Pay now, save later: Using insights from behavioural economics to commit consumers to environmental sustainability

Mahmoodi, Jasmin; Patel, Martin; Brosch, Tobias

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Pay Now, Save Later: Using insights from behavioural economics to commit consumers to environmental sustainability

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Corresponding Author:	Jasmin Mahmoodi Center for Affective Sciences, University of Geneva Geneva, Switzerland
First Author:	Jasmin Mahmoodi
Order of Authors:	Jasmin Mahmoodi
	Martin Patel
	Tobias Brosch
Abstract:	Focusing on delayed outcomes facilitates goal pursuit, but people exhibit a clear preference for immediate outcomes. Introducing immediate incentives (rewards or penalties) that are contingent on later performance can act as a commitment device to facilitate long-term goal pursuit. Here we apply these behavioural insights to the design of incentive-based electricity products that aim to commit consumers to conserve electricity. Such products are often effective in lowering consumption levels, but their uptake among consumers is relatively low. Across two experimental studies, we tested consumer acceptance of three novel incentive-based electricity products that applied a combination of rewards and penalties to commit consumers to conserve electricity in their homes. Results show that consumers were less likely to choose incentive-based products that offer an upfront reward (combined with a delayed penalty that applies upon failing to reach a conservation target). Our results further indicate that this may be the case because consumers perceived the upfront rewards as a less effective commitment device. Thus, while immediate rewards can be effective commitment devices to long-term goal pursuit, this does not seem to apply in the context of electricity conservation. Moreover, individual differences predicted choices of electricity products: Individual levels of loss aversion and temporal discounting predicted tariff choices, mediated by perceived tariff attractiveness and perceived incentive effectiveness. Our findings highlight the potential for designing behaviourally-informed incentives and energy products as well as the market potential for innovative incentive-based tariffs designed to help consumers commit to long-term conservation goals.@font-face {font-family:"Cambria Math"; panose-1:2 4 5 3 5 4 6 3 2 4; mso-font-charset:0; mso-generic-font-family:roman; mso-font-pitch:variable; mso-font-signature:-536870145 1107305727 0 0 415 0;}p.MsoNormal, li.MsoNormal, div.MsoNormal {mso-style-unhide:no; mso-style-qformat:yes; mso-style-parent:""; margin:0cm; mso-pagination:widow-orphan; font-size:12.0pt; font-family:"Times New Roman",serif; mso-fareast-font-family:"Times New Roman"; mso-ansi-language:EN-US;}.MsoChpDefault {mso-style-type:export-only; mso-default-props:yes;

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Suggested Reviewers:	Taciano L. Milfont taciano.milfont@vuw.ac.nz
	Ulf Liebe Ulf.Liebe@warwick.ac.uk
	Bas Verplanken b.verplanken@bath.ac.uk
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Highlights:

- Incentive-based products find acceptance among electricity consumers (21 – 45%)
- Consumers do not voluntarily choose products that apply upfront rewards as commitment to electricity conservation
- The decision bias loss aversion influences choices of incentive-based products
- Perceived tariff attractiveness and incentive effectiveness mediate incentive-based product choices

Title:

Pay Now, Save Later: Using insights from behavioural economics to commit consumers to environmental sustainability

Authors:

Jasmin Mahmoodi[1], Martin K. Patel[2], & Tobias Brosch[3]

[1] Swiss Center for Affective Sciences, University of Geneva, Chemin des Mines 9, 1202 Geneva, Switzerland, jasmin.mahmoodi@unige.ch
[2] Institute for Environmental Sciences (ISE) and Department F.-A. Forel for environmental and aquatic sciences (DEFSE), Faculty of Science, University of Geneva, Boulevard Carl-Vogt 66, 1205 Geneva, Switzerland, martin.patel@unige.ch
[3] Department of Psychology, University of Geneva, Boulevard du Pont d'Arve 40, 1205 Geneva, Switzerland, tobias.brosch@unige.ch

Corresponding author:

Jasmin Mahmoodi
Jasmin.Mahmoodi@unige.ch
Phone: +41(0) 22 379 09 31
Swiss Center for Affective Sciences (CISA), University of Geneva
Chemin des Mines 9, 1202 Geneva, Switzerland

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Conflicts of interest:

The authors have no conflicts of interest to declare.

Pay Now, Save Later: Using insights from behavioural economics to commit consumers to environmental sustainability

Abstract

Focusing on delayed outcomes facilitates goal pursuit, but people exhibit a clear preference for immediate outcomes. Introducing immediate incentives (rewards or penalties) that are contingent on later performance can act as a commitment device to facilitate long-term goal pursuit. Here we apply these behavioural insights to the design of incentive-based electricity products that aim to commit consumers to conserve electricity. Such products are often effective in lowering consumption levels, but their uptake among consumers is relatively low. Across two experimental studies, we tested consumer acceptance of three novel incentive-based electricity products that applied a combination of rewards and penalties to commit consumers to conserve electricity in their homes. Results show that consumers were less likely to choose incentive-based products that offer an upfront reward (combined with a delayed penalty that applies upon failing to reach a conservation target). Our results further indicate that this may be the case because consumers perceived the upfront rewards as a less effective commitment device. Thus, while immediate rewards can be effective commitment devices to long-term goal pursuit, this does not seem to apply in the context of electricity conservation. Moreover, individual differences predicted choices of electricity products: Individual levels of loss aversion and temporal discounting predicted tariff choices, mediated by perceived tariff attractiveness and perceived incentive effectiveness. Our findings highlight the potential for designing behaviourally-informed incentives and energy products as well as the market potential

for innovative incentive-based tariffs designed to help consumers commit to long-term conservation goals.

Keywords: Decision biases, Rewards and penalties, Immediate/delayed incentives, Commitment, Environmental sustainability, Consumer choices, Commitment devices

1. Introduction

Imagine a consumer with the long-term goal to contribute to environmental conservation by reducing household energy consumption. In order to do so, the consumer has to implement a number of practices that may have relatively undesirable immediate outcomes, such as taking colder and shorter showers or investing into home insulation, but that can considerably contribute to the long-term goal of reducing energy consumption. One big challenge for the behavioural sciences is to understand how immediate and delayed outcomes affect people's motivation and commitment to engage in long-term goal pursuit and how to use these insights to promote a range of choices and behaviours with desirable long-term effects, such as environmental conservation.

Previous research has shown that focusing on delayed outcomes facilitates long-term goal pursuit (Mischel, Shoda, & Rodriguez, 1989). A large body of literature also shows that when people have a choice between immediate and delayed outcomes, they have a strong preference for immediate outcomes (Kirby, Petry, & Bickel, 1999). This preference for immediate outcomes sometimes comes at the expense of more beneficial, delayed outcomes. This phenomenon is known as

temporal discounting and has been linked to impatience, impulsivity, and failures in self-control (e.g., Ainslie, 1975).

Commitment strategies have proven useful to help people overcome their preference for immediate outcomes and adhere to long-term goal pursuit across different domains, such as exercising, dieting, and energy conservation (see Mitchell et al., 2013 for a meta-analysis on exercising; see Wall, Mhurchu, Blakely, Rodgers, & Wilton, 2006 for a review on dieting; see Lokhorst, Werner, Staats, van Dijk, & Gale, 2013 for a meta-analysis on environmental behaviours). In the domain of energy conservation different commitment strategies have been shown to be efficient, including written commitments (Baca-Motes, Brown, Gneezy, Keenan, & Nelson, 2012) and incentives that are contingent on performance (e.g., Thogersen, 2003). Research further suggests that performance-contingent incentives are more effective in facilitating long-term goal pursuit when the incentives are realised immediately. For example, Woolley and Fishbach (2016) showed that playing music during exercise (i.e., immediate reward) increased persistence in exercising to improve health (i.e., long-term goal pursuit).

Here we investigate to what extent these findings can be leveraged to increase consumer acceptance of electricity product designs that use consumption-contingent incentives to commit to electricity savings in households. Previous findings showed that a combination of "carrots and sticks" is generally the most effective approach to induce behaviour change and increase performance (e.g., Armantier & Boly, 2015; Robalino & Lempert, 1999). In the context of electricity tariffs, penalties for overconsumption have led to larger behavioural plasticity than rewards for electricity savings (Prasanna, Mahmoodi, Brosch & Patel, 2018). At the same time, tariffs applying penalties are chosen less often by consumers. One strategy to increase

consumer choices of penalising tariff components is to combine penalties with rewards to encourage electricity savings (Mahmoodi, Prasanna, Hille, Patel, & Brosch, 2018).

Given that *immediate* incentives are an effective commitment strategy to increase long-term goal pursuit (e.g., Woolley & Fishbach, 2016), the main purpose of this study was to apply these insights to the environmental consumer context and to test whether consumer choices of incentive-based electricity products can be increased when the temporal distance to reception of the incentives is removed; that is, when a tariff applies *immediate incentives* to commit to near-future electricity conservation, rather than *delayed incentives* that apply retrospectively if a conservation target has been reached or missed.

In the following, we review the literature on the effects of temporal immediacy of outcomes on consumer goals and choices as well as the effects of positive and negative financial incentives on behaviour change. We outline how behavioural economics can help to design more effective incentives and how incentive-based commitment strategies can facilitate goal pursuit. We present two studies that apply these behavioural insights to the design of electricity products and test consumer choices of these products. Results are presented and discussed.

1.1 Temporal discounting: Immediate and delayed outcomes

The majority of smokers who want to quit, fail (e.g., Hughes, Keely & Naud, 2004), new years' resolutions are often unsuccessful (e.g., Miller & Marlatt, 1998), people want to exercise and diet, but fail (e.g., Stroebe, van Koningsbruggen, Papies, & Aarts, 2013). It is evident that goal pursuit is often guided by contradicting

immediate and delayed benefits and costs. For instance, people are aware of the delayed benefits of exercising (e.g., weight loss), but tend to opt for the immediate benefits instead, such as relaxing at home. This preference for immediate outcomes at the expense of more beneficial, later outcomes is known as temporal discounting and has been widely studied (see Frederick, Loewenstein, & Donoghue, 2002 for a review).

In what concerns financial gains, when offered US$100 now or US$150 six months from now, people tend to prefer the smaller amount right now (Baker, Johnson, & Bickel, 2003; Tesch & Sanfey, 2008). The more distant the delayed reward, the more people discount its value. In what concerns financial losses, when asked to pay US$150 now or US$200 in six months from now, people tend to prefer to pay a larger amount later (Estle, Green, Myerson, & Holt, 2006). However, compared to gains, losses are discounted at a lower rate (Abdellaoui, Attema, & Bleichrodt, 2010; Benzion, Rapoport, & Yagil, 1989; Loewenstein & Prelec, 1992; Loewenstein & Thaler, 1989; Mischel, Grusec, & Masters, 1969; Thaler, 1981).

There are however instances when people prefer to expedite losses or to postpone gains. For example, Loewenstein (1987) showed that people were willing to pay more to receive a kiss from a movie star with some days delay than to receive it immediately. Similarly, people were willing to pay more to avoid an electric shock that was delayed by a few hours or days than to avoid an immediate electric shock. These behavioural patterns suggest that the anticipation of outcomes can also influence choices: People sometimes savour the anticipation of a future reward (e.g., a kiss) and therefore want to delay it or they dread the anticipation of a future penalty (e.g., electric shock), which is why they prefer to "get it over with" (see also

Loewenstein, 1987; Thaler, 1981; Hardisty, Appelt, & Weber, 2013; Hardisty & Weber, 2009).

1.2 Incentives: Rewards and penalties

Financial incentives are a popular policy tool and have been applied to induce behaviour change and steer consumer choices across contexts (see, e.g., Levitt & Leventhal, 1986, for environment-related behaviour change). Many findings illustrate the effectiveness of both rewards and penalties in inducing behaviour change (Skinner, 1953) and in increasing people's performance and cooperation across different domains (see e.g., Charness & Gneezy, 2009; Fehr & Gaechter, 2000; Gneezy, Meier, & Rey-Biel, 2011; Lazear, 2000; Timlett & Williams, 2008; Volpp et al., 2008). A number of empirical findings suggest that, overall, penalties are more effective than rewards (e.g., Balliet, Mulder, & van Lange, 2011; Coad, de Haan, & Woersdorfer, 2009; Sutter, Haigner, & Kocher, 2010).

Insights from behavioural economics can explain these findings: The phenomenon of loss aversion describes that people's negative reactions to losses are greater than their positive reactions to gains of equivalent size. As a consequence, people go greater lengths to avoid a loss than to receive a gain of the same size (Kahneman & Tversky, 1979). At the same time, loss aversion also predicts that people would not voluntarily subscribe to loss-framed contracts where low performance is penalised (e.g., Hannan, Hoffman, & Moser, 2005; Luft, 1994). Despite this, some empirical studies suggest that people are indeed willing to voluntarily subscribe to loss-framed contracts (e.g., De Quidt, 2017; Fryer, Levitt, List, & Sadoff, 2012; Imas, Samek, & Sadoff, 2017). For example, Imas and

colleagues found that people have a 40% higher willingness to pay to perform a real-effort task under a loss-framed contract than under a gain-framed contract. Similarly, De Quidt found a higher voluntary acceptance of penalty-based contracts in comparison to reward-based contracts across a number of experiments. It has been suggested that people have preference for penalty-based contracts, because, since losses loom larger, they expect to perform better under these contracts and therefore penalty-based contracts serve as stronger commitment device than reward-based contracts to enhance goal pursuit (see also Imas et al., 2017; Kaur, Kremer, & Mullainathan, 2010, 2015). Hence, incentives may act as a commitment device by making rewards and penalties contingent on behavioural performance. Where penalties may serve as external deterrents against abandoning the pursuit of one's long-term goals, rewards may serve as an encouragement to act in accordance with one's goals (Brickman, 1987; see also Trope & Fishbach, 2000).

1.3 Behaviourally-informed incentives as commitment devices

Consumer choices and behaviours are not always easily changed simply by introducing financial incentives that reward what is desired and penalise what is undesired. In fact, financial incentives can sometimes backfire by undermining desired or by increasing undesired behaviours. For example, Frey and Oberholzer-Gee (1997) found that citizens are less likely to accept a nuclear repository close to their home when offered a positive financial incentive as compensation. In a field study, Gneezy and Rustichini (2000a) found that parents increasingly arrived late at their children's day-care-centre once a financial penalty was introduced for late-comers. These examples demonstrate that further considerations need to be made

when designing incentive-based commitment devices. While in some contexts micro-incentives are already sufficient to substantially influence consumer choices (e.g., having to pay a few cents for plastic bags; Homonoff, 2013), in other contexts sufficiently large incentives are required (e.g., a decrease in IQ test performance observed for small but not for large incentives; Gneezy & Rustichini, 2000b). Above all, for incentives to be effective and find acceptance, the rationale and rules behind the incentives should be sufficiently understood by the consumers (John, Smith, & Stoker, 2009).

Behavioural economics offers various insights that can be leveraged in a number of ways to improve the design of commitment devices in form of consumption-contingent incentives to make them more appealing to consumers. Considering the impact of loss aversion on people's choices and behaviours, one way to behaviourally inform incentive designs is by combining rewards with penalties. Thaler (1985) suggests that rewards can offset penalties that are similar in size, thereby overcoming loss aversion to some extent. Not only does previous research suggest that a combinational approach of both rewards and penalties is most effective in inducing behaviour change and increasing performance than offering penalties alone (Andreoni, Harbaugh, & Vesterlund, 2003; Armantier & Boly, 2015; Chen, Sasaki, Brännström, & Dieckmann, 2015; Robalino & Lempert, 1999; Sefton, Schupp, & Walker, 2006), but also that a combinational approach is perceived as fairest (Brink, 2011) and may therefore find greater acceptance among consumers. Additionally, the incentive design can be enhanced by designing a ratio between rewards and penalties that account for the findings of loss aversion that losses loom about twice as large as gains (Kahneman & Tversky, 1979). Offering a reward that is about twice as large as the penalty can, hence, further enhance the incentive design.

Considering the impact of temporal discounting on people's choices and behaviours, another way to behaviourally inform incentive designs is by offering consumers immediate, rather than delayed, financial incentives to increase consumers' commitment to pursue long-term goals. For example, Trope and Fishbach (2000) showed that people strategically used self-imposed penalties and postponed reception of financial rewards as self-control strategies to adhere to long-term goals. Hotel guests, who made a commitment at check-in, were much more likely to re-use towels during their stay (Baca-Motes, Brown, Gneezy, Keenan, & Nelson, 2012). Under consideration of time discounting, Woolley and Fishbach (2016) showed that offering immediate rewards in addition to delayed outcomes increased people's commitment to long-term goals, suggesting the potential of harnessing people's preferences for immediate outcomes as a strategy to increase long-term persistence.

1.4 Existing electricity tariff designs

A number of attempts have been made to embed financial rewards and penalties in electricity tariff designs with the aim to promote energy conservation among end-consumers (Borenstein, 2009; Faruqui & Sergici, 2010; Ito, Ida, & Tanaka, 2018; Mizobuchi & Takeuchi, 2013; Prasanna et al., 2018; Robalino & Lempert, 1999; Stamminger & Anstett, 2013; Winett, Kagel, Battalio, & Winkler, 1978). Previous experiences indicate that while both rewards and penalties are overall effective in promoting reductions in electricity consumption, penalties, or the combination of rewards and penalties, are most effective in promoting environmental conservation (Johnson, 2006; Prasanna et al., 2018; Robalino & Lempert, 1999).

Despite the increasing use of incentives in environmental policy (Aidt & Dutta, 2004; Karatas, Stoiko, & Menassa, 2016; Shogren, 2012) and the integration of rewards and penalties in electricity tariff designs specifically (e.g., Winett et al., 1978), the scientific literature has fallen short on evaluating consumer preferences and levels of acceptance of incentive-based electricity tariffs. Understanding consumer preferences for electricity tariffs may be less important in countries where governments and utilities impose these tariffs on electricity consumers (e.g., Dehmel, 2011), but can be of great interest to utilities and governments of countries where consumers freely choose their preferred tariff, such as Germany, the UK, or Switzerland (e.g., Boogen, Datta, & Massimo, 2016). A better understanding of the factors guiding consumers' tariff preferences would allow designing electricity tariffs that appeal to consumers, while at the same time promoting more sustainable consumption, as is mandated by many governments around the world (EED Directive, 2012; Stern et al., 1986).

Previous studies investigating consumers' tariff preferences have primarily focused on understanding and increasing consumer choices of green electricity tariffs (e.g., Chassot, Wüstenhagen, Fahr, & Graf, 2013; Diaz-Rainey & Ashton, 2011; Litvine & Wüstenhagen, 2011; Loock, Staake, & Thiesse, 2013; Momsen & Stoerk, 2014; Pichert & Katsikopoulos, 2008; Tabi, Hille, & Wüstenhagen, 2014). Few studies have attempted to gain a more detailed understanding of tariff choices by investigating consumer preferences for single features of electricity tariffs, showing that electricity price and electricity mix are, overall, most important to consumers (Burkhalter, Kaenzig, & Wüstenhagen, 2009; Kaenzig, Heinzle, & Wüstenhagen, 2013; Tabi et al., 2014). One study investigated consumer preferences for electricity tariffs that applied incentives to promote electricity savings, showing that consumers

attributed most importance to electricity mix, followed by price and incentives (Mahmoodi et al., 2018). The study also found that a combinational approach applying both rewards and penalties proved an effective strategy to increase consumer acceptance of penalty components embedded in tariff designs.

Existing tariff designs commonly apply electricity costs and incentives at the end of the year contingent on consumers' past electricity consumption (see e.g., Bertoldi, Rezessy, & Oikonomou, 2013). Hence, consumers derive immediate utility from consumption, but experience financial consequences with a delay, making electricity consumption similar to credit card borrowing, which can lead to biased decision-making and behaviours (Meier & Sprenger, 2010). While a number of psychographic characteristics (e.g., perceived consumer effectiveness) have been associated with consumers' tariff preferences (e.g., Tabi et al., 2014), constructs from the behavioural economics literature have additional explanatory power in predicting consumers' tariff choices, especially in the context of tariffs that apply incentives (Mahmoodi, Hille, Patel, & Brosch, 2020). For example, individual levels of loss aversion explained the effectiveness of penalties in shifting peak electricity demand (Bradley, Coke, & Leach, 2016). In line with predictions from prospect theory, loss-framed provision of information was more effective than gain-framed information in reducing household electricity consumption (Bager & Mundaca, 2017). However, loss aversion also implies that penalty contracts are less attractive to consumers and may not find acceptance from consumers in countries where electricity tariffs can be freely chosen. Indeed, Nicolson, Huebner, and Shipworth (2017) found that loss-averse consumers were less likely to switch to tariffs that use price incentives to shift peak electricity consumption.

As outlined above, one way of altering the perceived attractiveness and consumer acceptance of incentive-based tariffs that include penalty components is to combine them with reward components (Mahmoodi et al., 2018). The present research tested whether the design and consumer choices of such incentive-based tariffs can be further informed by using insights from behavioural economics. Previous studies showed that immediate, instead of delayed, incentives more effectively guide people's choices and long-term goal pursuit (e.g., Woolley & Fishbach, 2016). Hence, here we tested whether manipulation of the temporal distance (i.e., immediate versus delayed) of incentives (i.e., rewards and penalties) embedded in electricity tariffs can make such incentive-based tariffs more attractive to consumers.

2. Study 1

2.1 Study objectives and hypotheses

The objective of this study was to investigate consumer choices of electricity tariffs that apply consumption-contingent incentives to commit to electricity savings in households. The main focus was to test whether choices of such tariffs can be increased by manipulating the temporal distance to reception of the incentives embedded in the tariffs, given that previous research showed that people temporally discount the future and have preference for immediate, rather than delayed, outcomes (e.g., Loewenstein & Thaler, 1989). To this end, novel tariff designs were developed and contrasted to a previously tested tariff design, labelled *Bonus-Malus tariff* (see Mahmoodi et al., 2018). Similar to existing tariff designs (e.g., energy-saving feed-in

tariffs and progressive tariffs), the *Bonus-Malus tariff* incentivises household electricity conservation by means of a combination of rewards and penalties that apply *at the end of the year* depending on consumers' electricity consumption levels over the year (i.e., a reward if a pre-defined conservation target is reached and a penalty if the conservation target is missed). Two novel incentive-based tariff designs were developed for this study, where the temporal distance to receiving the reward and penalty, respectively, was removed. Under the *Signing Premium tariff*, consumers received an *immediate reward* for committing to reaching an electricity saving target. If the target was not reached at the end of the consumption period, consumers had to pay back the reward as well as an additional penalty. Under the *Financial Commitment tariff*, consumers paid an *immediate fee* as commitment to reach a saving target. If the target was reached, participants received their fee back at the end of the consumption period, alongside an additional reward (see Method sections for details).

In addition, the psychological mechanisms underlying consumers' tariff choices were investigated. Previous studies demonstrated that individual levels of loss and risk aversion may play a role in incentive-based electricity tariff choices (e.g., Mahmoodi et al., 2020). In light of the central role of the tariffs' immediate and delayed consequences, we also investigated the influence of individual levels of temporal discounting on tariff choices. In addition, consumers' appraisals of the incentive-based electricity tariffs, that is, perceived effectiveness of the incentives as well as overall tariff attractiveness, were assessed. The relationship between decision biases and appraisals in explaining tariff choices was examined.

Based on a previous study showing that electricity consumers overall prefer basic, non-incentive tariffs to tariffs that use a combination of rewards and penalties (Mahmoodi et al., 2018), it was hypothesised that consumers in this study will choose

basic tariffs more than any of the three incentive-based tariffs, i.e., Bonus-Malus, Signing Premium, and Financial Commitment tariffs (Hypothesis 1).

Based on the literature showing that people prefer immediate to delayed rewards (e.g., Hardisty & Weber, 2009; Thaler, 1981; Woolley & Fishbach, 2016), it was further hypothesised that consumers will show a preference for the tariff offering an upfront reward for committing to save electricity coupled with a delayed penalty for failing a pre-defined saving target, i.e., Signing Premium tariff, as compared to the Bonus-Malus tariff (Hypothesis 2).

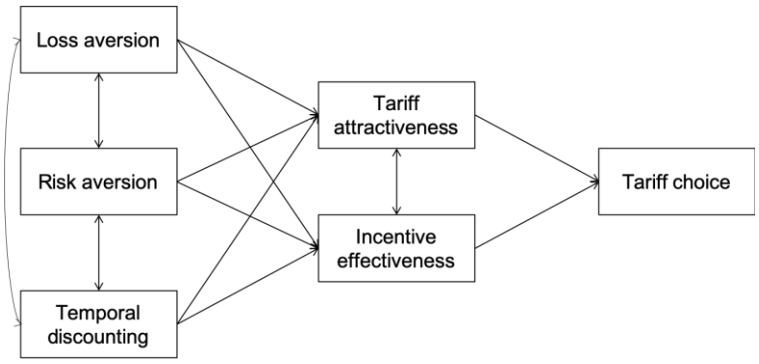
While the literature shows that people prefer to delay penalties, it also shows that penalties are discounted at a much lower rate than rewards and that there are circumstances where people prefer to expedite penalties (Loewenstein, 1987; Loewenstein & Thaler, 1989). The literature furthermore suggests that people indeed voluntarily subscribe to penalty-based, rather than reward-based, contracts, as they trigger greater commitment and people anticipate to more effectively improve their performance. In addition, previous studies showed that people voluntarily self-impose penalties to perform unpleasant tasks (Trope & Fishbach, 2000). Based on these findings, it was therefore hypothesised that consumers will show a preference for the tariff demanding an upfront fee for committing to conserve electricity coupled with a delayed reward for saving target fulfilment, i.e., Financial Commitment tariff, as compared to the Bonus-Malus tariff (Hypothesis 3).

Moreover, we proposed and tested a model integrating and formalising the effects of the decision biases on product appraisals and choices. As shown in Figure 1, the model predicts that individual differences in loss aversion, risk aversion, and temporal discounting predict consumers' electricity tariff choices, mediated via specific appraisals of the electricity tariffs, namely perceived tariff attractiveness and

perceived incentive effectiveness. Based on the previous literature on consumer choices in the energy domain, it was hypothesised that high levels of loss and risk aversion lower consumers' perceived tariff attractiveness and incentive effectiveness, leading to more choices of basic over incentive-based tariffs (Hypothesis 4).

Given the manipulation of the temporal distance of the incentives embedded in the tariff designs, we also examined individual discount rates in an exploratory fashion. It can be assumed that discount rates predict tariff choices particularly of the Signing Premium tariff, which is the only product that pays consumers an immediate reward to commit to electricity conservation. Similarly, discount rates may also predict choices of the Financial Commitment and of the Bonus-Malus tariffs, where a reward is offered with a delay at the end of the consumption period in dependence on previous consumption levels[1].

Figure 1. Proposed model explaining the relationship between decision biases, incentive-based tariff appraisals (i.e., perceived tariff attractiveness and incentive effectiveness), and tariff choice.



2.2 Participants

[1] While we had initially planned to exhaustively measure individual temporal discounting parameters, due to reasons outside our control, the employed temporal discounting questionnaire was not assessed in its entirety, thus not permitting us to estimate reliable discounting parameters. Also, only discount rates for positive outcomes were assessed, while the involvement of negative incentives in the tested products would have called for the assessment of discount rates for negative outcomes in addition.

Data were collected by a Swiss-based utility in March 2017. An invitation to participate in the online survey was sent out by the utility directly to a panel of 979 electricity consumers. Participation was voluntary, yielding a response rate of 55% and totalling to a sample of 535 participants (mean age = 51.9 years, *SD* = 14.0, range = 24 – 86 years), of which 189 (35.3%) were female. The survey took about 5 minutes to complete. Consumers gave informed consent for participation and were debriefed about the study's purpose. No deception was used, no personally identifiable information was accessible to the researchers involved in this study, and data were treated confidential at all times. As the official language of the region of Switzerland where this study was conducted was French, all materials and questions were administered in French (see Supplementary Material).

2.3 Procedure

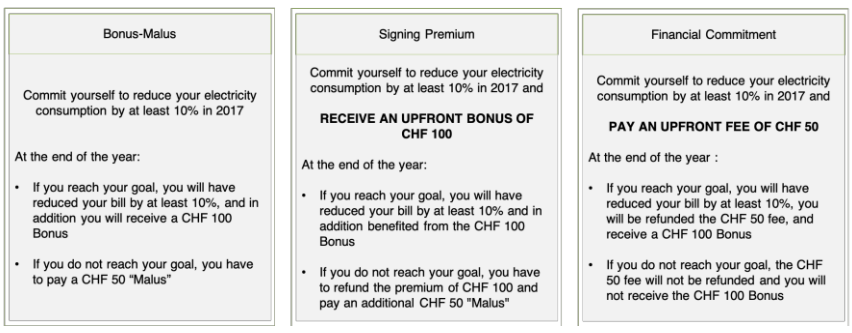
After informed consent was given, electricity consumers indicated their socio-demographic information (i.e., age and gender) as well as further residential and energy-related questions. Consumers were then randomly assigned to one of three experimental conditions, where one of the three incentive-based electricity tariffs were presented and explained. A one-item question assessed consumers' subjective understanding of the tariff conditions and incentive design ("This tariff is easy to understand"). Subsequently, perceived tariff attractiveness and perceived incentive effectiveness were assessed. Consumers were then asked to make a choice between the presented incentive-based tariff and a basic tariff, the latter of which did not apply any incentives. At the end of the study, individual levels of loss aversion, risk aversion, and temporal discounting were measured. All measures were held short due

to time and space constraints in this survey. A between-subject study design was employed to allow comparing tariff choices of each incentive-based electricity tariff with a basic, non-incentive tariff. We chose a between-subject study design both because of time constraints and to avoid cognitively overloading participants with multiple tariff choices of somewhat similar tariffs.

2.4 Choice experiment and tariff designs

In each choice task an incentive-based electricity tariff was contrasted with a basic electricity tariff that did not offer incentives for energy conservation. The three incentive-based electricity tariffs differed with respect to the temporal distance of the financial reward and/or fee. The amount of both financial reward and fee remained constant over all three experimental conditions and were balanced in accordance to predictions from loss aversion suggesting a gain-to-loss ratio of about 1.5 – 2.5 (i.e., CHF 100 reward [“gain“] and CHF 50 fee [“loss“]; Tversky & Kahneman, 1991; 1992). The three incentive-based electricity tariffs were all advertised explicitly to commit consumers to electricity savings in households and are described in detail in the following.

Figure 2. Three incentive-based electricity tariffs designed for the experimental online study.



2.4.1 Condition 1: Bonus-Malus tariff

In the first condition, participants could choose between a Bonus-Malus tariff and the basic tariff. The Bonus-Malus tariff was adapted from previous studies testing such combined reward-penalty tariff designs (i.e., Mahmoodi et al., 2018). This tariff incentivised a decrease in electricity consumption by offering a financial reward (i.e., CHF 100 Bonus) *at the end of the year*, if the consumer reached a saving target of at least 10% less electricity consumption as compared to the previous year. If the consumer did not reduce electricity consumption by at least 10% as compared to the previous year, a financial fee (i.e., CHF 50 Malus) applied *at the end of the year*.

2.4.2 Condition 2: Signing Premium tariff

In the second condition, participants could choose between a Signing Premium tariff and the basic tariff. The Signing Premium tariff offered consumers an *upfront financial reward* (i.e., CHF 100) to commit to decrease electricity consumption. If the consumer reached a saving target of at least 10% less electricity consumption as compared to the previous year, she would keep the financial reward. However, if the consumer did not reduce electricity consumption by at least 10% as compared to the previous year, the consumer would have to reimburse the financial reward plus an additional fee of CHF 50.

2.4.3 Condition 3: Financial commitment tariff

In the third condition, participants could choose between a Financial Commitment tariff and the basic tariff. The Financial Commitment tariff required consumers to pay an *upfront financial fee* (i.e., CHF 50) to commit to reduce electricity consumption. If the consumer reached a saving target of at least 10% less electricity consumption as compared to the previous year, the financial fee would reimburse to them plus an additional financial reward of CHF 100. However, if the consumer did not reduce electricity consumption by at least 10% as compared to the previous year, the utility would keep the financial fee (i.e., CHF 50).

2.5 Psychological variables

2.5.1 Loss aversion

An unincentivised lottery choice task was used to measure loss aversion (Gaechter, Johnson, & Herrmann, 2007, adapted from Fehr & Goette, 2007). In the binary lottery choice tasks (see Table 1), participants could accept or reject six different lottery choice tasks. Over the six lottery tasks, the probability of winning and losing the lottery was 50%. A fixed amount of CHF 6 could be won, while the amount that could be lost varied from CHF 2 (in lottery choice task 1) to CHF 7 (in lottery choice task 6). Only the first switching point over all lottery tasks was considered for each participant, while extreme cases accepting or rejecting all lottery tasks were also considered. Based on individual switching points, a score was calculated for each individual, where accepting lotteries were coded as 0 and rejecting lotteries coded as 1. Higher individual scores correspond to higher levels of loss aversion.

Table 1. Lottery choice tasks (taken from Gaechter, Johnson, & Hermann, 2007).		
Lottery	**Accept**	**Reject**
1. If the coin turns up heads, then you lose CHF 2; if the coin turns up tails, you win CHF 6.		
2. If the coin turns up heads, then you lose CHF 3; if the coin turns up tails, you win CHF 6.		
3. If the coin turns up heads, then you lose CHF 4; if the coin turns up tails, you win CHF 6.		
4. If the coin turns up heads, then you lose CHF 5; if the coin turns up tails, you win CHF 6.		
5. If the coin turns up heads, then you lose CHF 6; if the coin turns up tails, you win CHF 6.		
6. If the coin turns up heads, then you lose CHF 7; if the coin turns up tails, you win CHF 6.		

2.5.2 Risk aversion

A one-item measure for risk aversion was used to assess consumer's dispositional tendency to accept risk, irrespective of context or reference point (Maestas & Pollock, 2010). Dispositional risk aversion was operationalised on a scale coded from 1 (*I readily take risks*) to 7 (*I avoid risks as much as possible*). Higher individual scores correspond to higher levels of risk aversion.

2.5.3 Temporal discounting

Four discounting tasks were taken from Kirby et al.'s (1999) Monetary Choice Questionnaire, presenting hypothetical, binary choice tasks between smaller, immediate and larger, delayed rewards (e.g., "Receive CHF 54 today or CHF 80 in 30 days"). The reward magnitudes and delay periods varied and were presented in randomised order. Due to space and time constraints as well as due to reasons outside our control (i.e., the utility who collected data from their consumers on our behalf did not include the full list of temporal discounting items in the online study), we were able to use only four of the 27 discounting tasks, thus, we did not estimate individual *k*-values as an indicator for consumers' discount rates, as suggested by the authors. Instead, we calculated a discounting score ranging from 0 (always choosing the larger, delayed reward) to 4 (always choosing the smaller, immediate reward). The

four tasks from Kirby's questionnaire were all taken from the larger delayed reward category, but differed with respect to their associated discount rate in order to also capture consumers with extreme discounting tendencies (e.g., preference for immediate rewards even with short delays or preference for delayed rewards even with long delays).

2.5.4 Perceived tariff attractiveness and incentive effectiveness

Consumers indicated the attractiveness of the incentive-based tariff presented to them on a scale coded from 1 (*Not at all*) to 5 (*Very much*) as well as their perceptions about the incentives' effectiveness in motivating reductions in electricity consumption (i.e., *"This tariff could incentivise me to reduce my electricity consumption"*) coded on a scale from 1 (*Not at all*) to 5 (*Very much*).

2.6 Results

Table 2 provides an overview of the sample's socio-demographic as well as the psychological variables. In the following, the results of the choice experiment and from the proposed theoretical model underlying tariff choices are presented and discussed.

Table 2. Description of the 535 utility customer panellists.

	Overall sample		**Bonus-Malus tariff condition**		**Signing Premium tariff condition**		**Financial Commitment tariff condition**	
Mean age (in years)	51.9	(*SD* = 14.0)	53.7	(*SD* = 14.7)	51.4	(*SD* = 14.2)	50.7	(*SD* = 13.1)
Gender								
Male	64.1%		65.9%		63.3%		64.3%	
Female	35.3%		34.1%		36.7%		35.8%	
Loss aversion	3.54	(*SD* = 1.87)	3.67	(*SD* = 1.91)	3.38	(*SD* = 1.90)	3.29	(*SD* = 1.94)
Risk aversion	4.50	(*SD* = 1.47)	4.50	(*SD* = 1.54)	4.53	(*SD* = 1.47)	4.48	(*SD* = 1.40)
Temporal discounting	1.53	(*SD* = 1.08)	1.56	(*SD* = 1.07)	1.39	(*SD* = 1.06)	1.64	(*SD* = 1.08)

Tariff understanding	4.28	(*SD* = 0.97)	4.39	(*SD* = 0.93)	4.26	(*SD* = 0.90)	4.20	(*SD* = 1.06)
Tariff attractiveness	2.78	(*SD* = 1.25)	2.72	(*SD* = 1.24)	2.61	(*SD* = 1.30)	3.02	(*SD* = 1.18)
Incentive effectiveness	3.29	(*SD* = 1.22)	3.24	(*SD* = 1.24)	3.21	(*SD* = 1.28)	3.42	(*SD* = 1.14)

2.6.1 Choice experiment

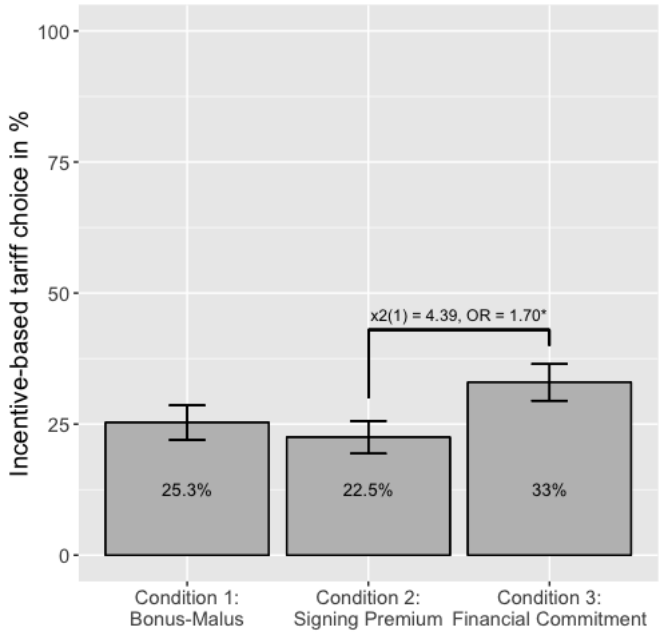
We first evaluated the one-item measure asking the ease of understanding of the electricity tariffs presented on a 5-point Likert scale, coded 1 (*Not at all*) to 5 (*Very much*). Consumers in all three tariff conditions reported a good understanding of the tariffs and the choice task presented to them, $M = 4.93$, $SD = 0.93$ in the Bonus-Malus tariff condition, $M = 4.29$, $SD = 0.90$ in the Signing Premium tariff condition, and $M = 4.20$, $SD = 1.06$ in the Financial Commitment tariff condition, $F(1, 533) = 1.73$, $p = .189$, $\eta^2 = 0.00$.

Across all experimental conditions the basic electricity tariff was chosen more often than any of the three incentive-based tariffs (74.7% in the Bonus-Malus condition, 77.5% in the Signing Premium condition, and 67.0% in the Financial Commitment condition), confirming Hypothesis 1. The difference between incentive-based and basic tariff choices was significant for all three conditions, as revealed by chi-square tests computed for each condition: $\chi^2(1) = 85.05$, $p < .001$, $\varphi = 0.49$ in the Bonus-Malus tariff condition, $\chi^2(1) = 105.72$, $p < .001$, $\varphi = 0.55$ in the Signing Premium tariff condition, and $\chi^2(1) = 40.22$, $p < .001$, $\varphi = 0.34$ in the Financial Commitment tariff condition.

A chi-square omnibus test was conducted to test for differences in choices between the three incentive-based tariffs. The result showed no significant difference between the three tariff conditions, $\chi^2(2) = 5.35$, $p = .069$, $\varphi = 0.10$. Post-hoc pairwise comparisons showed that neither the Signing Premium tariff (22.5%), $\chi^2(1) = 0.25$, $p = .619$, $\varphi = 0.03$, OR = 1.17 [1.07, 1.28], nor the Financial Commitment (33%), $\chi^2(1)$

= 2.19, p = .139, φ = 0.08, OR = 1.45 [1.32, 1.60], were chosen significantly more often as compared to the Bonus-Malus tariff (25.3%). Hypothesis 2 and 3 thus need to be rejected. A pairwise comparison between the two novel tariff designs revealed, however, that the Signing Premium tariff was chosen significantly less often than the Financial Commitment tariff, $\chi^2(1) = 4.39$, p = .036, φ = 0.11, OR = 1.70 [1.55, 1.88], indicating that consumers preferred electricity tariffs that require paying an upfront fee as commitment to electricity conservation to tariffs offering an upfront reward (see Figure 3).

Figure 3. Percentages of consumers choosing the incentive-based electricity tariffs in the three experimental conditions.



2.6.2 Psychological variables

We tested whether individual levels of loss aversion, risk aversion, and temporal discounting guide consumers' electricity product choices, and whether this is mediated by perceived tariff attractiveness and incentive effectiveness. Levels of

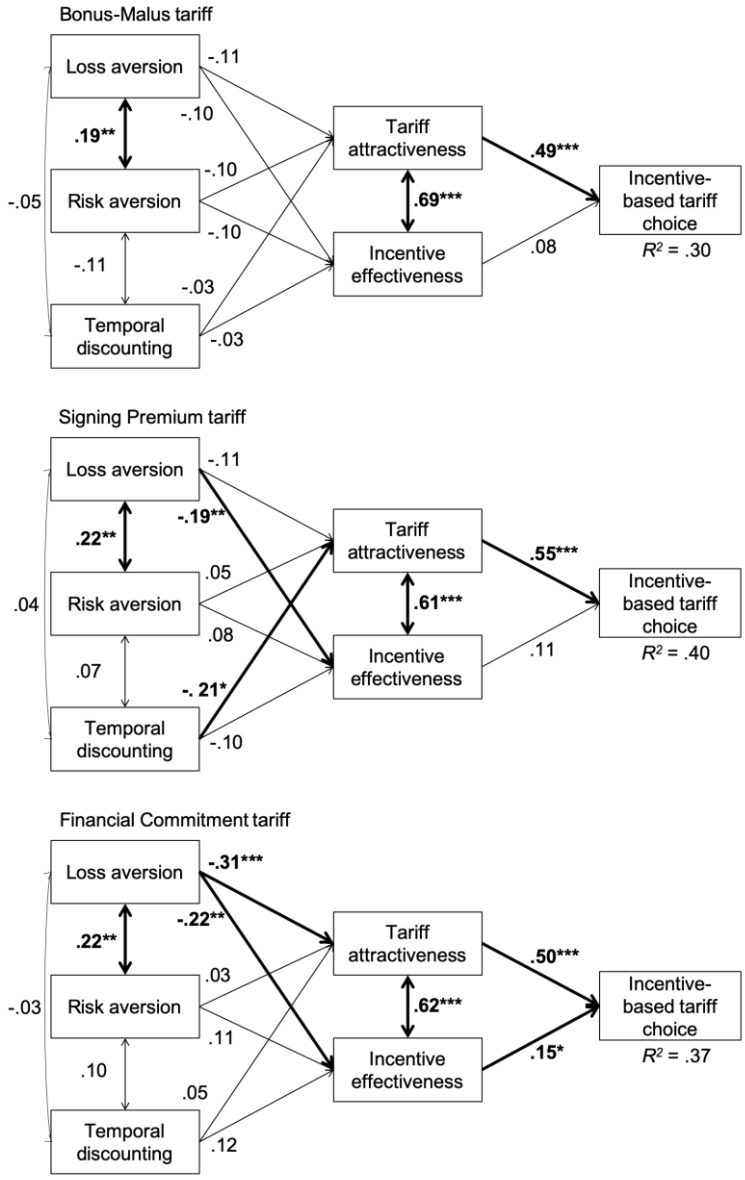
loss aversion can be found in Table 3 showing that lottery task 4 was the median cut-off lottery. Overall, moderate levels of risk aversion, $M = 4.50$, $SD = 1.47$, and discounting scores, $M = 1.53$, $SD = 1.08$, were found (see Table 2).

Table 3. Acceptance rates of the different lotteries in the lottery choice task.

Choice category and corresponding acceptance behaviour	Percentage	Implied acceptable loss
7) Reject all lotteries	28.4%	CHF <2
6) Accept lottery #1, reject lotteries #2 to #6	8.4%	CHF 2
5) Accept lotteries #1 and #2, reject lotteries #3 to #6	22.4%	CHF 3
4) Accept lotteries #1 to #3, reject lotteries #4 to #6	13.1%	CHF 4
3) Accept lotteries #1 to #4, reject lotteries #5 to #6	10.5%	CHF 5
2) Accept lotteries #1 to #5, reject lotteries #6	9.7%	CHF 6
1) Accept all lotteries	7.5%	CHF ≥7

Multi-group structural equation modelling (SEM) was performed to test the proposed model using the lavaan package (Rosseel, 2012) in the statistical computing software R (R Core Team, 2015). The model tests were based on robust weighted least squares (WLSMV), because the model included a binary outcome variable (Li, 2016). Goodness of fit criteria were based on Hu and Bentler (1999) with values of .95 for the comparative fit index (CFI), .08 for the standardised root mean square residual (SRMR), and .06 for the root mean square error of approximation (RMSEA) indicating good fit. The chi-square value for this model was non-significant, χ^2 (9, N = 535) = 9.24, p = .416, suggesting good fit between data and model. Other fit indices, such as CFI = 1.00, RMSEA = 0.01, 90% confidence interval [CI: 0.00, 0.09], SRMR = 0.02, and normed fit index (NFI) = 0.99 confirmed good model fit.

Figure 4. Results of the proposed model and pathways to tariff choice in the three experimental conditions: (1) Bonus-Malus tariff; (2) Signing Premium tariff; (3) Financial Commitment tariff. *Note*. Figure contains standardised parameter estimates. *p < .05, **p < .01, ***p < .001.



An additional descriptive examination of model fit across the three experimental conditions separately showed good fit between the data and the model in all three conditions. In the Bonus-Malus tariff condition, the chi-square value was non-significant at χ^2 (3, N = 178) = 5.97, p = .113 and other fit indices, CFI = 0.99, SRMR = 0.04, RMSEA = 0.08, 90% confidence interval [CI: 0.00, 0.16], NFI = 0.97 suggested good model fit. In the Signing Premium tariff condition, the chi-square

value was non-significant at χ^2 (3, N = 178) = 1.31, p = .726 and the other fit indices, CFI = 1.00, SRMR = 0.02, RMSEA = 0.00, 90% confidence interval [CI: 0.00, 0.09], NFI = 0.99 suggested good model fit in this condition as well. Likewise, model fit in the Financial Commitment tariff condition was good with a non-significant chi-square value of χ^2 (3, N = 179) = 1.95, p = .582, CFI = 1.00, SRMR = 0.02, RMSEA = 0.00, 90% confidence interval [CI: 0.00, 0.14], NFI = 0.99. Following recommendations by Chen (2007) the changes in CFI, RMSEA, and SRMR were not beyond the critical cut-off values. Hence, there did not seem to be substantial differences between the three models. Looking at the R^2 values across the three tariff conditions, it seems that the model fitted the data for the Signing Premium tariff and Financial Commitment tariff conditions better, as 7% and 10% more variance, respectively, were explained in these conditions than in the Bonus-Malus tariff condition.

2.6.2.1 Condition 1: Bonus-Malus tariff

The SEM for the Bonus-Malus tariff condition showed that higher tariff attractiveness significantly predicted choices of the Bonus-Malus tariff over the basic tariff (β = 0.490, p < .001). Perceived incentive effectiveness did not significantly predict tariff choice in this condition (β = 0.080, p = .313). None of the three decision biases significantly predicted tariff appraisals (i.e., perceived tariff attractiveness and incentive effectiveness; see Figure 4). Hence, the proposed model (Hypothesis 4) was not confirmed in the Bonus-Malus tariff condition.

2.6.2.2 Condition 2: Signing Premium tariff

The SEM for the Signing Premium tariff condition showed that higher tariff attractiveness significantly predicted choices of the Signing Premium tariff over the basic tariff (β = 0.553, p < .001). Perceived incentive effectiveness did not significantly predict tariff choices in this condition (β = 0.113, p = .093). Temporal discounting negatively predicted perceived tariff attractiveness (β = -0.214, p = .010), while loss aversion negatively predicted incentive effectiveness (β = -0.192, p = .006; see Figure 4). Preference for immediate outcomes (i.e., high discount rates) reduced perceived attractiveness of the Signing Premium tariff and high levels of loss aversion reduced perceived incentive effectiveness of the tariff. Hence, the proposed model (Hypothesis 4) was partly confirmed in the Signing Premium tariff condition.

2.6.2.3 Condition 3: Financial Commitment tariff

The SEM for the Financial Commitment tariff condition showed that tariff attractiveness and incentive effectiveness significantly predicted tariff choices, in that higher attractiveness and incentive effectiveness ratings were associated with choosing the Financial Commitment tariff over the basic tariff (β = 0.504, p < .001 for tariff attractiveness; β = 0.151, p = .041 for incentive effectiveness). Loss aversion negatively predicted perceived tariff attractiveness (β = -0.307, p < .001) and incentive effectiveness (β = -0.224, p = .003), in that high levels of loss aversion reduced perceived tariff attractiveness and incentive effectiveness (see Figure 4). Hence, the proposed model (Hypothesis 4) was partly confirmed in the Financial Commitment tariff condition.

2.7 Discussion

In this study, we tested behaviourally-informed consumption-contingent incentives embedded in electricity products with the aim to improve existing electricity product designs in a way to make these more attractive to consumers. Among consumers of a Swiss utility, we found that, overall, about 23 – 30% of electricity consumers chose electricity tariffs that apply a combination of consumption-contingent rewards and penalties. Hence, Hypothesis 1, that consumers choose basic tariffs more often than incentive-based tariffs was confirmed, which is consistent with previous findings (e.g., Mahmoodi et al., 2018).

It was further hypothesised that consumers have a preference for electricity products that apply *immediate* rewards (i.e., Signing Premium tariff) and penalties (i.e., Financial Commitment tariff), respectively, as compared to products that apply incentives only with a delay at the end of the consumption period (i.e., Bonus-Malus tariff). The results did not support these hypotheses (Hypothesis 2 and 3), which thus need to be rejected. However, the results revealed that consumers chose the Signing Premium tariff, which offered an immediate reward as commitment to reduce electricity consumption significantly less often than the Financial Commitment tariff, which applies an immediate fee as commitment to reduce electricity consumption. This result contradicts previous findings in the literature showing that introducing immediate rewards increased people's commitment to long-term goals (Woolley & Fishbach, 2016). In line with some previous findings from the behavioural economics literature, showing that people sometimes prefer immediate to delayed losses (e.g., Loewenstein, 1987; Loewenstein & Thaler, 1989; Mischel et al., 1969) and voluntarily self-impose penalties as a strategy to commit themselves to perform certain tasks (Trope & Fischbach, 2000), consumers in this study may have also

perceived the upfront fee embedded in the Financial Commitment tariff as an effective and attractive commitment device to conserve electricity, which they may have wanted to "get over with" (see Thaler, 1981). Given the somewhat unexpected and not initially hypothesised result that the product offering an immediate, upfront reward for near-future electricity conservation was chosen least often, a replication is needed in order to validate this finding. A replication is moreover warranted because the finding may have been the results of consumers potentially misunderstanding the tariff and incentive conditions, because consumers' understanding of the tariff and incentive designs were not verified objectively, but only subjectively by asking consumers if they thought they understood them. As such, the significantly increased preference for the Financial Commitment tariff could potentially be the result of a misunderstanding of the tariff and incentive conditions. Study 2 addressed this shortcoming by including a more elaborate comprehension task that participants had to answer after reading detailed information and explanations on the tariff and incentive conditions.

In addition to the choice experiment, a model was tested to predict consumers' tariff choices through measures from behavioural economics, namely risk aversion, loss aversion, and temporal discounting, as well as from consumer psychology, namely perceived tariff attractiveness and incentive effectiveness. It was hypothesised that high levels of loss and risk aversion lower consumers' perceived tariff attractiveness and incentive effectiveness and thereby lower incentive-based tariff choices. While risk aversion did not significantly predict tariff choice across the three experimental conditions, loss aversion significantly predicted tariff choice mediated by tariff attractiveness and incentive effectiveness for the Signing Premium tariff as well as the Financial Commitment tariff. The more loss-averse, the less likely

consumers were to choose these two incentive-based electricity products. These findings partially confirmed Hypothesis 4, suggesting that sensitivity or aversion to losses, but not risks, influences choices of incentive-based tariffs. This result is in line with previous studies showing that loss-averse energy consumers are less likely to change to demand-response tariffs that apply variable electricity prices (Nicolson et al., 2017). Hence, these insights confirm that loss aversion is not only a barrier to switching tariffs or providers (García-Acebrón, Vázquez-Casielles, & Iglesias, 2010), but also to the uptake of innovative, incentive-based electricity products.

We furthermore explored the impact of temporal discounting, which showed a significant effect only in the Signing Premium tariff condition. Somewhat surprisingly, high discount rates negatively predicted tariff attractiveness, which in turn positively predicted choice of the Signing Premium tariff. In other words, consumers with a preference for immediate rewards perceived the Signing Premium as less attractive, while tariff attractiveness still significantly predicted choices of the Signing Premium over the basic tariff. We suggest to interpret these findings with caution, as a number of methodological factors may potentially explain this counterintuitive result. First, the measure employed in this study was very short (only four out of 27 items), which may have led to inaccurate discount scores. Second, the reward embedded in the tariff design may not have been high enough to appeal to consumers when compared to a basic tariff. Third, the delayed penalty embedded in the Signing Premium tariff may have attracted consumers' attention disproportionally more than the upfront reward. Loss aversion negatively predicted perceived incentive effectiveness in this tariff condition, indicating that consumers found the combination of upfront reward and delayed penalty not very effective altogether.

In order to replicate and validate the unexpected, but potentially practically relevant result that an electricity product that applies an immediate reward (combined with a delayed penalty in case of failing to reach a conservation target; i.e., Signing Premium tariff) is chosen less often than a product that applies an immediate penalty (combined with a delayed reward in case of reaching a conservation target; i.e., Financial Commitment tariff), we conducted a replication of the choice experiment. This replication moreover allowed addressing the shortcoming that in Study 1, tariff understanding was assessed only subjectively, not objectively by means of a more elaborate comprehension task. As the main focus of the current research is the design of behaviourally-informed electricity products, we only replicated the choice experiment, without reassessing the individual difference measures from behavioural economics and consumer psychology.

3. Study 2

3.1 Study objectives and hypotheses

A replication of the choice experiment was conducted to validate the tariff choices observed in Study 1. As in Study 1, we expected that participants will choose the basic tariff more than any of the three incentive-based tariffs, i.e., Bonus-Malus, Signing Premium, and Financial Commitment tariffs. We moreover aimed to replicate the result from Study 1 that the Signing Premium tariff is chosen less often than the Financial Commitment tariff. An objective comprehension task was included to ensure that participants had read and understood the tariff conditions in the experiment.

3.2 Participants

An a priori power analysis was conducted using G*Power3 (Faul, Erdfelder, Lang, & Buchner, 2007), which indicated that in order to replicate the finding from Study 1 that the Signing Premium tariff was chosen least often with an effect size (φ) of 0.11, using a one-tailed test, and an alpha of .05, a total sample of 509 participants was required to achieve a power of 0.80. Data were collected in Germany by a professional market research institute from September to October 2020[2]. The data are representative of the German population by age and gender (see Table 4). An invitation to participate in the online experiment was sent out to a panel by the market research institute. Of 862 participants, 331 were excluded either because they failed to answer the comprehension tasks about the tariff designs described at the beginning of the experiment, or because they failed to answer a quality control item correctly. A total of 531 participants were included in the analyses (mean age = 44 years, *SD* = 13.2, range = 19 – 65+ years), of which 267 (50.3%) were female. The survey took about 5 minutes to complete. Because this study was administered in Germany, all material and questions were administered in German (see Supplementary Material). All participants gave informed consent for participation and were debriefed about the study's purpose. No deception was used, no personally identifiable information was accessible to the researchers involved in this study, and data were treated confidential at all times.

[2] In light of the COVID pandemic at the time of data collection, participants were reminded to assume "normal" years when making a tariff choice and asked to ignore potential COVID-related changes (e.g., required home office) affecting their current live circumstances.

3.3 Procedure

After giving informed consent, participants were randomly assigned to one experimental condition in a between-subject design, where one of the three incentive-based electricity tariffs were presented and explained. A four-item comprehension task followed to test whether participants read and understood the tariff conditions and incentive design. If participants did not answer the comprehension task correctly, they were referred to the explanatory text again. If they did not answer correctly after reading the explanatory text a second time, they were thanked and the survey ended for them. Their data were not included in the analyses. Participants where then asked to make a choice between the incentive-based tariff and the basic tariff. Subsequently, overall tariff attractiveness, perceived incentive effectiveness, overall subjective understanding of the tariff as well as socio-demographics characteristics were assessed. In addition, three items were assessed to account for effects of the COVID-19 pandemic on the present choice experiment. During the COVID-19 pandemic, many people lost work benefits, had cuts in their salary, or were laid off from their jobs temporarily or permanently. These and other measures that were put in place demanding people to stay at or work from home more than usual (e.g., Brynjolfsson et al., 2020). Given that such changes in people's lives may increase their energy consumption at home and influence their choices of consumption-contingent electricity products, we asked participants whether they were financially impacted (e.g., laid-off from work, cut in salary, etc.) by COVID, whether they were staying at and working from home more due to COVID, and whether they believed the COVID-related impact on their lives influenced their product choices in this experiment.

3.4 Choice experiment and tariff designs

The exact same tariff designs as in Study 1 were used for this replication study. Because this study was conducted in Germany, the tariff designs were presented in German and incentives were expressed in Euros instead of Swiss Francs (see Supplementary Material). As in Study 1, each choice task included an incentive-based electricity tariff and a basic electricity tariff that did not offer incentives for energy conservation.

3.5 Results

Table 4 shows the sample's socio-demographic characteristics and tariff-related perceptions, i.e., subjective understanding of the tariff conditions, overall tariff attractiveness, and perceived effectiveness of the incentives.

The groups did not differ significantly with respect to the socio-demographic characteristics age and gender nor with respect to the COVID-related measures. The groups did, however, significantly differ with respect to their subjective understanding of the tariff conditions, $F(1, 529) = 8.88$, $p = .003$, $\eta^2 = 0.02$, with respect to their ratings of the overall tariff attractiveness, $F(1, 529) = 6.46$, $p = .011$, $\eta^2 = 0.01$, as well as with respect to their perceptions of the incentive effectiveness, $F(1, 529) = 8.85$, $p = .003$, $\eta^2 = 0.02$. Post-hoc Tukey HSD tests revealed that participants rated the Bonus-Malus tariff as easier to understand than both the Signing Premium and the Financial Commitment tariffs, and that both the Bonus-Malus and the Financial Commitment tariffs were rated as more attractive and more effective in helping them conserve electricity than the Signing premium tariff (see Table 4).

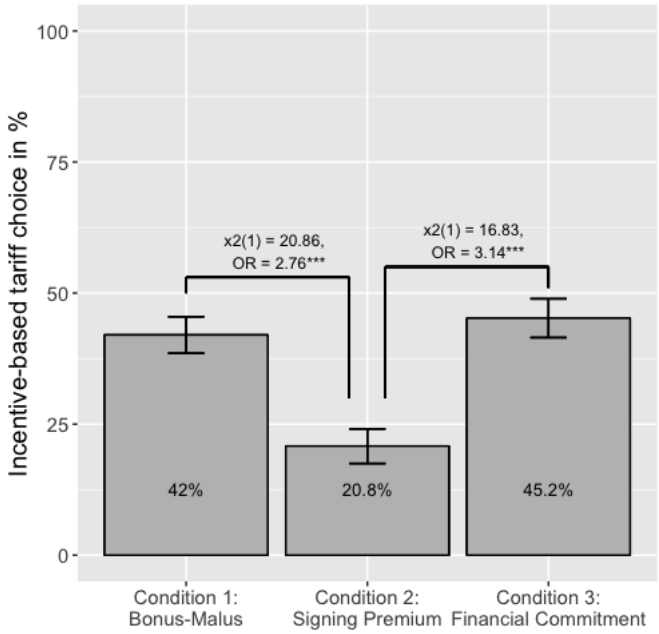
Table 4. Socio-demographics and psychographics for the representative sample of 531 German panelists.

	German population	**Overall sample**		**Bonus-Malus tariff condition**		**Signing Premium tariff condition**		**Financial Commitment tariff condition**	
Mean age (in years)	43.0	43.9	(*SD* = 13.20)	43.7	(*SD* = 13.11)	44.2	(*SD* = 13.9)	44.2	(*SD* = 12.90)
Gender									
Male	50.6%	49.7%		50.5%		50.6%		48.0%	
Female	49.4%	50.3%		49.5%		49.4%		52.0%	
Tariff understanding		4.34	(*SD* = 0.91)	4.51	(*SD* = 0.75)	4.24	(*SD* = 0.92)	4.21	(*SD* = 1.04)
Tariff attractiveness		3.26	(*SD* = 1.29)	3.33	(*SD* = 1.28)	2.95	(*SD* = 1.25)	3.45	(*SD* = 1.29)
Incentive effectiveness		3.44	(*SD* = 1.35)	3.55	(*SD* = 1.33)	3.10	(*SD* = 1.32)	3.62	(*SD* = 1.36)
Financial difficulties due to COVID		1.97	(*SD* = 1.21)	2.04	(SD = 1.23)	1.96	(SD = 1.20)	1.92	(*SD* = 1.20)
Staying/Working from home due to COVID		2.93	(*SD* = 1.51)	2.92	(*SD* = 1.53)	2.98	(*SD* = 1.47)	2.91	(*SD* = 1.52)
Influence on choices due to COVID		1.67	(*SD* = 1.02)	1.68	(*SD* = 1.00)	1.60	(*SD* = 0.93)	1.72	(*SD* = 1.10)

Across all three experimental conditions the basic electricity tariff was chosen more often than any of the three incentive-based tariffs (58% in the Bonus-Malus condition, 79.2% in the Signing Premium condition, and 54.8% in the Financial Commitment condition). However, in contrast to Study 1, the difference between incentive-based and basic tariff choices was statistically significant in the Bonus-Malus and the Signing Premium conditions, but not in the Financial commitment tariff condition, as revealed by chi-square tests computed for each condition: $\chi^2(1) = 9.61$, $p = .002$, $\varphi = 0.15$ in the Bonus-Malus tariff condition, $\chi^2(1) = 102.87$, $p < .001$, $\varphi = 0.58$ in the Signing Premium tariff condition, and $\chi^2(1) = 2.89$, $p = .089$, $\varphi = 0.09$ in the Financial Commitment tariff condition.

A chi-square omnibus test was conducted to test for differences in choices between the three incentive-based tariffs. This test revealed a significant difference between the three tariff conditions, $\chi^2(2) = 24.65$, $p < .001$, $\varphi = 0.22$. Post-hoc pairwise comparisons showed that the Signing Premium tariff (20.8%) was chosen significantly less often than the Bonus-Malus tariff (42%), $\chi^2(1) = 20.86$, $p < .001$, $\varphi = 0.25$, OR = 2.76 [2.51, 3.03], and the Financial Commitment tariff (45.2%), $\chi^2(1) = 16.83$, $p < .001$, $\varphi = 0.22$, OR = 3.14 [2.86, 3.46]. The difference between choices of the Bonus-Malus tariff and the Financial Commitment tariff was not significant, $\chi^2(1) = 0.27$, $p = .602$, $\varphi = 0.03$, OR = 0.88 [0.80, 0.97]. Study 2 thus replicates the finding that the Signing Premium tariff was chosen less often than the Financial Commitment tariff (see Figure 5).

Figure 5. Percentages of consumers choosing the incentive-based electricity tariffs in the three experimental conditions in Study 2.



3.6 Discussion

The aim of Study 2 was to replicate and validate the result that an electricity product that applies an immediate reward (combined with a delayed penalty in case of failing to reach a conservation target) is chosen less often than a product that applies an immediate penalty (combined with a delayed reward in case of reaching a conservation target), while addressing some methodological shortcomings of Study 1. As we included an objective comprehension task in Study 2, we can be confident that participants sufficiently understood the different product and incentive designs.

Results from Study 2 were largely in line with Study 1. Across both studies, consumers showed a general preference for basic over incentive-based electricity products (with exception for the Financial Commitment tariff condition). As in Study 1, in this study the Signing Premium tariff was also chosen significantly less often than the Financial Commitment tariff. However, unlike Study 1, here, the Signing

Premium tariff was also chosen significantly less often than the Bonus-Malus tariff. It is striking that, descriptively speaking, the Bonus-Malus tariff was chosen more often in this study (42%) than in Study 1 (25.3%). Whereas Study 2 tested consumers' comprehension of the Bonus-Malus tariff in a comprehension task, consumers in Study 1 merely reported how well they *thought* they understood the tariff and incentive conditions. Hence, it cannot be ruled out that the increased choices of the Bonus-Malus tariff observed in Study 2 were the result of consumers' better understanding of the tariff and incentive conditions. Overall, these findings support that immediate rewards are not a desired commitment strategy in the context of electricity products, but that consumers prefer delayed rewards that apply only once they fulfilled an electricity conservation target they committed to, as is the case in both the Bonus-Malus tariff and the Financial Commitment tariff.

4. Overall discussion

The present research aimed to develop behaviourally-informed consumption-contingent incentives embedded in electricity products to promote electricity conservation in households. Applying insights from behavioural economics, incentive-based products were designed that commit consumers to save electricity by means of a combination of immediate and delayed rewards and penalties. The main aim was to evaluate whether the introduction of immediate rather than delayed incentives can increase the uptake of incentive-based electricity products among electricity consumers.

The results show that, overall, about 23 – 30% (Study 1) and 21 – 45% (Study 2) of consumers chose electricity tariffs that apply a combination of consumption-

contingent rewards and penalties. These subscription levels correspond to subscription levels reported elsewhere (e.g., Nicolson et al., 2017) and demonstrate a substantial market potential for incentive-based electricity products.

Based on the review of the literature, it was initially hypothesised that consumers would show a preference for electricity products that apply *immediate* rewards (i.e., Signing Premium tariff) and penalties (i.e., Financial Commitment tariff), respectively, as compared to products that apply incentives only with a delay at the end of the consumption period (i.e., Bonus-Malus tariff). However, across both studies, this predicted pattern of choices was not observed. Rather, consumers displayed especially low preferences for the Signing Premium Tariff, which offers an immediate reward to commit consumers to conserve electricity, compared to the other two incentive-based products. This result contradicts previous findings in the literature showing that introducing immediate rewards in addition to delayed outcomes increased people's commitment to long-term goals (Woolley & Fishbach, 2016).

The results further show that this is likely due to consumers perceiving the Signing Premium tariff as the least attractive and least effective commitment device to household electricity conservation. In line with some findings from the behavioural economics literature which shows that people sometimes prefer immediate to delayed losses (e.g., Loewenstein, 1987; Loewenstein & Thaler, 1989; Mischel et al., 1969) and voluntarily self-impose penalties as a strategy to commit themselves to perform certain tasks (Trope & Fischbach, 2000), consumers here also perceived the upfront fee embedded in the Financial Commitment tariff as an effective and attractive commitment device.

Overall, our findings suggest that in the context of environmental conservation, consumers have a preference to *delay*, instead of expedite, rewards for their environmental conservation endeavours. Consumers seem to prefer to first "do the work" (i.e., conserve electricity) and only then "go play" (i.e., be financially rewarded). The findings further suggest that consumers have a preference to expedite penalties and use this as self-imposed commitment device to environmental conservation in the near-future. Products with such incentive design can have a number of advantages. First, requiring an upfront commitment fee that will only be reimbursed if a conservation target is fulfilled induces loss aversion. Consumers may go greater length to conserve electricity in order to avoid a financial loss under such a loss-framed commitment product (see also Bager & Mundaca, 2017). Second, this incentive design may harness consumers' optimism bias in the moment of choice, given that consumers tend to be overly optimistic about their abilities to change their behaviours in the future.

Moreover, in Study 1, a model was tested to predict consumers' tariff choices via the decision biases risk aversion, loss aversion, and temporal discounting, as well as consumers' appraisals of overall tariff attractiveness and perceived incentive effectiveness. Risk aversion did not significantly predict any tariff choice across the three experimental conditions, but loss aversion significantly predicted tariff choice mediated by tariff attractiveness and incentive effectiveness for the Signing Premium as well as the Financial Commitment tariffs. In other words, the more loss-averse, the less likely consumers were to choose these two incentive-based electricity products (see Nicolson et al., 2017 for similar findings). Results for temporal discounting were less conclusive, which is likely due to an incomplete measure that did not allow to estimate reliable discount rates. The present research is a first step towards

behaviourally informing incentive-based product designs and towards understanding the influence of decision biases in incentive-based product choices within the environmental context. However, further research is needed to confirm the findings from this research.

5. Practical implications

Findings from two studies indicate that when designing novel products that use consumption-contingent incentives to motivate environmental conservation, consumers do not choose products that apply immediate, upfront rewards (i.e., Signing Premium tariff), but prefer products that delay rewards and apply only once a conservation target has been reached (i.e., Bonus-Malus and Financial Commitment tariffs).

Overall, the present research offers avenues to behaviourally inform incentive designs that do not only promote sustainability, but also appeal to consumers. Decision biases, such as loss aversion and temporal discounting predicted choices of the products tested here, highlighting the importance of integrating constructs from behavioural economics into the environmental discourse (see also Hardisty et al., 2012). This is particularly important for models of consumer adoption, which are usually based on standard economic models of human behaviour. These standard models assume consumer rationality and posit that gains and losses are valued equally and independent of temporal dimensions, while real-world observations demonstrate behavioural anomalies suggesting differing valuation of gains to losses over time (e.g., Kahneman & Tversky, 1979; Loewenstein & Thaler, 1989). The present research highlights that these biases also play a role in consumer incentive-based

product acceptance. Harnessing these insights can enable marketers to design interventions that counteract (or leverage) the influence of these decision biases on consumer choices. For example, existing incentive-based tariff designs (see, e.g., https://ww2.sig-ge.ch/particuliers/consommer-mieux/reduire-vos-consommations/bonus-economies-energie) could be optimised to increase consumer acceptance and yield greater conservations efforts among consumers.

6. Limitations and future research

As any study, the present studies are also subject to a number of limitations, which are addressed in the following. First, while these studies were conducted among the electricity consumers of a Swiss utility and a representative German sample, respectively, the tariff choices made in the studies were hypothetical and consumers were aware that they did not make actual tariff choices. Therefore, no conclusions can be drawn about the *actual* adoption of incentive-based electricity tariffs, but the results rather indicate the *potential* for consumer acceptance of these tariffs. One future research step is to evaluate consumer responses to incentive-based electricity tariffs in the field based on a more realistic choice scenario with multiple tariff options.

A second limitation concerns the very short and concise measures due to time and space constraints, particularly the decision biases assessed in Study 1. Usually decision biases are modelled using parameter estimates derived from validated multiple-item questionnaires (e.g., Kirby et al., 1999 for temporal discounting; Holt & Laury, 2002 for risk aversion; Kahneman & Tversky, 1979 for loss aversion). Due to the time constraints, each of the biases was assessed using as few items as possible,

resulting in single-item (i.e., risk aversion) and four- or six-item questionnaires (i.e., temporal discounting and loss aversion). While these data allowed scoring ordinal-level values representing individual scores of these biases, they did not allow for more elaborate parameter estimates. Particularly the temporal discounting measure consisted of too few items to adequately compute discount values. Moreover, given that the tested products applied a combination of both rewards and penalties, discounting of negative outcomes should have been assessed in addition to discounting of positive outcomes. Therefore, the finding from Study 1 that high discount rates predicted lowered tariff attractiveness ratings of the Signing Premium tariff was surprising and should be interpreted with caution. Nonetheless, these results provide a first indication of which psychological mechanisms underlie choices in the context of electricity products that could be further unravelled in future research in order to derive more effective incentive designs and marketing strategies.

Altogether these limitations are starting points for future research. This research should include the testing of additional nudging strategies, which are inexpensive and easy to implement at large scale (Sunstein & Thaler, 2003). Given the influence of loss aversion on consumers' electricity choices, nudges can be developed to counteract this influence. For example, pre-selecting default tariff choices for consumers may have a counteracting effect and potentially increase subscription to incentive-based electricity tariffs (see Pichert & Katsikopoulos, 2008). Moreover, understanding the psychological mechanisms underlying the differing preferences and choices between consumers, such as individual levels of loss aversion, would allow marketers to identify segments of consumers and tailor to the differing consumer needs using micro-targeting. Electricity products using consumption-contingent incentives in form of rewards and penalties could then most

effectively target consumer segments who have little environmental concern, as those with little intrinsic motivation and who rely more on external motivators, such as in form of financial incentives, might benefit the most from incentive-based products to commit to environmental conservation (see also Mahmoodi et al., 2020).

7. Conclusion

Consumer acceptance of electricity products that use a combination of consumption-contingent rewards and penalties to incentivise electricity conservation in households were investigated across two choice experiments. Existing incentive-based product designs commonly apply rewards and/or penalties at the end of the year contingent on consumption changes in comparison to previous years (see e.g., Bertoldi, Rezessy, & Oikonomou, 2013). Relying on the behavioural economics literature showing that people prefer immediate outcomes (Kirby et al., 1999; Thaler, 1981) and that immediate outcomes can increase people's commitment to long-term goal pursuit (e.g., Trope & Fishbach, 2000; Woolley & Fishbach, 2016), the present study tested novel tariff designs that applied immediate, rather than delayed, incentives to promote household electricity savings. Results across two studies showed that consumers were least likely to choose incentive-based tariffs when these offered an immediate, upfront financial reward to commit to near-future electricity conservation (combined with a potential delayed penalty in case of failing to reach an electricity conservation target). Individual differences in decision biases and product appraisals accounted for these product choices. Consumers perceiving the products as more attractive were more likely to choose incentive-based electricity products as compared to a basic, non-incentive products. Perceived incentive effectiveness was

predictive of product choice only in the Financial Commitment tariff condition indicating that immediate, upfront penalties were perceived as most effective commitment device. These findings provide first insights on how to use insights from behavioural economics to behaviourally inform existing electricity products that use incentives to commit consumers to electricity conservation, which may be applicable to other instances of sustainable consumption as well.

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Author contributions

Jasmin Mahmoodi conceived the research idea and designed the experimental study. The original idea and experimental design were presented to a Swiss utility, which translated the study to French, contacted their panelists, and collected the data. The replication study was designed and set up by Jasmin Mahmoodi, while a market research institute was hired for participant recruitment. Jasmin Mahmoodi wrote the code for statistical computing, performed the data analyses, and prepared and wrote this manuscript. Tobias Brosch and Martin Patel reviewed and edited earlier versions of this manuscript. All authors approved the final version of this manuscript for publication.