jann, 2000; Gatersleben, Steg, & Vlek, 2002; Kennedy, Krahn, & Krogman, 2015; Nässén, Andersson, Larsson, & Holmberg, 2015; Poortinga, Steg, & Vlek, 2004).

We are not aware of any study on electricity use and future orientation. Yet, more often than not, energy saving involves a trade-off between short- and long-term outcomes. For example, purchasing an energy-efficient refrigerator or lowering thermostat settings in winter results in lower energy costs and helps protect the environment in the long run, while in the short term it leads to a loss of comfort and/or higher initial costs. We believe that future orientation may have an impact on all those environmentally relevant decisions where costs (monetary and otherwise) are more immediate while benefits are more delayed. We broadly understand future orientation as the extent to which an individual values future outcomes. The more value is placed on future outcomes, the more future-oriented a person is.

In previous research, this individual difference variable has been conceptualised either as a psychological orientation or as a subjective discount rate. While both strands of research refer to the same notion of a person (de-)valuing future outcomes as opposed to present outcomes, their empirical approaches differ. Discount rates are typically assessed by incentivised decisions between smaller sooner rewards and larger later rewards (Frederick, Loewenstein, & O'Donoghue, 2002). They have been shown to be related to various activities with long-term consequences, such as smoking, drug addiction, fitness training and educational decisions (Barlow, McKee, Reeves, Galea, & Stuckler, 2016; Golsteyn, Gronqvist, & Lindahl, 2014; Heutel, Bardford, Courtemanche, McAlvanah, & Ruhm, 2014; Lawless, Drichoutis, & Nayga, 2013). Regarding environmentally friendly behaviour in general, however, there is little research and what there is shows mixed results, both for studies in Western countries that did at best incentivise a few of their respondents (selected by means of lotteries; Bruderer Enzler, Diekmann, & Meyer, 2014; Franzen & Vogl, 2013a; Heutel et al., 2014) and in developing countries where studies have sometimes been able to incentivise all of their respondents (Clot & Stanton, 2014; Fehr & Leibbrandt, 2008; Javaid, Kulesz, Schluter, Ghosh, & Jiddawi, 2016).

In contrast, other studies measure attitudes towards the future on multiple items using rating scales. One of the most commonly used measures is the "Consideration of Future Consequences" (CFC) scale (Strathman, Gleicher, Boninger, & Edwards, 1994). This scale captures the extent to which a person is driven by short-term rewards or orients him- or herself towards long-term goals. Previous research indicates that CFC may be relevant in various areas of everyday life (Joireman & King, 2016), including environmental behaviour (Bruderer Enzler, 2015; Doran, Hanss, & Larsen, 2017; Khachatryan, Joireman, & Casavant, 2013; Milfont, Wilson, & Diniz, 2012). However, most of the reported findings pertaining to either the CFC scale or discount rates are based on self-reported behaviour (with few exceptions; Fehr & Leibbrandt, 2008; Joireman, Posey, Truelove, & Parks, 2009; Khachatryan et al., 2013). Furthermore, in most studies all data were collected within a single questionnaire or experimental session. Respondents' tendency to reduce cognitive dissonance may thus have inflated the relationships found, in particular regarding attitudinal measures, i.e. environmental concern and CFC. Accordingly, Bruderer Enzler (2015) found systematic evidence for a relation of the CFC measure and various kinds of environmentally responsible activities. No such relation was found for a measure of the subjective discount rate (Bruderer Enzler et al., 2014). However, these findings may have suffered from a self-reporting bias.

In the present study, these potential sources of bias are circumvented both by separating the measurement of environmental concern and future orientation from collecting information on behaviour, and by relying on an objective measure of behaviour, i.e. metered electricity use. This is done by combining questionnaire data with electricity usage data provided by a utility company. Furthermore, two measures of future orientation are used, i.e. the subjective discount rate and the CFC scale, thus allowing for comparison. It is commonly expected that the correlation between the discount rate and electricity use is positive (Hypothesis 1) while the correlation between CFC and electricity use is negative (Hypothesis 2), i.e. persons who devalue the future to a lesser degree also use less electricity. Finally, more environmentally concerned persons are also expected to use less electricity (Hypothesis 3). We believe that by shifting from self-reported to metered behaviour and by not assessing behaviour and individual characteristics within a single questionnaire, our hypothesis tests are less prone to bias. In this way, our analyses shed light on the longstanding debate on the use of behavioural vs. attitudinal measures. Furthermore, this paper is complemented by a series of exploratory analyses: we examine mediation and moderation models and whether households are interested in receiving further information on how they might save electricity.

2 Materials and Methods

2.1 Study Design and Participant Recruitment

A brief online survey was carried out in cooperation with a local energy supplier in the German-speaking part of Switzerland in 2016. A letter of invitation with a link to an online questionnaire was sent to 10,000 customers. As 1,392 persons participated in the survey, the resulting response rate was approximately 14%. In the following, we refer to those 723 respondents who provided answers to all variables considered in this study.

The study was announced as a scientific study by ETH Zurich and the University of Bern on the topic of energy use in Swiss households. The questionnaire did not include any sensitive questions and anonymity was ensured. The utility company linked the survey data to the households' electricity consumption during the previous year and made the then completely anonymised data available for analysis. At no point in time did the researchers know the identities of the participants. The respondents were not aware of the data linkage. In so doing, a possible bias was avoided (see Schwartz, Fischhoff, Krishnamurti, & Sowell, 2013 for "Hawthorne effects" in non-covert energy studies).

The questionnaire included an item battery on environmental concern (Diekmann & Preisendörfer, 2003) and a shortened version of the CFC scale. The latter scale was reduced to six items due to restrictions of survey space (imposed by the utility company). Thus, three items pertaining to an orientation towards the future and three items referring to immediate benefits were selected based on explorative analyses of data from other studies available to the authors. In order for the scale to go well with the remainder of the survey, a five-point response scale with verbal labels ranging from "does not apply at all" to "applies fully" was used. The item wordings of the two scales can be found in Table 1 and descriptive statistics for all variables can be found in the online appendix. For both environmental concern (Cronbach's α = .876) and the shortened CFC scale (α = .750), indexes were computed with higher values indicating a higher concern for the environment and the future, respectively.[1] The resulting scores theoretically range from 1 to 5 (i.e. the sum of response scores divided by the number of items).

To assess subjective discount rates, four questions were used requiring a choice between CHF 1,000 in one year's time and CHF 2,000, 1,500, 1,200 and 1,100 in two years' time respectively.[2] Responses were incentivised by a lottery: the participants were informed that three persons would be drawn at random to receive one of the payments they had opted for. After the field time ended, three lucky winners were selected and paid according to their decisions.

Based on the amount needed for a person to switch from the smaller sooner to the larger later reward, discount rates were inferred. For example, in theory, waiting for the later payment of CHF 2,000 (or CHF 1,500) suggests a discount rate of 100% or less (or 50% or less). For our analyses, patience for CHF 2,000 but not for CHF 1,500 was represented by 75%, i.e. the midpoint between 50% and 100%.

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[1] There is an ongoing debate (c.f. Joireman & King, 2016) as to whether CFC should be understood as one-dimensional (as did the original authors, Strathman et al., 1994) or two-dimensional (e.g. Joireman, Shaffer, Balliet, & Strathman, 2012). It has also been suggested that the frequently reported two-factorial structure might be the result of a method effect due to the wording of the scale (see Hevey et al., 2010; McKay, Morgan, van Exel, & Worrell, 2015). In line with the latter reasoning, we opted for the more parsimonious one-dimensional understanding of our six-item instrument. An initial confirmatory factor analysis without correlated error terms led to a poor fit, $\chi^2(9) = 184.23$, $p < .001$, RMSEA = .164 with 90% CI [.144, .185], *p*close < .001, CFI = .818, BIC = 10,269. However, after introducing error correlations (based on modification indices) between the three positively worded items, between the negatively worded items *cfc03* and *cfc11* and between *cfc07* and *cfc10* (both pertaining to "negative" or "problematic consequences"), the resulting fit was good, $\chi^2(4) = 7.55$, $p = .110$, RMSEA = .035 with 90% CI [.000, .073], *p*close = .693, CFI = .996, BIC = 10,125. Of course, this is not a unique solution.

[2] CHF 1,000 equalled roughly USD 1,000 in 2016. The wording and framing of the discounting items can be found in the online appendix.

Being willing to wait for all larger later rewards was interpreted as a discount rate of 5% (the midpoint between 0% and 10%), while no patience at all was represented as 100%. Incomplete but consistent patterns were interpreted if either two consecutive decisions indicate a tipping point from the larger later to the smaller sooner reward or the responses suggest one of the extreme categories.

Table 1. Item wording for the Consideration of Future Consequences (CFC) and environmental concern scales

	Item text
Shortened CFC scale[a]	I consider how things might be in the future. (*cfc01*)
	I am willing to sacrifice now in order to achieve future outcomes. (*cfc06*)
	I think it is important to take warnings about negative outcomes seriously even if the negative outcome will not occur for many years. (*cfc07*)
	I mainly act to satisfy my immediate concerns, figuring the future will take care of itself. (*cfc03*) *
	I think that sacrificing now is usually unnecessary since problematic future outcomes can be dealt with at a later time. (*cfc10*) *
	I only act to satisfy immediate concerns, figuring that I will take care of future problems that may occur at a later date. (*cfc11*) *
Environmental concern[b]	It bothers me when I think about the environmental conditions in which our children and grandchildren will probably have to live.
	If we continue down the same path, we are heading toward an environmental catastrophe.
	If I read news or watch TV news reports about environmental problems, I often become outraged and angry.
	There are limits on growth that our industrialized world has already exceeded or will soon reach.
	Most people in this country still do not act in an environmentally conscious way.
	In my opinion, many environmentalists exaggerate claims about environmental threats. *
	Politicians still do not do enough to protect the environment.
	In order to protect the environment, we should all be willing to reduce our current standard of living.
	Actions to protect the environment should be implemented even if they cause job losses.

Notes: * Items with stars were reverse-scored before creating the indexes.

[a] Items and translations were adopted from Bruderer Enzler (2015). For the current study, the scale was shortened from the original 12 items to 6 items as well as slightly simplified to increase readability. Item names in brackets use the original numbering by Strathman et al. (1994).

[b] Items taken from Diekmann and Preisendörfer (2001, 2003)

Furthermore, the survey included socio-demographic variables (year of birth, gender, highest level of education attained, household income in categories of CHF 2,000 up to more than CHF 12,000) as well as the number of rooms in the apartment, a binary question whether the respondent is a tenant or owns their apartment, and a series of five binary items indicating whether each of the following devices is present in the household: a television set, a dishwasher, a washing machine and a tumble drier (both exclusively accessed by the household), an electric stove (with or without oven). In addition, participants were asked whether their building used an electric heating system and whether they would be interested in receiving further information on energy-saving measures or not.

2.2 Analytical Approach

All analyses were carried out using Stata 15 (StataCorp., 2017). The three hypotheses of this study were analysed by means of Ordinary Least Squares (OLS) regression models. The results are presented both for all households and restricted to one-person households (Table 3). While the analyses using the full

sample have more power, they assume that the respondent's characteristics are representative of the whole household. The analyses of one-person households only, in contrast, allow for more strict tests of our hypotheses as only with this restriction, all variables refer to the same unit of analysis.

The hypothesis on environmental concern was tested separately from future orientation, thus not controlling for future orientation. The rationale is that these two concepts are theoretically and empirically related. Therefore, it would be difficult to disentangle the separate contributions of future orientation and environmental concern in explaining electricity consumption.

3 Results

3.1 Descriptive Results

While average household electricity consumption was 250 kWh per month, this figure was closely related to household size (mean consumption of one- to four-person households: 147, 265, 281 and 356 kWh/month, respectively). Overall, the participants indicated a relatively high degree of environmental concern and future orientation as assessed by the CFC scale (see Table 2). Furthermore, the two measures of future orientation, CFC and the discount rate, were correlated with one another (same as in previous research, e.g. Van Beek et al., 2017) as well as with environmental concern. The average discount rate was 38% and when excluding the most extreme cases (≥ 100%) it dropped to 29%. Previous research typically reports similar estimates, such as one study reporting 40% and 27% for Switzerland (the latter number was computed excluding cases with discount rates ≥ 100%; Bruderer Enzler et al., 2014) or another study reporting 28% for Denmark (Harrison, Lau, & Williams, 2002).

Table 2. Descriptive statistics and Pearson correlations for key independent variables (all households, n = 723)

	Mean	Cronbach's alpha	Pearson correlations	
			Discount rate	CFC
Discount rate (in %)	37.98	n/a		
CFC	4.18	.750	-.206***	
Environmental concern	3.86	.876	-.149***	.556***

Notes: n/a means "not available". *** $p < .001$

Median age of respondents was 54 years and the proportion of males was 63%. Thus, on average, the respondents were older than the general adult population, for which the median is 49 years, and males were overrepresented (compared to 49% males in the adult population; Swiss Federal Statistical Office, 2018). As in most surveys, there was an upward bias in education: 64% of respondents had earned a college (university of applied sciences) or university degree. For all further analyses, these two categories were used to form an indicator for "high education". Median household income fell into the category of CHF 8,000 to CHF 9,999 per month.

3.2 Who Uses More Electricity?

As can be seen in Table 3, there were positive effects of household size, apartment size, the number of electrical devices and having an electric heating system on electricity consumption. For one-person households, however, the effects for apartment size and heating system did not reach statistical significance. All models suggested gender differences (that are discussed further below). The effects of the remaining socio-demographic variables, including income, were not statistically significant.

Regarding our hypotheses, the results revealed that for all households, electricity use was negatively and statistically significantly related to both environmental concern (Hypothesis 3) and CFC (Hypothesis 2). The coefficients indicated that a one-unit increase of these variables was associated with a decrease in electricity use by 8.1 and 11.8%, respectively. In contrast, no significant relationship was observed for the subjective discount rate (Hypothesis 1). For one-person households, the significant effect of CFC remained but the effect of environmental concern lost significance. Yet a significant effect of environmental concern was present in a bivariate regression (β = -.160, t =-2.55, p = .012), while the discount rate showed no significant effect at all, either in multivariate or in bivariate analyses (bivariate regression: β = -.0001, t = -.16, p = .876 for all households and β = .0014, t = 1.09, p = .275 for one-person households).

Table 3. OLS regression of electricity consumption (in kWh, logarithmised) for all households and for one-person households

	All households			One-person households		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Discount rate (in %)	-.000			.001		
	(-.10)			(.51)		
CFC		-.126**			-.158*	
		(-3.12)			(-2.05)	
Environmental concern			-.084**			-.081
			(-2.63)			(-1.20)
Number of persons in household	.192***	.202***	.200***			
	(6.60)	(6.96)	(6.89)			
Number of rooms in apartment	.088***	.087***	.091***	.099+	.094	.103+
	(4.09)	(4.03)	(4.21)	(1.67)	(1.60)	(1.74)
Electrical devices[a]	.118***	.109***	.107***	.130**	.120**	.123**
	(5.79)	(5.37)	(5.19)	(2.91)	(2.68)	(2.73)
Electric heating system (0 = no, 1 = yes)	.193**	.188**	.191**	.127	.132	.120
	(2.82)	(2.77)	(2.81)	(.92)	(.97)	(.88)
Owns apartment (0 = no, 1 = yes)	-.071	-.065	-.066	-.073	-.060	-.064
	(-1.25)	(-1.16)	(-1.17)	(-.59)	(-.49)	(-.52)
Female (0 = no, 1 = yes)	-.129**	-.108*	-.099+	-.282**	-.255**	-.256*
	(-2.61)	(-2.16)	(-1.95)	(-2.89)	(-2.62)	(-2.56)
Age (in years)	.001	.001	.001	.001	.002	.002
	(.39)	(.51)	(.45)	(.35)	(.73)	(.45)
High education (0 = no, 1 = yes)	.017	.030	.024	.137	.148	.135
	(.35)	(.62)	(.49)	(1.31)	(1.44)	(1.31)
Household income (in CHF/month)	.000	.000	.000	-.000	-.000	-.000
	(.97)	(1.05)	(.78)	(-1.30)	(-1.53)	(-1.60)
Constant	4.078***	4.580***	4.402***	4.333***	4.996***	4.697***
	(31.32)	(22.16)	(24.60)	(19.67)	(12.95)	(12.75)
Observations	723	723	723	188	188	188
$R^2_{adj.}$	.286	.295	.293	.118	.137	.124

Notes: t statistics in brackets; + p < .10, * p < .05, ** p < .01, *** p < .001.

[a] Sum scale of five binary items indicating whether each of the following devices is available to the household: television set, dishwasher, washing machine and tumble drier (both exclusively accessed by the household), electric stove (with or without oven).

3.3 Exploratory Analyses Regarding Future Orientation

This section presents two sets of exploratory analyses: First, we explored whether the effects of future orientation on electricity use might be mediated by environmental concern. We argue that more future-oriented individuals might develop a more pronounced environmental concern that in turn influences their behaviour. This line of thought corresponds to the "awareness model" put forth by Joireman, Strathman, and Balliet (2006). Previous research provides support for this or very similar hypotheses (e.g. Bruderer Enzler, 2015; Joireman, Van Lange, & Van Vugt, 2004; Joireman et al., 2001). In our analyses, possible indirect effects for the discount rate were also explored even though there was no evidence for any direct effects (see Table 3). In recent literature on mediation, there is agreement that even in the absence of direct effects it is useful to model indirect effects (Hayes, 2014; Zhao, Lynch, & Chen, 2010).

Second, as an alternative to this awareness hypothesis, we analysed whether future orientation moderates the relationship between environmental concern and electricity use. This type of interaction hypothesis has been termed "concern model" by Joireman et al. (2006). Our proposition is that the more future-oriented a person is, the more their environmental concern influences their behaviour. However, previous research has yielded mixed results (e.g. Collins & Chambers, 2005; Joireman et al., 2004).

3.3.1 Mediation by Environmental Concern

To test whether the effect of future orientation on behaviour is mediated by environmental concern, indirect effects were estimated following the product of coefficients approach using the Stata command -sgmediation- written by Ender (2012). To determine the significance of the indirect effects, bias-corrected 95% confidence intervals were computed by bootstrapping (1,000 iterations; Hayes, 2009; Zhao et al., 2010). The upper section of Table 4 summarises the results of these analyses while the underlying models can be found in the online appendix.

Table 4. Summary of mediation analyses with electricity use as the dependent variable (in kWh, logarithmised)

Independent variable	Mediator	Sample[a]	Covariates[b]	Indirect effect	95% CI [LL, UL][c]
CFC	Environmental concern	All households	Without	-.0874[d]	[-.1481, -.0251]
		All households	With	-.0291	[-.0804, .0210]
		One-person households	Without	-.0575	[-.1778, .0723]
		One-person households	With	.0054	[-.1002, .1335]
Discount rate	Environmental concern	All households	Without	.0004[d]	[.0002, .0009]
		All households	With	.0002[d]	[.0001, .0005]
		One-person households	Without	.0005[d]	[.0000, .0013]
		One-person households	With	.0002	[-.0001, .0009]
Female	CFC	All households	Without	-.0190[d]	[-.0402, -.0048]
		All households	With	-.0217[d]	[-.0436, -.0084]
		One-person households	Without	-.0436[d]	[-.1097, -.0084]
		One-person households	With	-.0302[d]	[-.0883, -.0015]
Female	Discount rate	All households	Without	.0001	[-.0038, .0055]
		All households	With	-.0001	[-.0054, .0032]
		One-person households	Without	-.0067	[-.0470, .0052]
		One-person households	With	-.0038	[-.0454, .0076]
Female	Environmental concern	All households	Without	-.0421[d]	[-.0771, -.0149]
		All households	With	-.0305[d]	[-.0581, -.0058]
		One-person households	Without	-.0566	[-.1421, .0023]
		One-person households	With	-.0292	[-.0941, .0142]

Notes:
[a] All households: n = 723. One-person households: n = 188.
[b] The same variables are used as covariates as in Table 3.
[c] CI = confidence interval; LL = lower limit; UL = upper limit. All CIs from bootstrapping are bias-corrected.
[d] 95% CI does not include zero.

The results did not provide much support for mediation of the effect of CFC on behaviour: Only an analysis without covariates and relying on the full sample lent support to the hypothesis. Here, a one-unit increase in CFC was associated with a decrease of 8.4% in electricity use due to the indirect effect (in addition to a remaining direct effect that signified a reduction of 6.2% per one-unit increase in CFC). Thus, while there were direct effects (not controlling for environmental concern, cf. Table 3), our results did not consistently support mediation of these effects by environmental concern.

For the discount rate on the other hand, there were not any direct effects (cf. Table 3) but there were indirect effects. This held for all households and – when not controlling for further covariates – also for one-person households. The indirect effects suggested, depending on the model, that if the discount rate increased by 10 units (e.g. from 10% to 20%), the associated electricity use would increase by 0.2 to 0.5%.

3.3.2 Future Orientation as a Moderator

To explore whether future orientation acts as a moderator of the relationship between environmental concern and behaviour, models 3 and 6 in Table 3 were rerun twice – once including the interaction of environmental concern with CFC, once including the interaction with the subjective discount rate. Neither interaction term was significant – neither for the full sample nor for one-person households.[3]

3.4 Exploratory Analyses Regarding Gender

As can be inferred from Table 3, women in one-person households used about 22.5–24.6% less electricity than men. Even when controlling for other variables such as income, apartment size or electrical devices, the gender difference remained. In this section, these differences are explored in more detail.

Bivariate tests suggested that women (M = 4.11, n = 271) were not only more concerned with the environment than men (M = 3.71, n = 452), $t(721) = -7.18$, $p < .001$, but also more future-oriented as measured by CFC, $t(721) = -3.61$, $p < .001$ (M_{women} = 4.28, M_{men} = 4.13). However, there were no differences regarding discount rates, $t(721) = .14$, $p = .891$ (M_{women} = 37.6, M_{men} = 38.0).

To examine whether there were indirect effects of gender, mediation analyses were carried out applying the procedure described in section 3.3.1. The results (see lower section of Table 4) suggested that the effect of gender might indeed be mediated by CFC, but not by the discount rate. For example, for females in one-person households, the indirect effect through CFC accounted for a 3.0% lower electricity use (controlling for covariates). For environmental concern as a mediator, the evidence was mixed: While there were significant indirect effects for the full sample, the effects for one-person households were not significant.

To explore whether gender acts as a moderator of the relationship between behaviour and CFC (as suggested by Joireman & Liu, 2014), discount rates and environmental concern, respectively, regression models 3 and 6 in Table 3 were rerun each with the interaction of the variable of interest with gender. However, none of the added interaction terms were significant – neither for the full sample nor for one-person households.

[3] Results for all moderation analyses can be found in the online appendix.

3.5 Expressed Interest in Information on Energy-saving Measures

Finally, the effects of the discount rate, CFC and environmental concern on the interest in receiving information on energy-saving measures were analysed. The results are presented in Table 5.

Table 5. Binary logit models of interest in information on energy saving, all households and one-person households

	All households: wants information	One-person households: wants information
Discount rate (in %)	-.0001	.001
	(-.07)	(.19)
CFC	.117	.051
	(.70)	(.15)
Environmental concern	.529***	.793*
	(3.93)	(2.56)
Electricity use (log(kWh/month))	.228+	.787**
	(1.74)	(2.72)
Number of rooms in apartment	-.042	-.373+
	(-.56)	(-1.73)
Electrical devices[a]	.128+	.068
	(1.77)	(.44)
Electric heating system (0 = no, 1 = yes)	-.218	-.460
	(-.92)	(-.94)
Owns apartment (0 = no, 1 = yes)	.270	.087
	(1.40)	(.21)
Female (0 = no, 1 = yes)	-.125	-.131
	(-.72)	(-.38)
Age (in years)	-.009	.015
	(-1.39)	(1.23)
High education (0 = no, 1 = yes)	.249	.741*
	(1.48)	(2.02)
Household income (in CHF/month)	-.0001	-.0001
	(-1.56)	(-.86)
Constant	-3.442	-7.252
	(-3.51)	(-3.49)
Observations[b]	721	188
McFadden R^2	.040	.102

Notes: z statistics in brackets; + $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

[a] Sum scale of five binary items indicating whether each of the following devices is available to the household: television set, dishwasher, washing machine and tumble drier (both exclusively accessed by the household), electric stove (with or without oven).

[b] *n* is lower than in Table 2 since two persons responded to all items used in the hypothesis tests but did not indicate whether they were interested in receiving further information.

There were positive and statistically significant effects of electricity use and environmental concern on the expressed interest. In contrast, neither the effect of the discount rate nor CFC was statistically significant. Yet in bivariate logit models, CFC had a positive effect ($\beta = .424$, $z = 3.15$, $p = .002$ for all households and $\beta = .511$, $z = 2.04$, $p = .042$ for one-person households). The discount rate, in contrast, did not have any significant effect at the bivariate level ($\beta = -.002$, $z = -1.08$, $p = .281$ and $\beta = -.0005$, $z = -.13$, $p = .895$).

4 Discussion

In contrast to the majority of previous studies on future orientation, environmental concern and (self-reported) behaviour, we were able to base our analyses on subjective survey data as well as on objective data on electricity consumption supplied by a utility company. To assess the valuation of immediate versus future benefits, the survey included both a measure from economics, i.e. the subjective discount rate, and a psychological multi-item scale, i.e. a shortened version of the CFC scale.

The results indicated that CFC (Hypothesis 2) and environmental concern (Hypothesis 3) were both significantly and negatively related to electricity consumption. Increases in these variables by one unit were associated with decreases in electricity consumption by 8.1% and 11.8%, respectively. However, contrary to expectations, there were not any direct effects of discounting on electricity use (Hypothesis 1).

To analyse these relationships in more depth, we explored (in a post hoc fashion) alternative (or complementary) models of how environmental concern and future orientation might be interrelated with energy use. There was not any support for a moderation hypothesis that argued that a higher degree of future orientation would amplify the effect of environmental concern on behaviour. However, there was evidence that the discount rate may yet be related to behaviour, i.e. our analyses revealed an indirect effect mediated by environmental concern. While this is noteworthy in terms of theory, the absolute effects were small – depending on model specification, they indicated that an increase in the discount rate by 10 units (that is 10%) was associated with 0.5% increase in electricity use at most. Analogous mediation analyses for CFC did not suggest any indirect effects. However, this might be due to the high correlation between CFC and environmental concern which results in larger standard errors (c.f. Zhao et al., 2010). Overall, these additional results suggest it may be advisable for future research to look into such mediation models.

Since discount rates and CFC both assess the valuation of future versus immediate consumption, similar results for the two measures were expected. Yet, our analyses offer consistent support for effects of CFC while the evidence for discounting was mixed. Although this is in line with previous research, the question remains as to why this is the case. One possible reason is the discounting measure used in this study. Future research may want to compare alternative measures within the same study. These could be longer series of choice tasks (leading to more fine-grained measures and more variance), tasks involving lower monetary amounts or tasks with different incentives (certain payoffs, lotteries or purely hypothetical choices).

Furthermore, doubts have been raised whether discount rates do assess a trait and it has been noted that the measurement of temporal preferences may be confounded by other factors such transaction costs or risk preferences (cf. Frederick et al., 2002). In addition, some researchers argue in favour of domain-specific measures of discounting. While following the so-called "correspondence principle" (Ajzen, 1991), that is measuring concepts at the same level of specificity, may indeed increase correlations, this is also problematic as it may lead to an overestimation of the relevance of discount rates.

Hence, from the point of view of our results, the multi-item measurement of future orientation using a shortened version of the CFC scale seems to be of higher predictive validity than the discount rate. Our results did not only suggest that it may be advisable to assess future orientation by means of attitudinal scales – such as the CFC scale – instead of discounting measures, but also support the validity of studies relying on self-reported measures of pro-environmental behaviour. Even when analysing metered electricity consumption and thus ruling out the potential bias introduced by self-reported behaviour, our results were still in line with previous research. This is encouraging. However, earlier studies have shown that while self-reported and actual behaviour are correlated there is still a lot of

unexplained variance (Kormos & Gifford, 2014), which suggests researcher should – whenever possible – base their work on actual behaviour instead.

In addition, it should be noted that besides studies on future orientation, there is a wide range of psychological publications dealing with temporal aspects of conservation, see for example Gifford et al. (2009) for a study on temporal pessimism or McDonald, Chai, and Newell (2015) for a review on psychological distance. While these topics are outside of the scope of the present article, they may provide interesting avenues for future research. Furthermore, future studies may also want to analyse the relationship between temporal orientations and the choice of "green" energy contracts by customers. Previous research has shown that, in line with a status quo bias in decision making (Samuelson & Zeckhauser, 1988), the definition of green defaults is very effective in promoting the uptake of green tariffs (e.g. Ebeling & Lotz, 2015) but not much is known about individual differences relating to these choices.

An interesting by-product of our analyses was an unexpectedly large gender difference: In our study, women used roughly 23% less electricity than men even after controlling for relevant factors such as apartment size or income and when restricting the analyses to one-person households. This is in line with many previous studies on environmental behaviour that have reported that females were consistently behaving in a more environmentally friendly way (Kollmuss & Agyeman, 2000; Stern, Dietz, & Kalof, 1993; Zelezny, Chua, & Aldrich, 2000). However, these studies mostly relied on self-reported behaviour. Consequently – and in contrast to our study – it is not clear whether the reported gender differences are real or an artefact of more optimistic self-reporting by women than by men. Out of three earlier studies on actual electricity use and gender, one reported a lower per capita electricity use for households with a higher proportion of females (Brounen et al., 2012), whereas the other two indicated that a higher share of females in households or ZIP code areas was associated with higher electricity use (Elnakat & Gomez, 2015; Elnakat, Gomez, & Booth, 2016). However, the latter two studies reported only bivariate results, which is problematic since gender is associated with other determinants of electricity use, such as income and home size. Hence, our results lend further support to actual gender differences.

Additional exploratory analyses suggested that the effect of gender may be mediated by environmental concern and CFC but not by the discount rate. Furthermore, there was no interaction between gender and CFC and environmental concern, respectively, which suggests that the effects of these variables are not gender-specific. Further studies are needed to analyse the possible causes of the reported gender difference.

A major limitation of the present study is potential self-selection. As the response rate was low – as was to be expected based on earlier studies inviting customers of energy suppliers (Abrahamse & Steg, 2011; Ohler & Billger, 2014) – the question remains whether the resulting sample differs meaningfully from the general population for the purposes of the present study and thus whether the results hold for other segments of the population as well. For example, there are differences between sample and population in terms of gender and age. This might be due to the fact that the invitation letter likely went to the household head, who – in larger households – is often one of the older residents and is often male. Despite the introduction of the study as a study on the topic of "energy use" (not "energy saving"), it is possible that a sample of environmentally motivated households took part. While other studies have shown that environmental concern is comparatively high in Switzerland (Franzen & Vogl, 2013b), caution in generalising our results is warranted. Furthermore, since our study is cross-sectional, the results remain correlational in nature. Future (longitudinal) studies would be needed to analyse causal relationships.

Another limiting factor is our treatment of the CFC scale. We used a six-item scale and a confirmatory factor analysis only led to a good fit when introducing several correlated error terms.

While introducing such correlations based on empirical results and discussing them post hoc appears to be rather the rule than an exception, caution is warranted and future studies may consider using the 14-item version of the CFC scale put forth by Joireman et al. (2012). A carefully developed, methodologically tested and agreed upon short version of the CFC scale would be useful to future research in fields where questionnaire space is a particularly scarce resource as was the case for this study.

In terms of policy, the results presented in this paper are encouraging as they indicate that environmental concern and CFC are both related to electricity use. In addition, both more environmentally concerned persons and persons living in households with higher electricity requirements indicated more interest in information on energy saving. This is encouraging since particularly large consumers in tendency will have a greater potential for actual savings. Therefore, information provision, educational campaigns, etc. may well be beneficial. Due to higher consumption levels, policy measures regarding one-person households could focus more strongly on men as a target group. Well-planned communication of environmental and other long-term consequences of behaviour (e.g. financial savings) may have an impact on energy use.

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