Combining "carrot and stick" to incentivize sustainability in households

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Abstract: Electrical utilities are a main stakeholder for achieving sustainable policy goals. Effective tariff designs that incentivize electricity savings among consumers can contribute to fulfilling these goals. Prior research suggests that penalties are more effective in promoting behavior change, which can be explained by insights from behavioral economics: Loss aversion describes that people react more strongly to losses (penalties) than to rewards of the same magnitude and go greater lengths to avoid them. However, in markets where consumers freely choose their preferred tariff, it remains a major challenge to persuade consumers to voluntarily subscribe to penalizing tariffs. The present study employed a choice experiment using choice-based conjoint analysis to examine consumer preferences for electricity tariffs that apply a combination of rewards and/or penalties for electricity consumption. Results from a representative sample of Swiss electricity consumers show that consumers prefer tariffs that reward decreases in electricity consumption, rather than tariffs that penalize increases in consumption, but that tariffs combining rewards and penalties achieve substantial market acceptance. Direct tariff attractiveness ratings additionally support these findings showing that consumers perceive combined Bonus-Malus tariffs as sufficiently attractive. Future research avenues and implications for marketing strategies and energy policies are discussed.

*Highlights

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- Consumers prefer positive (Bonus) to negative incentives (Malus)
- Combining Bonus and Malus components increases acceptance for incentivized tariffs
- Potential for implementing incentivized tariffs in liberalized markets

Abstract

Electrical utilities are a main stakeholder for achieving sustainable policy goals. Effective tariff designs that incentivize electricity savings among consumers can contribute to fulfilling these goals. Prior research suggests that penalties are more effective in promoting behavior change, which can be explained by insights from behavioral economics: Loss aversion describes that people react more strongly to losses (penalties) than to rewards of the same magnitude and go greater lengths to avoid them. However, in markets where consumers freely choose their preferred tariff, it remains a major challenge to persuade consumers to voluntarily subscribe to penalizing tariffs. The present study employed a choice experiment using choice-based conjoint analysis to examine consumer preferences for electricity tariffs that apply a combination of rewards and/or penalties for electricity consumption. Results from a representative sample of Swiss electricity consumers show that consumers prefer tariffs that reward decreases in electricity consumption, rather than tariffs that penalize increases in consumption, but that tariffs combining rewards and penalties achieve substantial market acceptance. Direct tariff attractiveness ratings additionally support these findings showing that consumers perceive combined Bonus-Malus tariffs as sufficiently attractive. Future research avenues and implications for marketing strategies and energy policies are discussed.

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- Incentives
- Rewards and Penalties
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1. Introduction

While government and utilities are bound to fulfill stringent sustainable development policies, the global energy demand is rising (IPCC, 2014). Energy conservation strategies, particularly strategies aiming to minimize consumption and wasteful behaviors, pose a large potential in achieving the sustainable development goals (e.g., AGECC, 2010; Swart, Robinson, & Cohen, 2003). Electrical utilities can crucially contribute to achieving these goals, as many utilities are not only profit-driven, but have a clear mandate to help citizens to save energy (EED Directive, 2012; Fawcett, Rosenow, & Bertoldi, 2018; Sciortino, Nowak, Witte, York, & Kushler, 2011).

One way of promoting energy savings is by implementing effective tariff designs that motivate households to reduce their consumption. In this context, the behavioral sciences can make important contributions by offering insights into the most efficient behavior change mechanisms. Many promising intervention strategies to reduce energy consumption have been developed based on the implementation of goal-setting techniques (Harding & Hsiaw, 2014), provision of consumption feedback (Bertoldi, Serrenho, & Zhangeri, 2016), or consumption comparisons with a social reference group (Allcott, 2011).

One of the earliest and most prominent ways to trigger behavioral change across contexts are incentive-based strategies, which reward desired behaviors and punish undesired behavior (e.g., Skinner, 1953). In the domain of electricity consumption, incentives can be applied in different manners, for example, rewarding decreases in electricity consumption and/or punishing consumption increases (or failure to decrease consumption) (e.g., Bertoldi, Rezessy, & Oikonomou, 2013; Borenstein, 2009).

In the present contribution, we first provide a brief overview of the literature describing the impact of rewards and punishments on behavior, emphasizing differences between the two approaches in the efficiency to change behavior as well as potential pitfalls that need to be considered when applying incentive-based behavior change interventions. We then discuss recent experiences with incentive-based electricity saving tariffs and outline a tariff structure that aims at maximizing behavior change as well as consumer acceptance by combining reward and punishment to encourage energy savings.

1.1 Incentive mechanisms: Reward and punishment

Incentives and their impact on human behavior have been of great interest to both economists and psychologists. Applying incentives, that is, using rewards to increase the frequency of desired and punishments to reduce the frequency of undesired behaviors, have been shown to be effective in increasing cooperation (e.g., Fehr & Gächter, 2002), dieting (e.g., Volpp et al., 2008) and exercising (e.g., Charness & Gneezy, 2009), improving work performance (e.g., Lazear, 2000), and promoting environmental conservation (e.g., recycling; Bor, Chien, & Hsu, 2004; Timlett & Williams, 2008).

Both rewards and punishments are effective in triggering behavior change, while punishments have been found to be slightly more effective (Balliet, Mulder, & van Lange, 2011). Moreover, behaviors tend to change quicker in response to punishments (Azrin & Holz, 1966; Skinner, 1953) and behavioral changes sustain longer in response to punishments than to rewards (Sefton, Schupp, & Walker, 2007; Sutter, Haigner, & Kocher, 2010). Hence, punishments seem to be more impactful for long-term behavioral change as compared to rewards (see, e.g., Coad, de Haan, & Woersdorfer, 2009).

Standard economic models assume that decisions and behaviors are based exclusively on considerations of the maximization of individual utility, thus expecting a monotonic relationship between incentives and performance: The higher the financial incentive, the greater the resulting effort and performance (see also Ayres, 2010; Gneezy, Meier, & Rey-Biel, 2011), while effort and performance are expected to be minimal when there are no extrinsic incentives (Kreps, 1997). However, real-world behaviors do not follow this monotonic assumption. Instead, several additional factors influence the effect that incentives have on human decisions and behaviors, such as the type of incentive and the temporal distance to the reception of the incentive (e.g., Gneezy, 2003; Gneezy, Meier, & Rey-Biel, 2011). Models from behavioral economics can explain real-world observations of the effect of incentives on human decisions and behaviors and account for the asymmetrical effectiveness of rewards and punishments, allowing to take into account deviations from standard rational choice models. Loss aversion, as formalized in prospect theory, postulates that rewards and punishments are perceived as deviations from a neutral reference point, with rewards being perceived as gains and punishments being perceived as losses (Tversky & Kahneman, 1986, 1991). As the value function for losses is steeper than for gains, the displeasure associated with losses is up to twice as intense as the pleasure associated with gains (Kahneman & Tversky, 1979). As a consequence, people generally show greater behavior change in order to avoid a punishment (“loss”) than in order to receive a reward (“gain”; see, e.g., Fryer, Levitt, List, & Sadoff, 2012; Imas, Sadoff, & Samek, 2016; Tindall & Ratliff, 1974).

In addition to this asymmetric valuation effect, insights from psychology research explain that punishments may furthermore signal a stronger social behavior norm (e.g., Coad et al., 2009; Johnson & Krüger, 2004). Under threat of punishment, the desired behaviors may be perceived as obligatory, rather than voluntary, and might therefore trigger greater compliance (Mulder, 2008; Evers, Inbar, Blanken, & Oosterwijk, 2016). While findings suggest punishments produce greater behavioral change (Balliet et al., 2011), prospect theory additionally predicts that people, when offered a free choice, will vastly prefer gains to losses, and will thus more likely accept reinforcement contingencies that are based on receiving rewards than contingencies based on accepting punishments.

Empirical findings to support these theoretical predictions are, however, inconclusive: Where Luft (1994) as well as Hannan, Hoffman, and Moser (2005) showed that workers have a preference for bonus contracts that reward higher work performance, rather than penalty contracts that penalize lower work performance, other empirical findings demonstrate that, under certain circumstances, people are indeed willing to voluntarily choose loss contracts in the work context (De Quidt, 2017; Imas et al., 2016). A possible explanation for these findings is that loss contracts serve as commitment device. People may anticipate that they will work harder under threat of a potential loss (Imas, et al., 2016; Kaur, Kremer, & Mullainathan, 2015; Royer, Stehr, & Sydnor, 2012). De Quidt (2017) suggests that commitment alone cannot explain these findings, but that risk seeking behaviors under losses and greater salience of effort under loss contracts contribute to these voluntary subscriptions. Nonetheless, the exact psychological mechanisms and the role of loss aversion in incentive-based contract preferences are still inconclusive and more work is needed (cf. Imas et al., 2016).

1.2 Incentives and electricity tariffs

In light of the increasing prominence of using incentives in environmental policy (Shogren, 2012), their influence on environmental and sustainable actions and behaviors has been extensively studied (see Rode, Gómez-Baggethun, & Krause, 2015 for a review). For example, incentives have been successfully applied to promote waste management and recycling (e.g., Bor et al., 2004), energy conservation (e.g., Ito, Ida, & Tanaka, 2015), and change of transportation habits (e.g., Jakobsson, Fujii, & Gärling, 2002). Incentives have also proven useful for utility providers to design incentive-based conservation programs (e.g., Train, 1988).

While the above examples demonstrate the successful implementation of incentives to promote pro-environmental behaviors, other scientific insights illustrate that under specific circumstances, incentives (i.e., both rewards and punishments) can backfire and undermine the promoted behavior. This is particularly the case where behaviors have a moral component and can be driven by intrinsic motivation (e.g., blood donations, Mellström & Johannesson, 2008; acceptance of a nuclear waste repository in the neighborhood, Frey & Oberholzer-Gee, 1997). This so-called *crowding out effect* (Deci, 1971; Deci, Koestner, & Ryan, 1999) illustrates that monetary incentives, both rewards and punishments, can undermine intrinsic motivation and initial civic spirit.

Despite links between incentives for energy conservation and potential crowding out effects (see Stoft & Gilbert, 1994, for a summary), a number of successful incentive-based programs exist. For example, Energy-Saving Feed-In tariffs (ESFIT) apply rewards to encourage energy-saving behaviors. ESFIT usually set a pre-defined energy-saving target for consumers and pay a financial incentive upon target fulfillment (Bertoldi et al., 2013). In contrast to this, tariffs such as the progressive tariff (PT) punish overconsumption. PT apply an inverse demand function, where the price per kilowatt per hour (kWh) increases with every additional unit of consumed energy (Borenstein, 2009). Badouard (2012) and Faruqui (2008) studied the effectiveness of PT and report that PT can mobilize significant decreases in energy consumption. A recent review by Prasanna, Mahmoodi, Brosch, and Patel (2018) contrasted the energy-saving effectiveness of PT and ESFIT showing that, overall, penalty-based tariffs were more effective in mobilizing energy savings in residential consumers than reward-based tariffs.

Although these scientific insights suggest a greater effectiveness of punishments to promote electricity conservation, these punishment-based tariffs are implemented mainly in countries where the government regulates the electricity market and consumers do not choose their preferred tariff such as in China (Dehmel, 2011; Sun & Lin, 2013). Unlike this, in less regulated markets such as Switzerland, consumers often have the possibility to freely choose their preferred electricity tariffs from their utility provider, whereas in liberalized markets, such as within the European Union, consumers can also freely choose a utility provider. Hence, competition is strong and electricity tariffs with a rewarding incentive structure find greater implementation in these countries.

Implementing electricity tariffs that penalize consumption in countries where consumers can freely choose their tariffs is thus a challenge, as the perceived penalty that consumers face when increasing or failing to reduce their consumption can drastically decrease the attractiveness and, as a result, the acceptance of such tariffs. According to prospect theory, in comparison to a conventional flat rate tariff ("neutral reference point"), tariffs that apply a reward for electricity conservation ("gain") should be perceived as more attractive, while tariffs that apply penalties for electricity consumption ("loss") should be perceived as less attractive. Given the limited acceptance of penalizing electricity tariffs, exploring means to enhance consumers' willingness to subscribe to such tariffs is an important research avenue. As previous research has shown, people are indeed willing to voluntarily subscribe to loss contracts, which has been explained by people's expectations to perform better in order to avoid potential losses (e.g., Imas et al., 2016). It is worthwhile exploring whether the same is observed in the context of voluntary subscriptions to penalizing (i.e., loss) electricity tariffs.

Furthermore, the combinational approach of both bonus and penalty in one tariff is of particular interest, given that previous research showed that a combination of rewards and penalties yield the strongest effects on producing cooperation (e.g., Armantier & Boly, 2015; Andreoni, Harbaugh, & Vesterlund, 2003; Chen, Sasaki, Brännström, & Dieckmann, 2015). In studies investigating policy strategies to abate greenhouse gases, a combined strategy of both rewards and penalties was found to be the most effective strategy (Johnson, 2006; Robalino & Lempert, 1999). In another study, the combination of bonus and penalty components led to an ideal balance of perceived fairness and effort (Brink, 2011). Therefore, offering tariffs that apply a combination of rewards and penalties could pose an effective strategy to encourage electricity savings in households.

2. Purpose of the study and hypotheses

In light of the potential of incentive-based electricity tariff designs in promoting energy conservation, this study assesses the voluntary acceptance rate for electricity tariffs that offer a combination of different rewards and punishments for electricity consumption. First, the study explores the influence of different tariff attributes on consumer choices with a particular emphasis on the impact of incentives on consumer preferences. Second, it is hypothesized that larger rewards are preferred to smaller rewards, while the opposite is hypothesized for penalties. Third, it is hypothesized that, overall, electricity consumers perceive electricity tariffs that apply rewards, rather than penalties, to incentivize electricity conservation as more attractive. Lastly, the study investigates the hypothesis that preferences for tariffs applying a penalty can be increased when offered in combination with a reward component. Previous research suggests that people perceive combinations of rewards and penalties as fair (Brink, 2011) and perform better under such conditions (e.g., Armantier & Boly, 2015; Robalino & Lempert, 1999). Therefore, an important aim of this study is to investigate whether these tariffs can be made attractive to consumers to enhance acceptance for tariffs with such combination of incentive components.

For this purpose, a choice experiment was conducted online presenting a series of trade-off choices between electricity tariffs that differ with respect to a number of attributes. Some of these attributes have been shown to influence tariff acceptance in previous research (e.g., Goett, Hudson, & Train, 2000; Rowlands, Scott, & Parker, 2004). In Germany and Switzerland, price and electricity mix were the most important features, followed by location of electricity generation (Burkhalter, Kaenzig, & Wüstenhagen, 2009; Kaenzig, Heinzle, & Wüstenhagen, 2013; Tabi, Hille, & Wüstenhagen, 2014). In addition to these product attributes, the present study particularly emphasized the influence of reward and penalty components of electricity tariffs on consumer preferences.

3. Methods

The present study was administered online using the Sawtooth software. The online study consisted of two parts: In the first part, participants completed a choice experiment using choice-based conjoint analysis to implicitly assess tariff preferences. The choice experiment examined electricity tariffs differing with respect to a number of tariff attributes including financial rewards for electricity conservation (labeled “Bonus”) and punishments for overconsumption (labeled “Malus”). In the second part of the study, participants were randomly presented one out of four electricity tariffs, that is, a Bonus tariff, a Malus tariff, a Bonus-Malus tariff, or a Basic tariff (no incentive), and were asked to rate the perceived attractiveness of the tariff.

3.1 Choice-based conjoint analysis (CBC)

Conjoint analysis is a widely used marketing research technique that allows examining the relative importance consumers ascribe to features of a product. In choice experiments respondents repeatedly make trade-off choices between numbers of options. This is particularly useful when the product, or the product features, of interest are not on the market yet (Louviere, Hensher, & Swait, 2003). Choice-based conjoint analysis (CBC) is the most widely used method among conjoint analyses, which draws on hierarchical Bayes estimations (HB; Orme, 2010). Numerous studies in the field of energy research have applied the CBC methodology (e.g., Heinzle & Wüstenhagen, 2012; Ölander & Thøgersen, 2014; Salm, Hille, & Wüstenhagen, 2016).

Relevant electricity tariff attributes were selected based on research of the literature and were adapted to match the Swiss electricity market. The detailed attributes and levels that underlie the choice experiment in this study are listed in Table 1. The levels for the financial rewards and punishments (hereafter: Bonus and Malus, respectively) were designed based on interviews with researchers in the field of environmental sciences as well as from discussions with the utility provider in the canton of Geneva, Switzerland. Participants were briefed that the Bonus applied only when a pre-defined saving target (i.e., at least 10% less electricity consumption as compared to the previous year) was reached, while the Malus applied only when a pre-defined threshold (i.e., at least 10% more electricity consumption as compared to the previous year) was exceeded. Both Bonus and Malus were calculated as a percentage of the annual electricity bill. For example, reaching an electricity saving target of at least 10% on an average Swiss electricity bill of CHF 900 (equates to about US$ 900 or 800€[1]) would reduce the annual electricity bill by about CHF 90 (10% of CHF 900). On top of these savings, the utility would deduct an additional Bonus (e.g., 10%) from the electricity bill (see also Bertoldi et al., 2013). In contrast, increasing electricity consumption by more than 10% on an average Swiss electricity bill of CHF 900 would increase the annual electricity bill by about CHF 90. On top of these expenses, the utility provider would add an additional Malus (e.g., 10%) to the

[1] The 2017 annual average exchange rate for CHF to USD was 1.02 and 0.90 to EUR (https://www.oanda.com/currency/average).

electricity bill. The percentages for the Bonus and Malus ranged from 0% (no Bonus/Malus) to 20% in incremental steps of 5%.

The five levels for the tariff attribute *electricity mix* were selected to represent a continuum of electricity mixes ranging from non-renewable to renewable resources commonly available in Switzerland (see Tab. 1). At the time of conducting the study, the average electricity mix in Switzerland consisted of about 55% hydropower and 45% nuclear power corresponding to Mix 2 in this study (Swiss Federal Statistical Office, 2017a). The different electricity mixes allowed testing consumers' propensity to choose green and brown mixes.

The levels for *location of electricity generation* varied with respect to the proximity of electricity generation to the consumer. This tariff attribute was designed to test whether consumers have preference for locally generated electricity (i.e., in the respective Canton or in Switzerland) as compared to electricity imported from other countries (i.e., Europe), or where the generation location is unknown.

The levels of the *monthly electricity price* were selected based on the average electricity costs of a household in Switzerland ranging from CHF 55 to CHF 85 per month. In addition to showing the influence of price on tariff acceptance, these values were used to estimate participants' willingness to pay for changes in the levels of the other tariff attributes.

Table 1. Lists of attributes and levels for the choice experiment.

Attributes	**Levels**				
Bonus*	No Bonus	5% Malus	10% Bonus	15% Bonus	20% Bonus
Malus*	No Malus	5% Malus	10% Malus	15% Malus	20% Malus
Electricity Mix	55% Nuclear 45% Fossil fuels	60% Hydropower 40% Nuclear	60% Hydropower 40% Fossil Fuels	65% Hydropower 35% Solar	100% Solar
Location of generation	Unknown	Europe	Switzerland	Canton	
Price	CHF 55/month	CHF 65/month	CHF 75/month	CHF 85/month	

**Note.* The Bonus (e.g., 20% deducted from the next electricity bill) applied when a pre-defined saving target (i.e., at least 10% less electricity) was reached. The Malus (e.g., 20% on top of the next electricity bill) applied when a pre-defined threshold (i.e., above 10% more electricity) was exceeded.

The experiment employed a full-profile design meaning all five attributes of a product were shown at the same time in each of the choice tasks. Such a design ensures that the choice experiment is as close to a real-life electricity tariff choice as possible. All consumers answered 12 consecutive choice tasks each consisting of three randomly generated alternatives. In each choice task, consumers made a trade-off choice between the three alternatives by indicating their preferred choice. After consumers indicated their preference, an additional question item assessed whether they would *actually* buy the product they just chose or not (i.e., “none” option). An exemplary choice task is shown in Figure 1.

Figure 1. Choice task example.

	Tariff 1	*Tariff 2*	*Tariff 3*
Bonus	No Bonus	15% Bonus	No Bonus
Malus	No Malus	10% Malus	5% Malus
Electricity Mix	100% Solar	60% Hydropower 40% Nuclear	55% Nuclear 45% Fossil fuels
Location of generation	Europe	Unknown	Switzerland
Monthly Price	CHF 75	CHF 85	CHF 65
	○	○	○

4. Results

This section will first present the results from the hierarchical Bayes (HB) estimation for the entire population (N = 1’062) revealing the overall attribute importance scores for the electricity attributes. Second, consumers’ implicit willingness to pay for the different product attributes of the electricity tariffs, such as Bonus and Malus, will be examined and explicit attractiveness ratings of these incentive schemes will be presented.

4.1 Participants

Data were collected online via a professional market research (respondi AG), who recruited 1’062 participants from a large, Swiss-based panel. The target population of the study consisted of households in Switzerland taking into account the distribution of the population by gender, age, and region. The Swiss-representative sample consisted of 323 (30.4%) French-speaking and 739 (69.6%) German-speaking participants. The age ranged from 18 to 90 years, with a mean age of 44.25 years (*SD* = 14.5). Five hundred and fifty-four (52.2%) were female and 505 (47.6%) were male. Three participants refused to indicate their gender. Of all participants, 84.7% indicated to be the responsible in their household to make energy-related decisions (e.g., choosing energy tariffs or purchasing appliances), while the rest of the sample reported another person to be responsible for these decisions (e.g., landlord or parent). Table 2 summarizes the socio-demographic information of the participant sample.

Table 2. Socio-demographic characteristics of the sample *N* = 1,062 compared to the structure of the Swiss population.

	Study sample		*Swiss population*		*Study sample*		*Swiss population*
Mean age (years) [a]	44.3	(14.5)	42.08	**Income** [e]			
				Below CHF 3000	152	14.3%	13.9%
Gender [b]				CHF 3000 - 6000	464	43.7%	27.1%
Female	554	52.2%	50.5%	CHF 6000 - 10000	331	31.2%	40.6%
Male	505	47.6%	49.5%	Above CHF 10000	115	10.8%	17.4%
Refused to answer	3	0.2%					
Education [c]				**Civil status** [f]			
Required basic				Single	298	28.1%	44.1%
education	27	2.6%	16.6%	Married or in partnership	606	57.1%	42.8%
Basic apprenticeship	22	2.1%	4.6%	Divorced/Separated	137	12.9%	8.3%
High school	35	3.4%	1.2%	Widowed	13	1.2%	4.8%
Apprenticeship	320	30.2%	31.2%	Refused to answer	8	0.75%	0.01%
Fulltime trade school	100	9.5%	4.1%				
Gymnasium (Matura)	100	9.5%	8.3%				

				Household size [g]			
University/Higher profession training	453	42.8%	33.8%	1 person	234	22.0%	35.3%
				2 persons	413	38.9%	32.7%
Employment [d]				3 persons	186	17.5%	13.3%
Employee	632	59.5%	52.1%	4 persons	171	16.1%	12.7%
Self-employed	73	6.9%	8.5%	≥ 5 persons	58	5.5%	7.7%
Apprentice	6	0.6%	3.5%				
In training/Student	87	8.1%	4.5%	**Property ownership** [h]			
Housewife/husband	69	6.5%	4.1%	Owner	341	32.1%	37.4%
Unemployed	40	3.8%	2.8%	Rent or sublet	644	60.7%	56.0%
Retired	125	11.8%	20.8%	Shared housing	66	6.2%	2.9%
Other	30	2.8%	2.1%	Other	11	1.0%	3.7%

[a] Swiss Federal Statistical Office (2017b).
[b] Swiss Federal Statistical Office (2016a).
[c] Swiss Federal Statistical Office (2017c).
[d] Swiss Federal Statistical Office (2010).
[e] Swiss Federal Statistical Office (2007), assuming 1.45 gainfully employed people per household.
[f, g] Swiss Federal Statistical Office (2016b).
[h] Swiss Federal Statistical Office (2017a).

4.2 Part-worth utility values

The dataset from the choice experiment on electricity tariffs is based on 12’744 choice observations (12 choice tasks completed by 1’062 respondents). Data were used as input for a hierarchical Bayes (HB) estimation (see Rossi & Allenby, 2003 for a detailed discussion of hierarchical Bayes modeling). HB estimation allows calculating part-worth utility values, which describe the impact a change in one specific attribute level has on the overall utility of a product. The standard deviation from the mean of the averaged part-worth utility value represents the variance in the individuals’ preferences. The larger the standard deviations, the more do the consumer preferences differ for the respective attribute level (Orme, 2010). Table 3 summarizes the choice experiment’s results with the mean utility values and corresponding standard deviations. Overall, the part-worth utilities demonstrate that higher levels of Bonus and lower levels of Malus were preferred. Respondents also had a preference for electricity from renewable energy sources and for electricity generated in Switzerland or the local canton, rather than electricity from European or unknown sources.

Table 3. Hierarchical Bayes (HB) estimation of mean average part-worth utilities for *N* = 1’062.

Bonus		**Average Utilities (ZC Diffs)**	**SD**
	No Bonus	-38.10	(22.7)
	5% Bonus	-14.01	(15.5)
	10% Bonus	5.59	(11.7)
	15% Bonus	16.95	(13.9)
	20% Bonus	29.56	(20.4)
Malus			
	No Malus	37.61	(41.4)
	5% Malus	18.24	(16.9)
	10% Malus	0.76	(13.7)
	15% Malus	-21.44	(22.3)
	20% Malus	-35.17	(29.4)
Electricity Mix[a]			
	Mix 1 (55% N, 45% F)	-84.48	(56.7)
	Mix 2 (60% H, 40% N)	-37.84	(46.8)
	Mix 3 (60% H, 40% F)	-3.25	(29.9)
	Mix 4 (65% H, 35% S)	63.35	(45.5)
	Mix 5 (100% S)	62.22	(60.0)
Location of electricity generation			
	Unknown	-16.16	(16.9)
	Europe	-10.37	(14.9)
	Swiss	12.29	(14.2)
	Canton	14.24	(18.2)
Monthly price		-395.05	(243.3)
None option (would not buy)		21.95	(93.6)

[a] N = nuclear power; F = fossil fuels; H = Hydropower; S = solar power.

4.3 Attribute importance scores

The HB estimation of the choice experiment reveals the varying influence the attributes have on consumers’ choices. These attribute importance scores are obtained by calculating the difference between the part-worth utility values and express the relative importance an attribute has on the overall utility of a product (Orme, 2010). Attribute importance scores are standardized and expressed in percentages summing up to 100% across all attributes.

Figure 2. Attribute importance scores (*N* = 1'062).

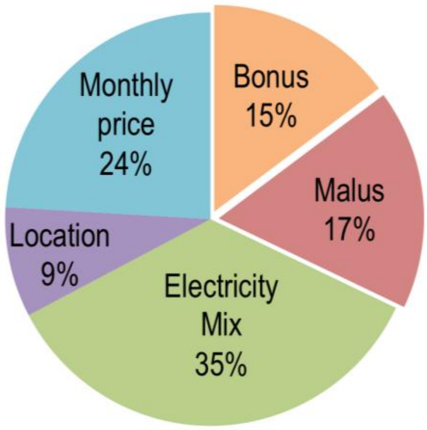


Figure 2 shows that, overall, the most important attribute was electricity mix (35%) followed by monthly price (24%) and incentive components (15% for Bonus, and 17% for Malus). Location of electricity generation constituted the least important attribute (9%). A t-test was computed to test for differences in the importance scores between Bonus and Malus. The analysis shows that attribute importance for Bonus was significantly lower than that for Malus, $t(1061) = -6.47$, $p < .001$, $d = 0.20$. In other words, the attribute Malus influenced consumer choices more strongly than the attribute Bonus. This result is in line with expectations from prospect theory, however, the difference between Bonus and Malus is not as large as theoretically expected. Where previous research showed that losses loom about twice as large as gains (Kahneman, Knetsch, & Thaler, 1991), the current results indicate only a two-percentage points difference.

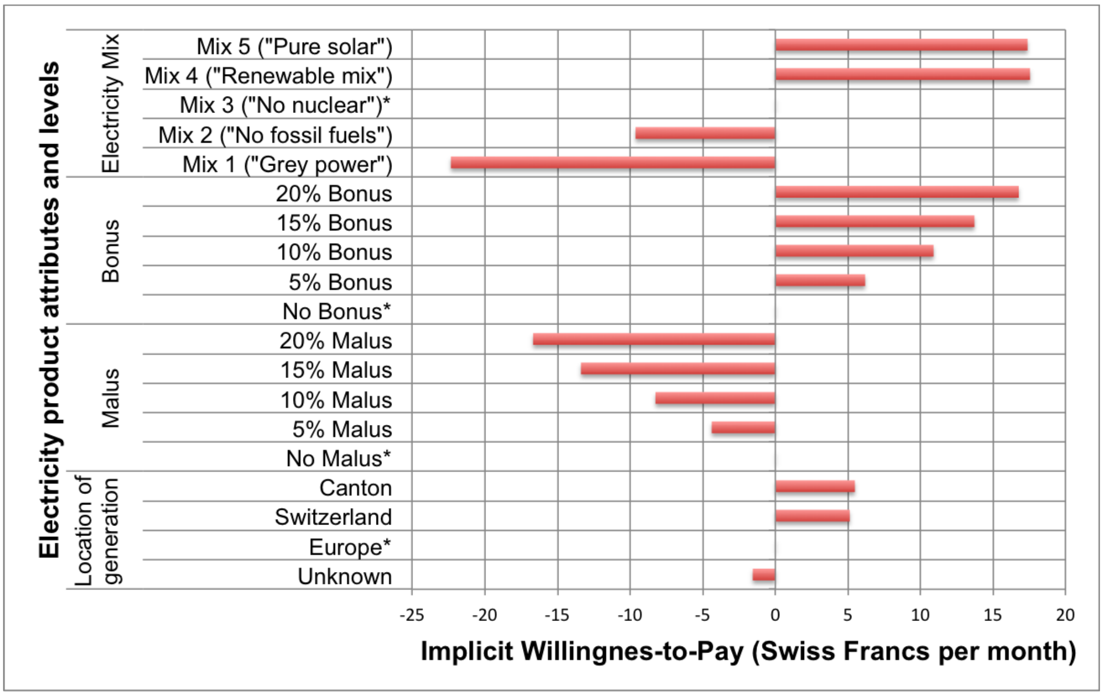
4.4 Implicit willingness to pay

Median implicit willingness-to-pay (WTP) indicates the upper boundary of the amount that participants are willing to pay for an upgrade in the level of a respective tariff attribute. First, the monthly electricity costs were estimated based on individual preferences as linear coefficient. Then, WTP was calculated by dividing the difference in part-worth utilities for levels of the other attributes by the individual price coefficient. To facilitate interpretation, the WTP is expressed relative to a pre-defined reference product consisting of no Bonus and no Malus, electricity mix “Mix 3”, and European location of energy generation. Furthermore, interpretation of the WTP results should be made under the consideration that these results depict hypothetical tariff choices (e.g., Ladenburg & Olsen, 2010; List, Sinha, & Taylor, 2006). Individual implicit WTP were calculated for the change from one attribute level to the reference product’s attribute level using the following formula:

$$WTP_{change} = \left(\frac{\beta_{i1} - \beta_{i2}}{\beta_{price}}\right)$$

where β_{i1} is the part-worth utility value for attribute level $i1$, β_{i2} is the part-worth utility value for attribute level $i2$, and β_{price} is the linear coefficient for the attribute monthly electricity costs. Figure 3 shows the part-worth utility values, revealed in the CBC, as the consumers’ median WTP. The results show that consumers’ changes in WTP were most pronounced for the tariff attribute electricity mix, followed by the attributes Malus and Bonus. The least changes in WTP were observed for the attribute location of electricity generation.

Figure 3. Implicit willingness-to-pay for tariff attribute levels relative to default, which is marked with asterisks.



Relative to a reference product offering no Bonus at all, the WTP increases almost linearly with increasing Bonus from 0 – 20%. All else staying equal, switching to a Bonus of 5% increases WTP by CHF 6.52 per month and household, and switching to a Bonus of 20% increases WTP by CHF 17.84. Comparing WTP for the different levels of Bonus (i.e., 5 – 20%), the non-parametric Mann-Whitney U test indicates that these differences in implicit WTP across the Bonus levels are significant.

The opposite is observed for the Malus, where, relative to a reference product offering no Malus at all, the WTP decreases almost linearly with increasing Malus (from 5% to 20%). All else staying equal, switching to a Malus of 5% decreases WTP by about CHF -3.91. Similarly to the WTP for Bonus, WTP for Malus changed almost linearly reaching a WTP of about CHF -16.18 for a 20% Malus. These differences in WTP for the different levels of Malus were significant among all comparisons of the increments of Malus. ($p < .001$; see Tab. 4 in Appendix A1).

These results indicate that implicit WTP for an electricity tariff is heightened significantly ($p < .001$) when incentivizing electricity conservation with a Bonus and lowered significantly ($p < .001$) when incentivizing conservation with a Malus. In other words, consumers are willing to pay more for larger rewards and lower penalties. Precisely, consumers were willing to pay about CHF 214 more annually to subscribe to a tariff offering a 20% Bonus for reaching a saving target, while the willingness to pay for a tariff applying a 20% Malus for increasing consumption decreased by about CHF -194 annually. These findings indicate that the amount consumers are willing to pay for the outlook of receiving a Bonus exceeds the actual, average value of the reward: A 10% consumption reduction on an average annual electricity bill corresponds to a bill of CHF 810. In this case, the 20% Bonus would amount to no more than CHF 162. Based on this calculation, consumers in this study were willing to pay CHF 52 more than the maximal Bonus they would receive on their average annual electricity bill. In contrast, consumers' willingness to pay to avoid facing a 20% Malus for increasing consumption corresponded to the actual, average value of the penalty: A 10% consumption increase on an average annual electricity bill corresponds to a bill of CHF 990. In this case, the 20% Malus would amount to about CHF -198. Based on this calculation, consumers in this study revealed a willingness to pay to avoid a Malus tariff that was below the actual Malus payment. The results indicate that consumers would be willing to overpay to subscribe to a Bonus tariff, while the decrease in willingness to pay for a Malus tariff correspondents to the actual value of the Malus.

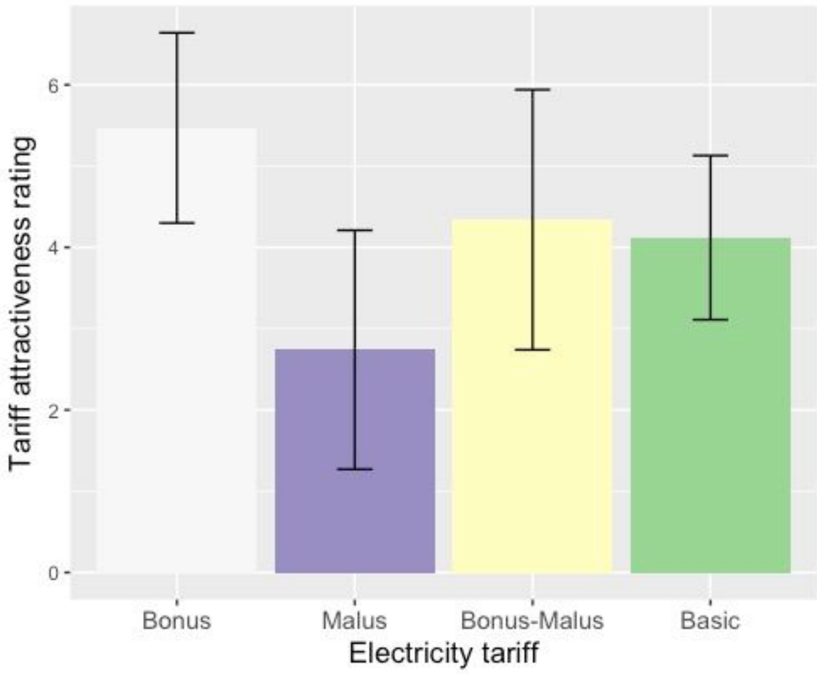
4.5 Tariff attractiveness

Tariff attractiveness was rated in an explicit self-report measure on a 7-point Likert scale. In a between-subject design, consumers were grouped randomly presented one of four electricity tariffs: 1) the Bonus tariff, where 20% was deducted from the annual bill if a saving target of at least 10% was reached ($n = 308$); 2) the Malus tariff, where an additional amount of 20% had to be paid if consumption was increased by a more than 10% ($n = 250$); 3) the combined Bonus and Malus tariff, which applied both Bonus and Malus component ($n = 253$); and 4) the Basic tariff that offered no incentives for electricity savings ($n = 251$).

Tariff attractiveness (see Fig. 4) was significantly different among the groups, $F(3, 1058) = 197.70$, $p < .001$, $\eta^2 = .38$. Consumers assigned to the Bonus tariff reported the highest tariff attractiveness ratings (mean = 5.46, $SD = 1.17$), while respondents in the Malus tariff condition reported the lowest attractiveness ratings (mean = 2.74, $SD = 1.47$). Where the combined Bonus and Malus tariff was presented, respondents gave moderate tariff attractiveness ratings (mean = 4.34, $SD = 1.6$), which was significantly lower than ratings for the Bonus tariff, $t(450.36) = 9.353$, $p < .001$, $d = 0.82$, but significantly higher than the ratings for the Malus tariff, $t(498.26) = -11.70$, $p < .001$, $d = 1.04$.

Similarly to the Bonus-Malus tariff, respondents in the Basic tariff (no incentives) condition also gave moderate tariff attractiveness ratings (mean = 4.12, $SD = 1.01$). While descriptively the Bonus-Malus tariff yielded higher mean attractiveness ratings than the Basic tariff, the relevant statistical test failed to reach significance ($t(425.76) = 1.92$, $p = .056$, $d = 0.17$). The Bonus-Malus tariff is hence approximately equally attractive as the Basic tariff. The results from the explicit tariff attractiveness rating suggest that consumers, overall, perceived Bonus tariffs as most attractive and Malus tariff as least attractive. Importantly, results also show that the negative impact of perceived tariff attractiveness induced by the Malus component could be compensated for by the Bonus component.

Figure 4. Mean values and SD bars of the tariff attractiveness ratings for the four between-subject conditions.



5. Discussion

The present study aimed to investigate consumer preferences with respect to electricity tariffs that apply incentives, precisely, a combination of both rewards and penalties, as a strategy to mitigate electricity consumption. Particularly, the study tested the influence of rewards and penalties on consumers' tariff choices with a particular focus on penalizing ("loss") tariffs. Furthermore, consumers' willingness to pay for incentive-based electricity tariffs as well as explicit attractiveness ratings were examined. One goal of this study was to evaluate whether penalizing tariffs could be made attractive when offered in combination with a rewarding component for electricity conservation.

For this purpose, three incentive-based electricity tariffs were developed and tested in an implicit choice experiment: 1) The Bonus tariff offered consumers a reward (e.g., 20% deducted from the next electricity bill) if a saving target (i.e., at least 10% less consumption than the year before) was reached; 2) The Malus tariff applied a penalty (e.g., 20% on top of the next electricity bill) if consumption increased (i.e., above 10% more consumption than the year before); 3) The Bonus-Malus tariff offered a combination of reward for decrease and penalty for increase in consumption. A fourth Basic tariff applied no incentives. Participants answered a series of choice tasks to reveal implicit tariff preferences as well as explicit self-report measures concerning their tariff preferences.

The results of the implicit choice experiment showed that incentives, thereby referring to both rewards and penalties, were important tariff attributes that factored into consumers' tariff choices. The joint attribute importance of Bonus and Malus amounted to 32%, with Malus components being significantly more important (17%) than Bonus components (15%). While the Malus component constituted a more important attribute, this importance did not translate into greater preference for or liking of Malus components. On the contrary, the heightened importance of Malus components reflected consumers' avoidance of it when making tariff choices. In fact, consumers showed greater preference for Bonus tariffs rather than Malus tariffs, in that consumers preferred higher levels of Bonus that reward electricity conservation and lower levels of Malus that penalize increasing consumption. The implicit willingness-to-pay (WTP) analysis further revealed that consumers were willing to pay about CHF 7 to CHF 18 per month more in order to receive a Bonus (i.e., 5 –

20% Bonus) and were willing to accept a Malus (i.e., 5 – 20% Malus) when paying CHF -4 to CHF -16 per month less for the tariff.

Assuming an average annual electricity bill of CHF 900 (equivalent to about US$ 900 or 800€), consumers could receive about CHF 162 under the 20% Bonus. The WTP revealed that, on average, consumers were willing to pay about CHF 214 (i.e., 12 months x CHF 17.84) more annually in order to be able to subscribe to a Bonus tariff. Similarly, consumers could have to pay an additional CHF 198 under the 20% Malus. The WTP analysis showed that, on average, consumers were willing to accept a Malus tariff, if such tariffs were reduced by about CHF 194 (i.e., 12 months x CHF -16.18). These findings could suggest that consumers seem to overestimate the value of the potential Bonus, while they do not show this bias when considering the value of the potential Malus. This finding is interesting in the context of marketing considerations for incentive-based electricity tariffs, as the Bonus tariff may be marketed with a higher monthly price that exceeds the actual value of the Bonus component, while the monthly price for the Malus tariff would not have to be lowered beyond the actual value of the Malus component. These observations are favorable for the market implementation of Bonus and Malus tariffs from a financial perspective, given that the incentives can be completely compensated for by changes in the actual tariff prices, thus, making them more cost-effective.

Moreover, the explicit tariff attractiveness ratings further supported the findings from the implicit choice task and willingness-to-pay analysis. While the Bonus tariff was rated most and the Malus tariff least attractive, the combined Bonus-Malus tariff was rated more attractive than the Malus tariff indicating that a Bonus component can compensate Malus components in electricity tariffs. The results are line with expectations from prospect theory (Kahneman & Tversky, 1979), in that consumers are more likely to voluntarily subscribe to a Bonus tariff (“gain”) than a Malus tariff (“loss”). The magnitude of the asymmetry, however, is lower than assumed based on previous empirical findings from loss aversion (Kahneman et al., 1991), which may be explained by the relatively low expense level of monthly electricity bills (CHF 900 is equivalent to 12.5% of the average disposable household income in Switzerland). Nonetheless, Malus tariffs found acceptance, even if relatively low, among consumers. Previous research from work contracts has shown that people are indeed willing to voluntarily subscribe to penalty contracts, potentially in anticipation of greater effort under the threat of loss (e.g., Imas et al., 2016). Similar mechanisms could be in place for voluntarily Malus tariff subscriptions. Furthermore, a combinational approach of rewards and penalties can pose an optimal strategy, given that such Bonus-Malus contracts lead to a balance of perceived fairness and effort (Brink, 2011). Potential consumer barriers that could hinder acceptance of the incentive-based electricity tariffs proposed in this study could include uncertainty and risk with respect to the conditional nature of the incentives relying on consumers’ ability to save electricity, the hidden costs of switching tariffs, which are novel and unfamiliar to consumers, and the potential loss of comfort related to behavioral changes required to reach the defined saving target. Consumer heterogeneity could further explain differences in consumer acceptance of such incentive-based tariffs. Incentive structures that are appealing to some may be unappealing to others because of differences in saving intentions, beliefs of personal efficacy, or susceptibility to cognitive biases (e.g., loss aversion). The exact psychological mechanisms underlying these voluntarily incentive-based tariff subscriptions, however, need yet to be investigated.

6. Conclusion and Policy Implications

The aim of this study was to test different incentive-based electricity tariff designs and the acceptance thereof among electricity consumers in Switzerland. Prior research has shown that tariffs that incentive-based tariffs can yield substantial electricity savings, while tariffs that penalize overconsumption are more effective in mobilizing energy conservation than tariffs that reward decreases in consumption (Prasanna et al., 2018). No research has so far evaluated consumer preferences for such incentive-based tariffs.

The results from an implicit choice experiment showed that incentives considerably influenced participants' tariff choices, with Malus components yielding higher importance than Bonus components. While participants preferred lower levels of Malus components, the opposite was true for Bonus components. However, consumer acceptance of tariffs with penalizing component could be significantly increased when offered in combination with a reward for electricity conservation. Explicit attractiveness measures of the different tariffs supported the findings from the implicit choice experiment: Bonus tariffs were rated most attractive, while Malus tariffs were rated least attractive. The attractiveness for combined Bonus-Malus electricity tariffs was significantly higher than for the Malus tariff, indicating that Malus components can be made attractive when offered in combination with a Bonus component. Moreover, participants' willingness to pay to subscribe to a Bonus tariff exceeded the actual value of the Bonus, while their willingness to accept a Malus tariff corresponded to the actual value of the Malus. In summary, the results suggest that a combination of both rewards and penalties (i.e., Bonus-Malus tariffs) can increase acceptance among consumers. Such Bonus-Malus tariffs are also more cost-effective, given that the Malus component can compensate for the additional costs incurred by the Bonus component (see also Bertoldi et al., 2013; Johnson, 2006).

The present findings provide first insights and market potential of consumer acceptance of such incentive-based electricity tariffs in a country where people freely choose their electricity tariffs, which is important in light of intensified concerns about climate change (e.g., Bodansky, 2001) and increasing pursuit of sustainable development policies (e.g., UNFCCC, 2015). Thus, these findings are valuable to both utilities and to policy makers, as the implementation of incentive-based tariff structures, particularly Bonus-Malus tariffs, could shift into political and corporate debate.

Nonetheless, the translation of these findings to retail tariffs calls for further analysis taking into account specific market aspects and technicalities, policy aspects, and socio-economic implications. Retail tariffs are composed of three parts, namely the actual cost of electricity (i.e., cost of generation or wholesale price [e.g., 25 – 40%]), network charges (i.e., for maintaining and renewing the power grid [e.g., 25 – 50%]), and taxes/levies (i.e., renewable electricity charge, local fees, VAT, etc. [e.g., 20 – 50%] (see also Grave et al., 2016). Electricity saving tariffs only influence the former, that is, the actual cost of electricity. Network charges and related taxes/levies, in contrast, represent fixed-cost components that reduce the effectiveness of altered energy prices under incentive-based tariffs. In other words, the impact of incentive-based electricity tariffs does not only depend on the size of the incentive, but also on the level of the network charges and of the taxes/levies.

Government and providers are subject to pursuing a sustainable development policy (EED Directive, 2012; Fawcett, 2018; Sciortino et al., 2011), while energy market liberalization opens up the market to rising competition, as consumers are able to freely choose from a range of electricity products and utilities. The challenge is thus to design tariff structures that can promote energy conservation among consumers, while holding up to the rising competition on the energy market by appealing to consumers. Alternatively, these incentive-based tariff structures could be made mandatory. In either scenario, it is a prerequisite for the introduction of incentive-based tariffs that households have detailed insight into their electricity demand calling for a smart meter rollout with easily understandable display options. According to the EU's Energy Efficiency Directive the vast majority of all households should have a smart meter within a few years (EED Directive, 2012), providing households with a much better insight into their electricity consumption.

Further socio-demographic implications ought to be considered for the implementation of incentive-based tariff structures. While practically all households have unexploited opportunities for reducing their electricity bill, for example by installing more efficient lighting (de Almeida, Fonseca, Schlomann, & Feilberg, 2011), tenants have less options than owners of houses or apartments, for example with regard to built-in kitchen appliances belonging to the landlord (Levinson & Niemann, 2004). Incentive-based electricity tariffs would also lead to higher bills for large households, including both high-income (with many/large appliances and high intensity of use) and low-income households, thereby exacerbating distributional issues including fuel poverty. As a consequence, such tariffs could be particularly discriminating against consumers who already reduced consumption to their possible minimum, for example, after having been subscribed to the Bonus-Malus tariff for a number of years. To avoid this effect, incentive-based tariffs could alternatively be designed to rely on an estimation of average expected electricity consumption as reference, instead of using the previous year's consumption level as a reference as in the present research design. Incentive-based tariff could moreover discriminate against low-income household, who cannot further reduce their electricity consumption. However, low-income households with excessive consumption levels could benefit most from these incentive-based tariffs, as the financial savings incurred through reduced electricity consumption could be spent on other goods and services (Howland, Murrow, Petraglia, & Comings, 2009).

In conclusion, the scientific literature and energy market indicate that there is substantial potential for the implementation of incentive-based electricity tariffs. Future research should further study the short-term and long-term effectiveness of incentive-based electricity tariffs as well as alternative incentive structures, such as continuous incentives (e.g., 5% Bonus for 5% electricity saving, 10% for 10% electricity saving, etc.) to also reach consumers with lower energy saving potential. A symmetrical Bonus-Malus tariff, where no reward or penalty applies when consumption stays flat, could also be designed to avoid rebounds in following years. The tariff designs suggested here could be extended to the consumption of other energy sources, such as gas consumption. Furthermore, investigating individual differences among consumers could provide a better understanding of consumer choices and behaviors with respect to incentive-based tariff choices. Interventions and nudges that can likewise make Malus tariffs more attractive to consumers and more willing to subscribe for such Malus or Bonus-Malus tariffs should be designed and tested.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Appendix A1

Table 4. Results of non-parametric Mann-Whitney U pairwise comparison for willingness-to-pay for different levels of the five tariff attributes in comparison to the default product.

		Mann-Whitney U test
Electricity Mix[a]		
	Mix 1 (55% N, 45% F) - Mix 2 (60% H, 40% N)	392960***
	Mix 1 (55% N, 45% F) - Mix 4 (65% H, 35% S)	61255***
	Mix 1 (55% N, 45% F) - Mix 5 (100% S)	100290***
	Mix 2 (60% H, 40% N) - Mix 4 (65% H, 35% S)	145380***
	Mix 2 (60% H, 40% N) - Mix 5 (100% S)	188510***
	Mix 4 (65% H, 35% S) -Mix 5 (100% S)	587100
Bonus		
	5% Bonus - 10% Bonus	412530***
	5% Bonus - 15% Bonus	342740***
	5% Bonus - 20% Bonus	285620***
	10% Bonus - 15% Bonus	486370***
	10% Bonus - 20% Bonus	420350***
	15% Bonus - 20% Bonus	495730***
Malus		
	5% Malus - 10% Malus	648010***
	5% Malus - 15% Malus	748700***
	5% Malus - 20% Malus	798710***
	10% Malus - 15% Malus	663440***
	10% Malus - 20% Malus	715120***
	15% Malus - 20% Malus	617230***
Location of electricity generation		
	Unknown - Swiss	167330***
	Unknown - Canton	185130***
	Swiss - Canton	558890

Note: Default tariff consisted of electricity mix 60% Hydropower and 40% Fossil fuels (Mix 3), No Bonus, No Malus, and European location of electricity generation.
[a] N = nuclear power; F = fossil fuels; H = Hydropower; S = solar power.
*** $p < .001$

Title page

Running Head
INVESTIGATING CONSUMER PREFERENCES FOR INCENTIVE-BASED ELECTRICITY TARIFFS

Title:

Combining "Carrot and Stick" to Incentivize Sustainability in Households

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