



Engaging customers in demand response programs: The role of reward and punishment in customer adoption in Switzerland

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ABSTRACT

It is challenging to engage customers in demand response programs, which require significant interventions in customers' normal energy consumption patterns. Moreover, little is known about how customers can be motivated to adopt innovations that promote collective benefits. This research investigates the effectiveness of the two most basic elements of incentive-based policies — reward and punishment — with regard to customer participation in the sustainable energy domain. We counter the prevailing assumptions in innovation and technology research that favor the use of reward rather than punishment to engage customers. Based on a series of experimental studies, we find mixed evidence. It appears that punishment is at least as effective as reward in engaging customers in sustainable technology innovations. Even more importantly, both reward and punishment are shown to overcome concerns relating to technology. Moderated mediation reveals that economic incentives and disincentives ameliorate critical obstacles because customers more strongly favor their own personal benefit over the collective benefit and are more willing for 'self-serving' reasons to adopt technology that contributes to collective benefits. The findings of this research thus have novel practical and theoretical implications for energy innovation involving customers.

1. Introduction

Consider the following event that motivated this research: An electricity provider was looking for an effective strategy to attract consumers to join its demand response (DR) program. While offering monetary rewards was one option for the provider, this was eventually ruled out by the managers as this type of incentive is too expensive to stimulate engagement in these programs on a larger scale. Punishments were contemplated as an alternative option because this appears to be effective in other domains (e.g., road traffic) where desired behavior is not rewarded but rather undesired behavior is punished (e.g., speeding). Nonetheless, the intuition of the management was that punishments might not be suited to engage consumers in an energy context. Even more so, conventional wisdom may suggest that consumers respond very negatively to such incentives, developing a feeling of unfairness, which ultimately damages their relationship with the company. But is this managerial intuition actually accurate?

Consumer engagement and energy behavior is a central debate in energy and social sciences. Energy behavior is analyzed based on energy

use characteristics [1] and through the application of machine learning [2]. Studies from the United Kingdom have revealed particularities of energy behavior in relation to different levels of grid connectivity [3], and it is well known that social psychological factors are impactful for the acceptance of smart meters [4]. Additionally, larger reviews have shown the relevance of energy social science research in household energy behavior interventions [5].

Overall, it remains challenging to engage consumers more actively in the energy system, although they are increasingly playing an active and decisive role in innovation development [7]. This role for consumers has been found to be important in new product development [8,9] as embedded lead users [10]. Shifting the focus towards a "customer-active paradigm" [11], researchers have considered customer engagement in value creation in a variety of contexts. Although engaging consumers appears to be a central issue in innovation management, knowledge of how to do it is sparse. Thus far, rather few studies have investigated personal traits and the effect of this on innovation success [12], or have examined how innovation can facilitate the engagement of customers in value creation (e.g., contributions to firm-hosted user communities

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[14]).

Research into innovation involving customers predominantly looks at industries in which willingness-to-engage is generally high, and has ranged from open-source software innovation [14], to mountain-biking [15], computer-controlled musical instruments [13], and all-terrain vehicles [16]. Given this selection of industries, in which participation seems to be intrinsically motivated, identifying how to engage customers appears to be less necessary. As a result, the different mechanisms that drive customer co-production [17] and the boundary conditions that produce willingness to co-create among individuals [18] remain largely unexplored.

This is particularly true for domains in which the general interest of consumers is low but information is required, such as those involving pro-social products or services. Especially in the context of sustainability innovation, innovation sometimes requires customers to make trade-offs that are undesirable. In the energy industry, for instance, increasing the share of fluctuating renewable energy production requires customers to participate more actively in value creation and capture in the power sector [19–21]. Sometimes this comes at the cost of convenience: a disadvantage for customers [22] which reduces willingness to adopt such technologies. Managing this challenge requires novel insights into how customers can be stimulated to engage “for the greater good”; that is, how better to balance short-term individual disadvantage and long-term (ecological) benefits. Unfortunately, customers appear to be relatively hesitant to take a more active role in sustainable energy innovation and to engage in adopting sustainable solutions with utility companies.

This paper contributes to managing this problem by addressing the question of how to engage customers in sustainable energy markets. The present research is embedded in the context of DR programs for which consumer engagement is a particular challenge [6]. DR programs are expected to operate as a policy framework for organizing consumer engagement (for a description of such programs, see appendix). As we spell out in the theory section of this paper, one approach to designing DR programs follows the traditional economic perspective and predicts that associated price effects trigger behavior change [23,24]. In contrast, the behavioral view suggests that psychological mechanisms may be intertwined with incentives and disincentives to shape sustainable consumer behavior [25,26], while individual-level variability plays a role in determining their efficacy. We contribute a micro-level integration of these two perspectives. A series of studies explored how and which customers can most effectively be incentivized through specific policies to take part in DR programs [27,28].

The paper is organized as follows: Section 2 describes an interdisciplinary review of the current body of research and develops a theoretical framework about the effectiveness of reward and punishment in stimulating co-creation in domains with significant societal implications. Section 3 reports the design and procedure of our three experimental studies and presents the main results. We conclude in section 4 by discussing implications for the development of effective incentive schemes in sustainable innovation involving customers and further research.

2. Theory

2.1. The crucial role of active consumers in sustainability solutions

Innovative business models provide novel solutions for accommodating large shares of renewable energy [20]. One such solution are DR programs in which customers and companies cooperate in novel ways to create value by re-organizing supply and demand in a flexible manner. According to the US-Federal Energy Regulatory Commission, DR can be defined as “changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized” [29]. For example, such programs would

allow for excess solar energy in the grid to be used, or prevent energy shortages at different times of the day. This could involve running a dishwasher only at times when there is enough energy available from renewable energy sources. An exemplary description of a DR program, wherein the energy provider controls a household electrical appliance, is provided in the appendix (which also served as an explanation of the DR concept for the participants in the experimental studies that are later presented). While DR defines the arena in which innovation and production with customers happens, it is less clear how to motivate customers effectively to take part in DR programs. We draw on behavioral theory insights differentiating the impact on human behavior by different forms of intervention [5]. Our initial hypothesis is that interventions will improve individual participation in demand response programs. In the following section, we provide a review of the most basic policy instruments for engaging consumers.

2.2. Policy instruments: The instrumental effects of reward and punishment

Reward and punishment are the two fundamental policy options that are employed to stimulate specific behaviors of individuals and groups of consumers. The effectiveness of such incentives and disincentives can be explained using competing perspectives.

From a classical economic perspective, monetary incentives and disincentives are instruments that modify behavior through price effects [30,31,24,26]. Rewards or fines imposed for specific behavior affect the cognitive cost-benefit calculations of the utility-maximizing individual and are undertaken more or less consciously. Such rational considerations make the targeted behavior more (reward) or less (punishment) attractive [23]. Various studies provide evidence that rewards are especially capable of stimulating a target behavior, such as engaging in cooperation [32–34] (for an overview see [23]), health behavior (e.g., [35,36]), and environmental conservation [24,37–40]).

According to interdependence theory, incentives and disincentives are effective tools for solving social dilemmas and reduce the discrepancy between personal benefit and collective benefit [23]. For example, a behavioral change that promotes collective benefits, such as switching to sustainable products and services, often entails short-term costs for the individual. As a consequence, the self-interest in behavioral change that creates collective long-term benefits can be rather low. The introduction of economic incentives and disincentives increases self-interest and therefore potentially reduces the conflict between personal benefit and collective benefit [23,41]. Furthermore, the higher the rewards or punishments are, the greater their effectiveness at guiding behavior is expected to be, from the classical economic perspective [42]. Various studies provide evidence that larger incentives or disincentives are indeed more effective than smaller ones [43–46].

2.3. Psychological effects of reward and punishment

The effectiveness of reward and punishment can also be approached from a psychological perspective [24,26,31,47–50]. It appears that various mechanisms can enhance, reduce or even undermine price effects [31]. The risk that incentive-based policies with extrinsic financial motivators backfire can be explained by the fact that they potentially crowd out any initial intrinsic motivation [31,47,51–57]. This crowding-out effect occurs when extrinsic motivators—economic incentives or disincentives—undermine intrinsic motivation. In some cases, this can even have negative effects on the targeted behavioral change, such as decreasing recycling behavior [54]. Economic incentives and disincentives may also provoke psychological reactance [58,59] when they are perceived as being intrusive and controlling. In such cases, individuals may reduce their effort (or simply not engage in the intended behavior) as they find their initial intrinsic motivation is not acknowledged [54]. This situation can be attributed to the fact that incentives or disincentives signal distrust [26] and the fact that

individuals perceive them as a threat to their personal freedom [58]. Also, subjective perceptions of self-determination are negatively affected [59,60] when external incentives or disincentives are interpreted as being controlling.

There is ample evidence that extrinsic motivators in the form of financial rewards or punishments can have negative effects on environmental decision making due to the crowding-out effect [54]. Frey and Stutzer show that the introduction of monetary incentives or disincentives can also be supportive in the long run [48]. Introducing a reward for pro-environmental behavior or punishing people who do not perform a specified behavior can help to overcome free-riding and related rationalizations, such as concerns that other people will free-ride [48,61]. Furthermore, incentives as well as disincentives can be interpreted as signals of social norms [24,40,50].

It is considered of particular importance that financial rewards or punishments may undermine the desired behavioral effect if they shift the decision mindset from ethical or social framing to an economic framing [62–64]. Correspondingly, scholars find that the provision of financial incentives shifts people's mindset from a social one to an economic one, and as a result, individuals attach more importance to the magnitude of the incentive [46]. This shift towards economic reasoning following the introduction of small incentives can have a negative effect on the intended behavior. When economic reasoning is prevalent, small fines might signal that the behavior that was responsible for the sanction is not so unfavorable, making the punishment the price of such behavior, thereby releasing individuals from perceiving moral responsibility [43,44,48]. Similarly, small rewards can signal that the target behavior is not overly important [45,62]. In the following section, we embed these two overarching perspectives to understand better how incentive policies can stimulate the adoption of a sustainable technology that requires a significant modification of customers' habitual consumption patterns.

2.4. Sustainable DR programs: Reward vs. punishment?

In the context of sustainable DR programs, the question arises whether to employ positive incentives based on rewarding participating customers, or sanction-based policies that use punishments. A meta-analysis by Balliet et al. [23] indicates that incentives and disincentives are equally effective, but punishments have a slightly greater effect on transforming the behavior of individuals. This slightly greater effect may be explained by the principal and widely acknowledge premises of prospect theory. While individuals are likely to perceive rewards as gains, punishments are likely to be considered losses, which are known to have greater implications for behavior change [65–67]. The steeper value function for losses and loss aversion suggests that individuals will be more likely to comply with requests when they can avoid losses compared to when they can make equivalent gains [65,66]. Hence, the effects of rewards and punishments are asymmetrical. Greitemeyer and Meyer [68,69] demonstrate the existence of such asymmetrical patterns and observe that the avoidance of punishment is a stronger external motivator than striving to obtain a reward.

When confronted with a punishment, Mulder demonstrates that people are more likely to perceive the targeted behavior as obligatory, whereas in a reward situation the target behavior is perceived as being voluntary [70]. Punishments therefore outperform rewards in communicating moral or social norms [70]. However, for punishments to be more effective than rewards at fostering moral engagement and internalizing a targeted behavior, incentives have to be placed in a moral context and should not be perceived as being too harsh [70,71]. Recent research provides evidence for these observations by demonstrating that policies based on punishment are more readily accepted than policies that reward if the relevant behavior is obligatory, rather than voluntary [72].

Beyond communicating social norms, asymmetries might be expected because of the effects of negativity. That is, punishments should

be more effective than rewards in shaping behavior because negative events are generally known to have a stronger effect than positive events [73]. Yet, for the very same reason, punishments may be more likely to have negative side effects, can be perceived of as hostile acts, and thus inhibit reciprocity and cooperation [31]. Compared to rewards, punishments are therefore more likely to provoke reactance [74,75] and negative affect [76,77]. However, such negative side effects might only arise if the targeted behavior is perceived as being voluntary rather than obligatory [70,72], and thus the punishment is perceived as being unfair [78–81]. Having discussed the mechanisms determining the implications of monetary rewards and punishments, we next discuss the critical conditions under which these incentive policies are effective at stimulating the adoption by customers of sustainable technologies, and more specifically, DR programs.

2.5. Customer concern mitigates the effectiveness of policy instruments

Emerging sustainability innovations, such as DR programs, are often relatively new to customers and require the use of complex technologies that are not yet widely known among the general population. Such innovations are therefore likely to evoke concerns in consumers. These concerns, for example, may be related to loss of control over household appliances or data security [19,82–84]. Consumers may share similar concerns with regard to DR programs which may be expected to qualify the effectiveness of incentive-based policies (punishments and rewards). Frey and Stutzer argue that crowding out only occurs under conditions when the pro-environmental action involves a low-cost decision [48]. For decisions involving high costs, the intrinsic motivation to act in an environmentally friendly manner may not suffice to change behavior [48,85]. If consumers are significantly concerned regarding a DR program, it is harder for them to overcome these concerns and join it. Put differently, such concerns boost the individual (mental) cost of joining a DR program and thus constitute a barrier [86], reducing the likelihood that people will engage in the target behavior [86]. We hypothesize that it is particularly in this scenario when an economic incentive or disincentive can foster motivation to participate in DR programs. This assumption is based on the fact that DR programs increase the benefits of a targeted behavior and thus help to overcome barriers resulting from a high level of concern [86].

In summary, both reward and punishment are expected to elicit a positive effect on intentions to participate in DR programs due to the price effect [24], which reduces the discrepancy between collective benefit and personal benefit [23]. However, the effectiveness of incentives is not universal and, critically, depends on the individual that is required to adopt the sustainable technology (and thereby substantially modify normal consumption patterns). It is our fundamental assumption that the effect of incentives and disincentives on the intention-to-join a DR program also depends on the concerns that consumers have in regard to the DR program. This effect should be particularly prominent for those customers with a high level of concern compared to those with lower concerns. One reason is that in the former case monetary incentives can help to overcome concerns and are less likely to crowd out intrinsic motivation. Economic incentives or disincentives more strongly push such customers towards acting for personal interest over collective interest. In response to punishments and rewards, it is the particularly concerned individual who may become more willing to adopt a technology that contributes to the collective interest. These assumptions are tested in a series of experiments.

3. Experimental studies

A series of experimental studies investigated the effectiveness of punishment and reward on increasing customers' willingness to join DR programs. The current research is located in the domain of energy consumption in Switzerland where consumer participation in such programs is of pivotal importance for promotion collective interests (e.

Table 1
Regression results (Study 1).

	Intention to join DR program							
	B	SE	t-value	p	B	SE	t-value	p
<i>Experimental manipulation</i>								
Constant	4.395	0.217	20.216	***	4.377	0.203	21.607	***
Concerns					-0.658	0.143	-4.602	***
Punishment	1.052	0.306	3.440	***	1.060	0.285	3.719	***
Reward	0.534	0.304	1.753	+	0.569	0.284	2.006	*
Punishment by concern					0.502	0.190	2.638	**
Reward by concern					0.444	0.196	2.268	*
<i>Conditional effects for different concern levels</i>								
<i>low concern level (-1SD)</i>								
Punishment					0.302	0.399	0.758	ns
Reward					-0.100	0.413	-0.242	ns
<i>high concern level (+1SD)</i>								
Punishment					1.818	0.410	4.432	***
Reward					1.239	0.406	3.051	**
	Self-(vs. collective) interest							
	B	SE	t-value	p	B	SE	t-value	p
<i>Experimental manipulation</i>								
Constant	0.672	0.047	14.267	***	0.671	0.046	14.435	***
Concerns					-0.034	0.033	-1.003	ns
Punishment	0.234	0.066	3.534	***	0.239	0.065	3.652	***
Reward	0.195	0.066	2.963	**	0.194	0.065	2.973	**
Punishment by concern					0.097	0.044	2.224	*
Reward by concern					0.065	0.045	1.457	ns
<i>Conditional effects for different concern levels</i>								
<i>low concern level (-1SD)</i>								
Punishment					0.092	0.092	1.008	ns
Reward					0.095	0.095	1.003	ns
<i>high concern level (+1SD)</i>								
Punishment					0.385	0.094	4.095	***
Reward					0.292	0.093	3.138	**
	Loyalty towards energy provider							
	B	SE	t-value	p	B	SE	t-value	p
<i>Experimental manipulation</i>								
Constant	4.971	0.137	36.170	***	4.966	0.133	37.291	***
Concerns					-0.209	0.094	-2.227	*
Punishment	-0.019	0.193	-0.100	ns	-0.013	0.187	-0.068	ns
Reward	-0.269	0.192	-1.400	ns	-0.243	0.187	-1.304	ns
Punishment by concern					0.227	0.125	1.813	+
Reward by concern					-0.033	0.129	-0.256	ns
<i>Conditional effects for different concern levels</i>								
<i>low concern level (-1SD)</i>								
Punishment					-0.355	0.262	-1.353	ns
Reward					-0.194	0.271	-0.714	ns
<i>high concern level (+1SD)</i>								
Punishment					0.330	0.270	1.222	ns
Reward					-0.293	0.267	-1.098	ns

Notes. *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$ + $p \leq 0.1$. The control group serves as the reference, all products mean centered for product.

g., reducing pollution and related impacts on society). To draw conclusions about the potential negative side effects of punishments, we also investigate the effect of reward and punishment on loyalty towards the energy provider that offers them, and on the perception of the fairness of such offers. We opted to use participation in a fully DR program as the decision problem, which defines the context for all the experiments described in the following.

3.1. Study 1

3.1.1. Objective

Study 1 was designed to investigate the potential of economic incentives and disincentives for encouraging customers to participate in DR programs. The investigation also explores the reason why reward and punishment are effective. In addition, we also test our theoretical proposal that economic incentives and disincentives are particularly effective at modifying the behavior of customers with a high level of concern about technology because their focus is shifted towards self-

serving goals rather than the need to contribute to collective goals.

3.1.2. Participants and design

A total of 154 undergraduates from a Swiss university participated in a laboratory experiment. We employed a between-subject design with two experimental groups (punishment vs. reward) and a control group that received no incentive. Participants were randomly assigned to one of the groups. Four participants were excluded because they did not understand the task, which gave us a total sample size of $N = 150$ (35.3% female and 63.3% male, 1.4% missing; $M = 24.33$ years old, $SD = 2.95$, 2% missing).

3.1.3. Procedure and materials

After being exposed to materials that contained the experimental manipulation, participants completed a paper-based survey as part of a class assignment. Subjects in all groups first read an introduction to DR programs and their importance for a sustainable energy future. This introduction served two purposes. First, we ensured that the participants

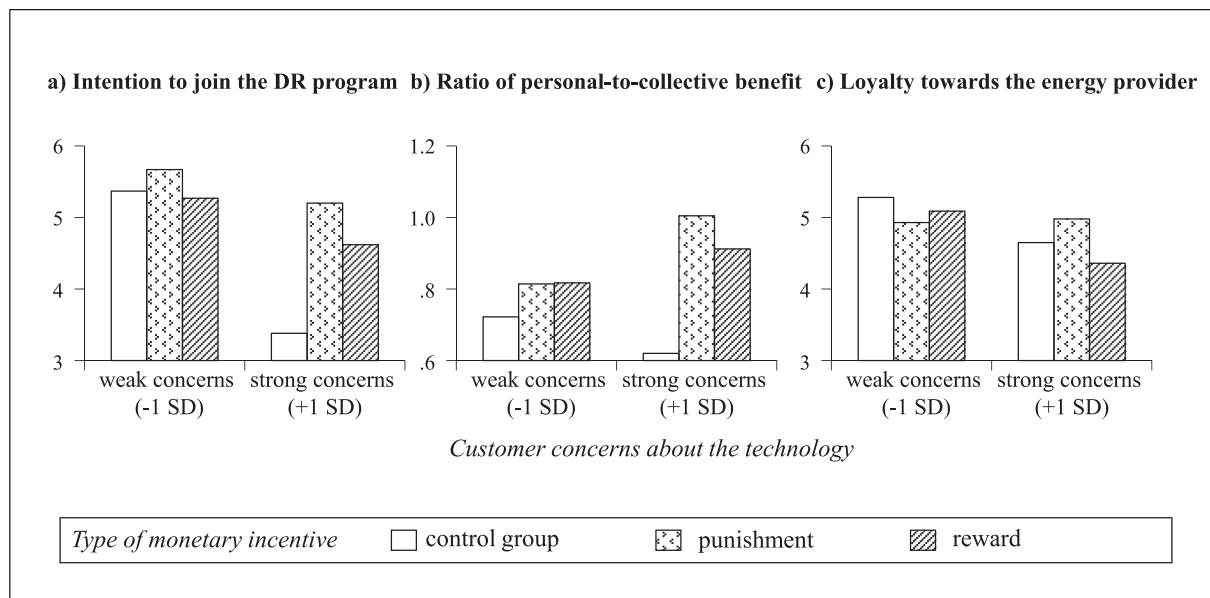


Fig. 1. Influence of experimental factor on dependent variables (Study 1).

understood the concept of DR programs. Second, it highlighted the importance of DR programs for a sustainable energy future.¹ Accordingly, participants were required to balance personal benefits and collective benefits when confronted with an extrinsic motivator (reward and punishment).

After the introduction, participants were informed that their current energy provider was going to introduce a DR program next year. The DR program was limited to the automatic control of their dishwasher. Subjects were informed that they would be able to override the energy provider's signal twice a month. This description of the DR program was supported by visual materials (see Appendix A).²

Participants in the control group then directly answered the questions measuring the dependent variables and other measurements after reading a description of the DR program. Participants in the experiment either received the information that they would get a discount of 50 CHF per month (reward condition) off their electricity bill, or that they could avoid an extra fee of 50 CHF per month (punishment condition) by joining the DR program. As regards the latter, we framed the punishment condition as a negative reinforcement (avoidance of loss) rather than a positive punishment (a direct loss) because the former strengthens the connection with the desired behavior rather than weakening it (Solomon, 2004).

3.1.4. Measures

To measure readiness to join the DR program, we adapted a seven-point, three-item instrument from White and Peloza [87] which has high reliability ($\alpha = 0.96$). Loyalty towards the energy provider was assessed with the help of a scale that consisted of five items (three items adapted from Bell, Auh, & Smalley [88], and the first two loyalty items by Zeithaml, Berry, and Parasuraman [89], $\alpha = 0.80$). As the key intervening mechanism that is expected to explain the effectiveness of the rewards and punishments, we additionally measured the extent to which joining automatic DR programs was perceived to benefit the individual (personal benefit): "I personally benefit if I join the FLEX-Program" [90] and the extent to which the program benefits the

environment and society (collective benefit, $\alpha = 0.86$): "Through joining the FLEX-Program I create benefit for society", and "Joining the FLEX-Program is good for the environment." Items were answered using seven-item Likert scales (1 = not at all; 7 = very much). To capture the relative weight of the two types of interest, we calculated the ratio of personal benefit to collective benefit for further analysis ($ratio = \frac{benefit_{personal}}{benefit_{collective}}$). As the key catalyst that determines the conditions under which economic incentives and disincentives may be particularly helpful, we measured participants' concerns regarding joining automated DR programs. The two-item scale was adapted from Curtius et al. [82]. Answers were also provided using seven-point Likert scales (1 = not at all; 7 = very much; wording: "To what extent do you fear the following when thinking about joining the FLEX program?" a) "I will lose control over my household appliances", and b) "I cannot control what happens to my consumption data, and I am afraid that my consumption data will be abused")³. Finally, participants provided socio-demographic information (age, gender, and place of residence, etc.).

3.1.5. Results

In the first step, regression analyses estimated the effects of the experimental factor (reward and punishment, with the control group as the reference) on the intention to adopt the automated DR program, the ratio of personal benefit to collective benefit, and loyalty towards the energy provider. The analysis further examined if the effects of reward and punishment on these dependent variables were qualified by customers' concerns towards DR programs (all variables are mean centered). Estimation results are presented in Table 1.

The impact of the monetary incentives and customer concerns explained a large share of the variance in intention to join the DR program ($R^2 = 0.21$, $F_{(5, 144)} = 7.79$, $p < .001$). Evidently, rewards and punishments increase intention to join the DR program considerably (punishment: $B = 1.060$, $SE = 0.285$, $t = 3.719$, $p < .001$; reward: $B = 0.569$, $SE = 0.284$, $t = 2.006$, $p < .05$). We also observe that concerns about automated DR programs are a critical obstacle that impairs readiness to join such programs ($B = -0.658$, $SE = 0.143$, $t = -4.602$, $p < .001$).

¹ All studies were carried out in Switzerland where energy efficiency has been widely discussed in the media and in political debates. The need to act in an energy efficient way is widely supported by the population (SRF, 2017).

² All study materials were pretested with students to ensure comprehension and with an energy provider to ensure accuracy and external validity.

³ To avoid the experimental manipulation becoming distorted and avoid carry-over effects, we used temporal and psychological separation (Podsakoff, MacKenzie, Lee & Podsakoff, 2003) and measured concerns regarding DR programs at the end of the survey.

.001). However, as expected within our conceptual framework these implications can be substantially reduced with the help of monetary incentives or disincentives. Accordingly, the effects of rewards and punishments are significantly qualified by customer level of concern (punishment \times concern: $B = 0.502$, $SE = 0.190$, $t = 2.638$, $p < .01$; reward \times concern: $B = 0.444$, $SE = 0.196$, $t = 2.268$, $p < .05$). As highlighted by the conditional effects detailed in Table 1, it is particularly strongly concerned customers for whom punishment ($B = 1.818$, $SE = 0.410$, $t = 4.432$, $p < .001$) and reward ($B = 1.239$, $SE = 0.406$, $t = 3.051$, $p < .01$) increases the readiness to adopt automated DR programs. By contrast, incentives and disincentives did not affect the intention to join the DR program for consumers with a low level of concern ($p > .1$). As depicted in Fig. 1a, adoption rates were relatively high for consumers with low concerns about the technology, and thus fewer barriers.

As they might be perceived as unfair or discriminating, we also tested if monetary incentives and especially disincentives potentially reduce customer loyalty. Again, our model explains a significant proportion of variance in loyalty towards the energy provider ($R^2 = 0.10$, $F_{(5, 144)} = 3.06$, $p < .05$). However, this finding must be primarily attributed to the fact that loyalty towards the provider decreases with elevated levels of concern about the technology ($B = -0.209$, $SE = 0.094$, $t = -2.227$, $p < .05$). Both rewards and punishments were ineffective at changing loyalty, however; a situation which is illustrated in Fig. 1c. This finding implies that punishments involve less of a threat of unwanted (negative) side effects than originally expected.

3.1.6. Reasons for the effects of the incentives and disincentives

In the next step, we examined the reasons why punishment and reward are particularly influential regarding subjects who are concerned about technology. Interdependence theory argues that incentives and disincentives have a positive effect on behavior because they reduce the discrepancy between self-interest and collective interest [23]. In line with our reasoning, both factors increase the subject's perceptions of personal benefit over collective benefit, captured as the ratio of personal to collective benefit (punishment: $B = 0.239$, $SE = 0.065$, $t = 3.652$, $p < .001$; reward: $B = 0.194$, $SE = 0.065$, $t = 2.973$, $p < .01$). Again, we observe that this impact is qualified by the level of customer concern about DR programs. Although the interaction term does not reach significance for rewards ($p = .15$; punishment: $p = .03$), the conditional effects clearly hint that the impact of punishment ($B = 0.385$, $SE = 0.094$, $t = 4.095$, $p < .001$) and reward ($B = 0.292$, $SE = 0.093$, $t = 3.138$, $p < .01$) strongly enhances the dominance of self over collective interest, whereas it is nonsignificant for less concerned individuals ($ps > 0.32$).

Regression analysis further shows that a higher level of personal benefit compared to collective benefit contributes to readiness to join the DR program ($B = 1.563$, $SE = 0.354$, $t = 4.415$, $p < .001$). To test for this mechanism, mediation analysis finally examined whether the ratio of personal to collective benefit mediates the effect of rewards and punishments on intention to join the DR program. In doing this, we further explored whether this mediation is qualified by the level of customer concern about the technology. Employing the Preacher and Hayes [91] bootstrapping procedure (10,000 samples) and the PROCESS macro [92], we determined the conditional indirect effects of incentives and disincentives (dummy coded with the control group as the reference) on the adoption of the DR program according to the ratio of personal to collective benefit, contingent on customer concern. Results derived by moderated mediation analysis are presented in Table 2 (the full moderated mediation model is provided in Appendix C). For the indirect effects, we highlight the different levels of concern (low – 1 SD below the mean; moderate – mean; high – 1 SD above the mean). The conditional indirect effect is significant if the bias-corrected 95% confidence interval does not include 0 (90% interval for marginal effects). The results support the hypothesis: both punishment and reward increase perceptions of personal over collective benefits, particularly for customers with strong concern which affects willingness to join the

Table 2

Conditional indirect effects of reward and punishment at different levels of concern about automated DR programs (Study 1).

	Effect of reward and punishment on joining automated DR programs operating through self-(vs. collective) interest					
	Punishment		Reward			
Concern about automated DR programs	IE	SE	BS	IE	SE	BS
Weak concern	0.115	(0.145)		0.104	(0.141)	
Moderate concern	0.251	(0.133)	*	0.305	(0.139)	*
Significant concern	0.432	(0.203)	*	0.575	(0.257)	*
Index of moderated mediation	0.091	(0.063)	+	0.135	(0.082)	*

Notes. IE... indirect effect, SE... standard error of 95%-confidence interval (CI), BS... bootstrapping (10,000 samples), * 95%-CI $\neq 0$, + 90%-CI $\neq 0$.

automated DR program. Hence, especially for consumers with strong doubts and worries, reward and punishment make personal benefit more salient than the collective benefit, increasing willingness to participate.

3.1.7. Robustness check

It is important to note that the conditional indirect effects reported in Table 2 are based on the estimated regressions. An alternative sensitivity analysis was therefore conducted to double-check overall findings. To this end, a median split was employed to split the sample according to subjects' concern about automated DR programs, and the mediation analysis was rerun. As highlighted in Fig. 2, only for the concerned subjects can we observe the effect of rewards and punishments on the mediating variable (personal vs. collective benefit) that affects readiness to join DR programs. Hence, results are stable.

3.1.8. Discussion

Study 1 reveals that both punishment and reward are helpful for nudging customers towards taking a more active role; namely, adopting an automated DR program. Both policy instruments were shown to be particularly supportive for customers who have significant concerns or worries about the new form of technology, which is a critical obstacle that reduces readiness to accept the program. As mediation analysis clearly outlines, the efficacy of reward and punishment unfolds because both increase the satisfaction of personal over collective benefit. Or, put differently, as punishment and reward can increase personal benefit, it is especially the hesitant consumers who are more likely moved by the economic incentive to adopt a DR program that serves collective interests. For those who are less concerned, rewards and punishments are less influential. For these consumers, doubts about the technology are much less of a barrier and they are more willing to participate, regardless of whether economic incentives or disincentives are involved. Remarkably, loyalty towards the company is not damaged by reward nor punishment. While this is not surprising for rewards, this is an encouraging observation for punishments as conventional wisdom might suggest that they backfire and companies are hesitant to apply them. Having revealed that different policy instruments to promote collective interests can be beneficially employed, the next stage of the research focuses on the magnitude of the reward and punishment. More importantly, we seek to overcome the particularities of the sample in Study 1. Not only are they rather young, students often reside in small and special housing arrangements, with low electricity bills that might sometimes be paid flat-rate as part of the rent. DR could seem hypothetical to parts of this population and some participants might have considered the technology relevant especially for their future lives. With Studies 2a/b, we explore whether the responses to (dis)incentives also emerge at different degrees of rewards or punishments when addressing a representative, non-student sample.

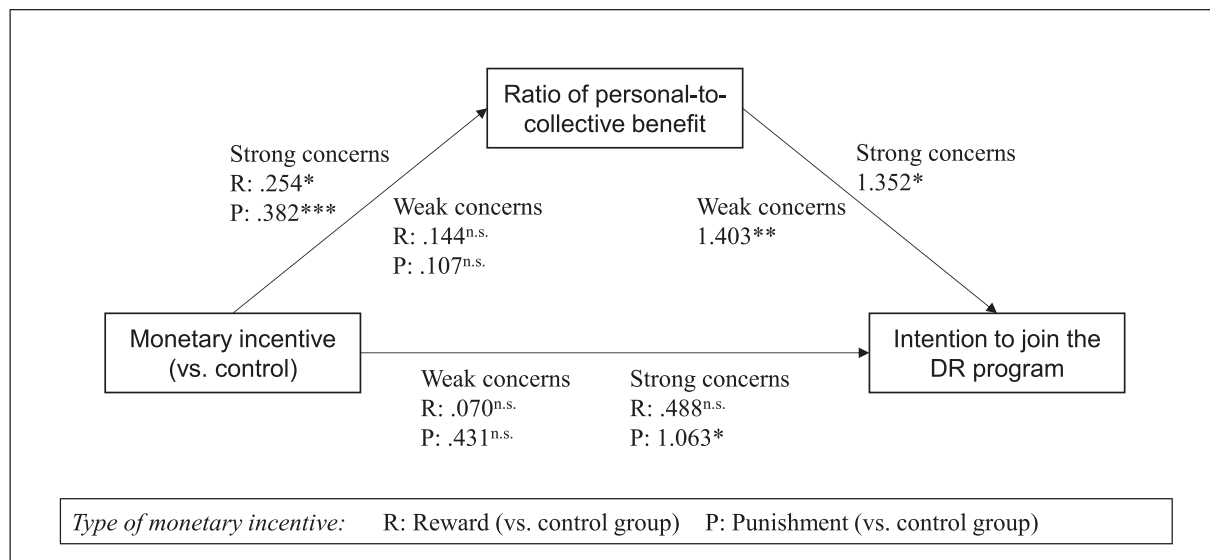


Fig. 2. Direct and indirect effects of the experimental factor related to level of concern (Study 1, Sub-samples for weak and strong concerns with automated DR programs are based on a median split).

3.2. Studies 2a and 2b: Small and large rewards and punishments

To investigate the impact of economic (dis)incentives and to strengthen the ecological validity of the observed positive implications of punishments, we ran two follow-up studies using a representative sample of the population. More precisely, we aimed to test whether findings varied with the size of the reward and punishment. The 50 CHF per month we used in Study 1 constitutes a very large incentive or disincentive as it is >50% of the average energy cost of a typical household in Switzerland (Statista, 2016). The magnitude of the incentive could thus be perceived as controlling, thereby crowding out intrinsic motivation and leading to reactance [24,26,48]. In contrast, monetary incentives of a small magnitude are often perceived as less controlling than those of a high magnitude, and thus may be less likely to evoke this negative effect [48]. Further, small rewards and punishments have the potential to “crowd-in” intrinsic motivation. In contrast to crowding-out, crowding-in describes a situation in which extrinsic rewards acknowledge and thus reinforce initial intrinsic motivation instead of undermining it [24,93]. Small rewards and punishments are prone to be perceived as acknowledging and supportive of any initial intrinsic motivation, rather than controlling [52,54]. Moreover, earlier research suggests that small incentives or disincentives signal social norms better than larger ones [24,40,61]. Two follow-up experiments were conducted at this second stage of research which either employed the larger amount used in Study 1 (Study 2a) or a smaller amount (Study 2b). As a second central objective, the research extended the experimental design to a broader population.

3.2.1. Participants and design

The sample for Stage 2 of the current project consisted of 119 (Study 2a) and 352 panel participants (Study 2b) that were representative of the population in the field of study with regard to age, gender, place of residence, and home-ownership (see Appendix D). We used the same protocol as in the first stage. Again, we employed a between-subject design with two experimental groups (punishment vs. reward) and a control group that received no incentive. Participants were randomly assigned to one group.

3.2.2. Procedure and materials

Panel members participated online in exchange for payment in Study 2a and 2b (1 CHF per participant). The procedure and materials were the same as for Study 1. We systematically varied the magnitude of (dis)

incentive between the two studies. The amount of reward and punishment in Study 2a was 50 CHF (reward or punishment per month), and only 5 CHF in Study 2b.⁴

3.2.3. Measures

Both studies used the same measures as in Study 1 to assess intention to join the DR program ($\alpha \geq 0.94$) and loyalty towards the energy provider ($\alpha \geq 0.79$). As an extension of the previous investigation, we included the perception of fairness of the offer to join the DR program as a third dependent variable (three bipolar items using a seven-item scale: unfair vs. fair; wrong vs. right; unreasonable vs. reasonable; items from Campbell [94]). The instrument had a high level of reliability in both studies ($\alpha \geq 0.93$). Again, we measured the ratio of personal to collective benefit ($\alpha \geq 0.92$), and a measure of the concern regarding the DR program as the relevant moderating variable. Appendix D presents the socio-demographic data and further information (e.g., the highest level of formal education, income, household size, etc.) that were additionally collected for Studies 2a and 2b.

3.2.4. Results

Regression results of Study 2a and Study 2b are presented in Table 3. A significant proportion of the variance in the intention to join the DR program was explained in both experiments (Study 2a: $R^2 = 0.21$, $F_{(5, 113)} = 6.16$, $p < .001$; Study 2b: $R^2 = 0.19$, $F_{(5, 346)} = 15.82$, $p < .001$). Congruently, readiness to join the automated DR program was highly significantly reduced in relation to raised levels of consumer concern for both large (Study 2a: $B = -0.554$, $SE = 0.140$, $t = -3.953$, $p < .001$) and small economic incentives (Study 2b: $B = -0.338$, $SE = 0.095$, $t = -3.567$, $p < .001$). However, only for the small amount (Study 2b) were we able to observe the influence of reward and punishment (punishment: $B = 0.693$, $SE = 0.234$, $t = 2.962$, $p < .01$; reward: $B = 0.398$, $SE = 0.235$, $t = 1.694$, $p < .1$); except for a marginal main effect for large rewards ($B = 0.613$, $SE = 0.365$, $t = 1.678$, $p < .1$).

In the follow-up studies, the main effects of rewards and punishment (Study 2b) are not contingent on the levels of consumer concern. As illustrated in Fig. 3, customers with a low level of concern had generally stronger intentions of joining the DR program than consumers who had greater concern about such new technologies. Yet, for this

⁴ Five CHF was considered a small reward or punishment in the focus group discussion.

Table 3

Regression results for large (Study 2a) and small (Study 2b) rewards and punishments.

Study 2a: Large rewards and punishment		Intention to join the DR program							
Experimental manipulation		B	SE	t	p	B	SE	t	p
Constant		4.436	0.261	16.967	***	4.555	0.240	19.008	***
Concerns						-0.554	0.140	-3.953	***
Punishment		0.393	0.370	1.063	ns	0.422	0.341	1.237	ns
Reward		0.613	0.365	1.678	+	0.353	0.342	1.031	ns
Punishment by concern						0.105	0.210	0.502	ns
Reward by concern						0.282	0.203	1.385	ns
<i>Conditional effects for different concern levels</i>									
<i>low concern-level (-1SD)</i>									
Punishment						0.249	0.526	0.472	ns
Reward						-0.112	0.454	-0.247	ns
<i>high concern level (+1SD)</i>									
Punishment						0.596	0.443	1.347	ns
Reward						0.818	0.503	1.626	ns
		Loyalty towards energy provider							
Experimental manipulation		B	SE	t	p	B	SE	t	p
Constant		4.846	0.174	27.923	***	4.869	0.169	28.772	***
Concerns						-0.108	0.099	-1.087	ns
Punishment		0.010	0.245	0.042	ns	0.075	0.241	0.310	ns
Reward		-0.124	0.242	-0.512	ns	-0.255	0.242	-1.055	ns
Punishment according to concern						-0.158	0.148	-1.066	ns
Reward according to concern						-0.100	0.144	-0.694	ns
<i>Conditional effects for different concern levels</i>									
<i>low concern level (-1SD)</i>									
Punishment						0.335	0.372	0.902	ns
Reward						-0.090	0.321	-0.282	ns
<i>high concern level (+1SD)</i>									
Punishment						-0.186	0.313	-0.594	ns
Reward						-0.419	0.355	-1.181	ns
		Fairness perception							
Experimental manipulation		B	SE	t	p	B	SE	t	p
Constant		5.154	0.220	23.412	***	5.259	0.198	26.556	***
Concerns						-0.491	0.116	-4.237	***
Punishment		0.060	0.311	0.192	ns	0.116	0.282	0.413	ns
Reward		0.553	0.307	1.800	+	0.422	0.283	1.491	ns
Punishment according to concern						0.000	0.173	0.000	ns
Reward according to concern						0.440	0.168	2.616	*
<i>Conditional effects for different concern levels</i>									
<i>low concern-level (-1SD)</i>									
Punishment						0.116	0.458	0.254	ns
Reward						-0.380	0.395	-0.962	ns
<i>high concern level (+1SD)</i>									
Punishment						0.117	0.366	0.319	ns
Reward						1.147	0.416	2.760	**
Study 2b: Small rewards and punishment		Intention to join the DR program							
Experimental manipulation		B	SE	t	p	B	SE	t	p
Constant		4.034	0.178	22.683	***	4.121	0.165	24.900	***
Concerns						-0.338	0.095	-3.567	***
Punishment		0.821	0.253	3.251	***	0.693	0.234	2.962	**
Reward		0.578	0.253	2.285	*	0.398	0.235	1.694	+
Punishment by concern						-0.126	0.139	-0.904	ns
Reward by concern						-0.200	0.133	-1.498	ns
<i>Conditional effects for different concern levels</i>									
<i>low concern-level (-1SD)</i>									
Punishment						0.909	0.342	2.662	**
Reward						0.741	0.332	2.232	*
<i>high concern level (+1SD)</i>									
Punishment						0.477	0.327	1.456	ns
Reward						0.055	0.324	0.169	ns
		Loyalty towards energy provider							
Experimental manipulation		B	SE	t	p	B	SE	t	p
Constant		4.931	0.107	45.942	***	4.935	0.108	45.630	***
Concerns						-0.014	0.062	-0.218	ns
Punishment		0.096	0.152	0.631	ns	0.081	0.153	0.528	ns
Reward		0.157	0.153	1.027	ns	0.142	0.153	0.922	ns
Punishment according to concern						-0.123	0.091	-1.346	ns
Reward according to concern						-0.054	0.087	-0.625	ns

(continued on next page)

Table 3 (continued)

Study 2b: Small rewards and punishment Experimental manipulation	Intention to join the DR program							
	B	SE	t	p	B	SE	t	p
<i>Conditional effects for different concern levels</i>								
<i>low concern level (-1SD)</i>								
Punishment					0.291	0.223	1.304	ns
Reward					0.235	0.217	1.083	ns
<i>high concern level (+1SD)</i>								
Punishment					-0.130	0.214	-0.606	ns
Reward					0.048	0.212	0.227	ns
<i>Fairness perception</i>								
Experimental manipulation	B	SE	t	p	B	SE	t	p
Constant	4.978	0.139	35.814	***	5.052	0.132	38.271	***
Concerns					-0.288	0.075	-3.812	***
Punishment	0.413	0.197	2.091	*	0.306	0.187	1.637	ns
Reward	0.471	0.198	2.379	*	0.347	0.187	1.853	+
Punishment according to concern					-0.084	0.111	-0.752	ns
Reward according to concern					0.004	0.106	0.039	ns
<i>Conditional effects for different concern levels</i>								
<i>low concern-level (-1SD)</i>								
Punishment					0.449	0.272	1.648	ns
Reward					0.340	0.265	1.284	ns
<i>high concern level (+1SD)</i>								
Punishment					0.162	0.261	0.621	ns
Reward					0.354	0.258	1.372	ns

Notes. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$ + $p < 0.1$.

representative sample of the population in Study 2a, monetary incentives and disincentives seem to be much less powerful than observed in Study 1. Nonetheless, the pattern illustrated in Fig. 3 may hint to a slight trend of reward and punishment for consumers, particularly for consumers with a high level of concern, albeit these effects do not reach significance (punishment: $B = 0.596$, $SE = 0.443$, $t = 1.347$, $p = .181$; reward: $B = 0.818$, $SE = 0.503$, $t = 1.626$, $p = .107$).

For small rewards and punishments (Study 2b), on the other hand, we observed an incentive-induced increase in the intention to join the automated DR program. Note that these effects observed for the rather small amount were not contingent on the user's level of concern (interaction effects for punishment: $B = -0.126$, $SE = 0.139$, $t = -0.904$, $p > .05$; reward: $B = -0.200$, $SE = 0.133$, $t = -1.498$, $p > .05$). The average indirect effects suggest that the direct effects of rewards and punishments can be explained by a shift in the focus towards satisfying self over collective interest (Table 3). The conditional effects are presented in Table 4 (Appendix E for the full Study 2a and 2b models). While the reward and punishment were rather ineffective in Study 2a, both types of incentives fostered the participant's intention to join the automated DR program in Study 2b. This can be seen through the highly significant shift from personal to collective benefits (indirect effects for punishment: $IE = 0.200$, $SE = 0.085$, $p < .01$; reward: $B = 0.259$, $SE = 0.093$, $p < .01$). Note, Table 4 also shows the conditional indirect effects, although the index of moderation is not significant, such that the interpretation needs to focus on the average indirect effect.

Additionally, a closer look at the impacts of the incentives and disincentives did not reveal that punishments are more or less effective than rewards of smaller or larger amounts (Studies 1, 2a and 2b: $ps > 0.05$). Also, regarding the possibility of 'backfiring' effects on customer loyalty towards the energy provider or perceptions of fairness, we could not observe significant effects for punishment nor reward ($ps > 0.1$). Note that concerns about the technology were found to reduce perceptions of fairness towards the energy provider in both studies (Study 2a: $B = -0.491$, $SE = 0.116$, $t = -4.237$, $p < .001$; Study 2b: $B = -0.288$, $SE = 0.075$, $t = -3.812$, $p < .001$). This stresses the importance to consider customer concerns in this domain. In one condition, rewards were even able to increase perceptions of fairness for consumers with high concerns when they are big enough (Study 2a: $B = 1.147$, $SE = 0.416$, $t = 2.760$, $p < .01$; Study 2b: $B = 0.354$, $SE = 0.258$, $t = 1.372$, $p > .05$). Overall, and similarly to Study 1, these results of Study 2a and 2b do not

provide evidence to support the existence of marked negative side effects in terms of motivating consumers to join DR-programs. Aside from participation intentions, we did not observe any negative imprint on perceived fairness or loyalty to the provider, regardless of consumer's level of concern. While this lack of negative impact is not surprising for rewards, it is intriguing that punishments—to a certain extent—appear to be accepted, even increasing consumers' intentions to join the automated DR program when they are not too high (i.e., significant effect in Study 2b).

4. Discussion and conclusions

The research was designed to improve our understanding of the different ways to motivate people to take a more active role in the energy industry. More specifically, the research focused on encouraging customers to join DR programs. In Studies 1 and 2b, we found that the two most basic classes of policy instruments — punishment and reward — can be effective tools for increasing involvement and motivating the adoption of automated DR systems. This is a notable observation because conventional wisdom may suggest that negatively-oriented policy instruments produce the opposite effect and punishments generally demotivate consumers. However, we obtained consistent evidence across the three studies that this does not appear to be the case. In none of the studies, involving different populations and different amounts of the incentives, did we observe the negative effects of punishments. It is important to mention that this tool did not differ substantially from the more positively-oriented incentive that can involve considerable costs to energy providers. In addition to adoption intentions, we observed no negative effects on customer loyalty or fairness perceptions. This implies that the threat of punishments, at least in the domain of automated DR programs, may be less imminent than originally thought or even overestimated.

Yet, as suggested by the findings, the effectiveness of rewards and punishments can depend on individual differences. Customers, evidently, vary in the extent to which they hold concerns and doubts regarding DR programs that are implemented and often marketed with environmental purposes. Given that behavior is often more strongly guided by personal (rather than altruistic) motivation, it was the basic premise of this research that economic incentives play a role in shifting attention such that they associate this technological solution with

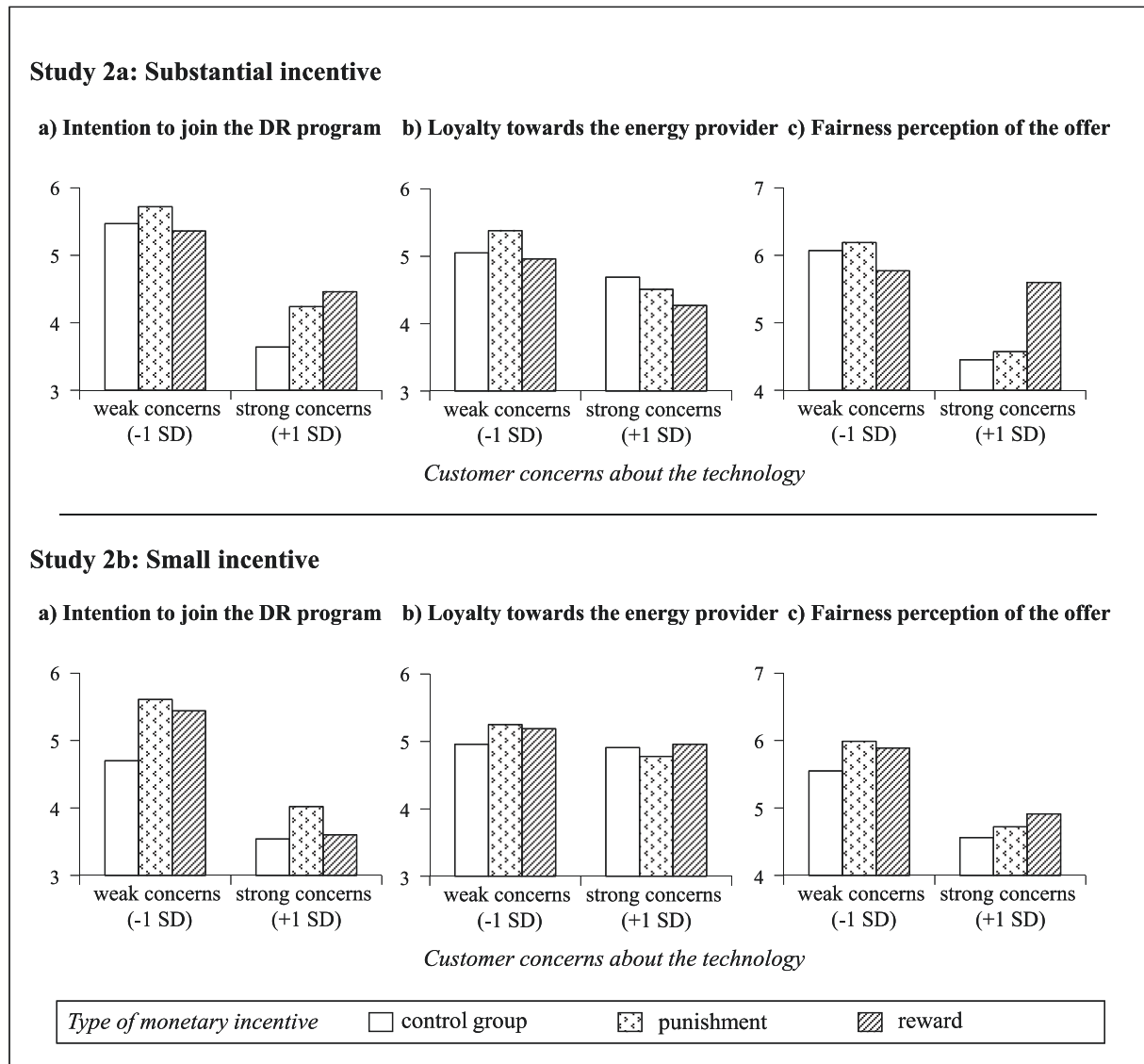


Fig. 3. Means of intention to join, loyalty towards energy provider, and fairness perception across treatments (Studies 2a and 2b).

greater personal over collective benefit. In Study 1, we found evidence of this incentive-induced shift; consumers perceived increasing personal benefits of DR programs compared to collective benefit. That is, the economic incentives made them to interpret automated DR programs more strongly in terms of personal benefit and less in terms of collective benefits. This applied particularly to customers with significant concerns or doubts about this technology. More concerned consumers perceive greater personal costs (which is what makes them concerned) and these greater personal costs can be balanced by personal benefits. Such balancing is not needed and, hence, less likely to occur for less concerned consumers. Likewise in Study 2b, we observed that this shift towards perceiving greater personal over collective benefits explains the effects of rewards and punishments on customer's adoption intentions.

Note, when comparing the studies using a representative sample of the relevant population (Studies 2a and 2b), only small rewards and punishments proved effective. The results may suggest that economic incentives and disincentives affect behavioral intention when they are small, rather than large (Study 2a vs 2b). It is possible that smaller incentives are generally perceived to be less controlling [48], and are therefore more effective at crowding in intrinsic motivation due to their potential to signal social norms and their expressive function [24,40,54,61]. We propose that the small incentives and disincentives

employed in our studies did not modify behavioral intentions due to a shift towards economic reasoning, which has been shown to decrease feelings of moral responsibility [46,48]. Considering the mixed evidence on the amount of economic (dis)incentives in our research, we call for further studies on the matter. Nevertheless, with the incentive-induced shift in perceptions of personal and collective benefits, this investigation allowed to shed some light into the mechanism by which they operate. In this regard, it is a very interesting finding that both rewards and punishment — albeit conceptually very different — were found to raise customer's perception of personal over collective benefit. Also, the observed differences for the various samples in this research highlight that the economic incentives and disincentives can be differently effective in the marketing of environmentally-friendly technologies and encouraging sustainability innovations involving customers. We collected data from very diverse samples (students, representative for the population) that principally vary in age, shared values as well as living situation and financial status, among others. Nonetheless, even in the general population, we did not observe a boomerang effect of economic disincentives that appears to prevent some providers from adopting this tool.

Table 4

Conditional indirect effects of reward and punishment for Study 2a and Study 2b.

Effect of reward and punishment on joining automated DR programs operating through self-(vs. collective) interest						
	Punishment		Reward			
	IE	SE	BS	IE	SE	BS
Substantial monetary incentive (Study 2a)						
Average indirect effect	0.031	0.083		0.052	0.083	
Concerns about automated DR programs						
Weak concern	0.029	(0.091)		0.028	(0.065)	
Moderate concern	0.022	(0.054)		0.020	(0.051)	
Significant concern	0.014	(0.102)		0.013	(0.077)	
Index of moderated mediation	-0.004	0.049		-0.005	0.030	
	Punishment		Reward			
	IE	SE	BS	IE	SE	BS
Small monetary incentive (Study 2b)						
Average indirect effect	0.200	0.085	**	0.259	0.093	**
Concerns about automated DR programs						
Weak concern	0.135	(0.090)	+	0.195	(0.103)	*
Moderate concern	0.166	(0.074)	*	0.216	(0.082)	*
Significant concern	0.197	(0.105)	*	0.236	(0.126)	+
Index of moderated mediation	0.018	0.037		0.012	(0.046)	

Notes. IE... indirect effect, SE... standard error of 95%-confidence interval (CI), BS... bootstrapping (10,000 samples), * 95%-CI \neq 0, + 90%-CI \neq 0. Conditional indirect effects are just presented for informative reasons.

4.1. Managerial implications

Building on our findings, we advise policy makers and practitioners as well as researchers to take into account the use of both rewards and punishments when considering the most effective design for incentive schemes. Our results indicate that negative side effects of punishments might be less of a threat than originally thought, at least in the context of automated DR programs. We find that punishments are as effective as rewards in terms of increasing behavioral intentions, and appear to not jeopardize customer loyalty. While the initial costs of the implementation of sanction-related schemes may be higher because of the substantially greater communication efforts needed to prevent negative media coverage and strong reactance, punishment as a policy instrument is more cost efficient in the long run [7,42,95]. Punishment-based programs are not associated with variable costs as these do not increase or decrease with the number of individuals who comply with them. By contrast, the cost of reward schemes increases substantially when more individuals perform the rewarded behavior. Consequently, maintaining a punishment-based incentive structure may be easier and more cost efficient in the long run. The latter might also be found preferable for use in innovation processes with customers because they regulate free-riding [48,61,96]. Nevertheless, it cannot be stressed enough that ethical issues that may arise should be considered. For this reason, the results of the research described herein should not be considered to apply to products or services that are of critical importance to humans (e.g., health services) and/or situations in which the use of punishment would contradict ethical principles (e.g., would discriminate against specific groups of customers).

4.2. Limitations and avenues for further research

Although we conducted a series of studies involving experimental manipulations of rewards and punishments, we acknowledge that the experimental design did not involve observations of real behavior. We therefore welcome further research that could complement our experimental approach, such as investigations of how forms of punishment are employed and communicated (e.g., as taxes, fees, fines, or service costs) [97]. An improved future study of behavior could also involve other

types of models [98]. Further, of great interest is to gain understanding about any potential spillover effects. This would provide answers to questions such as: Do monetary sanctions trigger or inhibit spillover effects on non-intended behaviors? If punishments communicate a social norm and rewards do not, is it plausible that disincentives are more effective at increasing positive behavioral-reaction-related spillovers? [99,100]. In addition, who should introduce the incentive schemes, and should these actors be different in the case of the introduction of punishment and reward schemes [23,70]? What precise theory explains and predicts more narrowly the effects of different types of incentives? Our research made use of a scenario-based technique, which should be extended to other techniques and sampling methods. For example, it is possible that the lack of meaningful effects on loyalty is due to the nature of the method or the sample that was obtained (e.g., some participants might not have a relationship with an energy provider because of their current living situation, such as students residing in certain housing arrangements that often include electricity flat-rates as part of the rent). Finally, and of special interest to the energy sector, future research should test the sensitivity of our results with regard to different designs of DR programs, such as DR programs in which customers react to signals (e.g., text messages) by personally switching an appliance on or off, which requires greater effort.

Declaration of Competing Interest

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

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Appendix A. – Study materials

Translated from German

Introduction and description of demand response program

With “Energiewende”, the Swiss government aims at making possible a sustainable and secure energy supply from renewable energy sources in the future. One way to reach this goal is to introduce programs that balance the demand and supply of renewable energy. Such programs rely on flexibility with the energy consumption of consumers (Demand-Response). For example, such programs would allow for excess solar energy in the grid to be used, or prevent energy shortages at different times of the day (e.g. running the dishwasher only at times when there is enough energy available from renewable energy sources). For such programs to work, consumers would need to allow their energy provider to control their appliances.

A scenario for such an energy consumption flexibility program is described below:

Please imagine that your current energy provider wants to introduce this program. Think about how you would react as a customer in a liberalized energy market (meaning that you can easily and at any time change your energy provider).

Your energy provider will introduce a program to improve the flexibility of energy consumption next year: the FLEX-Program. This program will allow you to use electricity from renewable resources more efficiently.

What does this mean for you?

Your dishwasher will be equipped (free of charge) with a WLAN signal receiver to allow the automatic control of the device⁵. If you switch on your dishwasher, it may be that the washing program will not start immediately. Depending on whether there is enough electricity from renewable sources available in the grid, your energy provider will send a signal to a smart meter to automatically start your dishwasher's washing program. Through this automatic steering process it may take longer until your dishes are clean. However, it will be guaranteed that the washing program will automatically be started within 6 h, so that it does not take >8 h for your dishes to be cleaned. Twice per month you will have the opportunity to start your washing program independently – and thus prevent the automatic control of your dishwasher – by pushing a button on a mobile app, on an online portal, or by pushing a button on the dishwasher (Fig. A1).

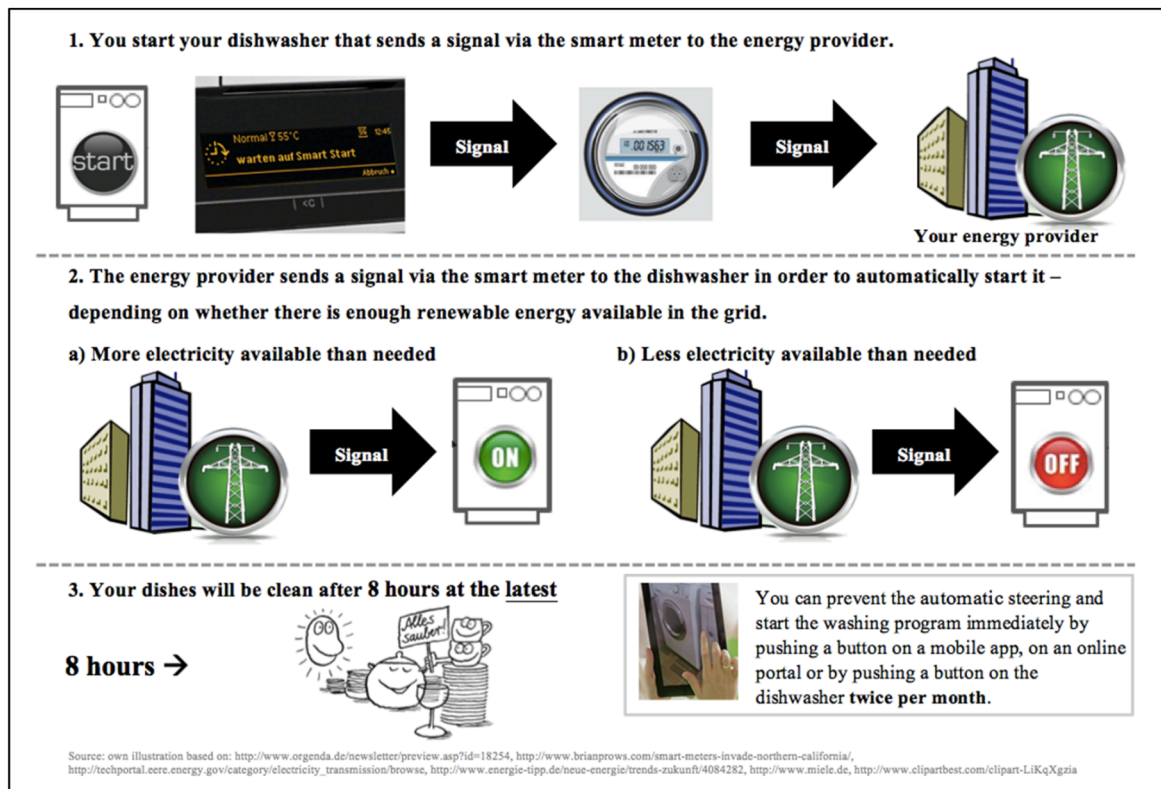


Fig. A1. Illustration. Note. In Study 2a, the DR program did not allow the subject to override the signal from the energy provider and manually operate the dishwasher. Thus, the DR program in Study 2a was slightly more controlling than the one described in Study 1.

⁵ The automatic steering process via WLAN was developed in cooperation with manufacturers and will not affect the proper operating mode and lifetime of your device.

Appendix B. – Experimental manipulations

You now can decide whether you wish to participate in the FLEX-Program or not.

Control group: /

Reward Group: If you join the FLEX-Program and allow your dishwasher to be steered automatically by your energy provider, you will **receive** a **discount** of 50 CHF per month on your electricity bill.

Punishment Group: If you join the FLEX-Program and allow your dishwasher to be steered automatically by your energy provider, you can **prevent** an **additional fee** of 50 CHF per month on your electricity bill.

Appendix C. – Full moderated mediation Models: Study 1

	Ratio of personal benefit to collective benefit (mediator)			
	B	SE	t-value	p
Constant	0.671	0.046	14.435	***
Punishment	0.239	0.065	3.652	***
Concern	-0.034	0.033	-1.003	ns
Punishment by concern	0.097	0.044	2.224	*
Reward	0.194	0.065	2.973	**
Reward by concern	0.065	0.045	1.457	ns
Intention to join DR program (dependent variable)				
$R^2 = 0.29, F(6, 143) = 9.85, p < .001$				
	B	SE	t-value	p
Constant	3.447	0.301	11.434	***
Punishment	0.729	0.284	2.572	*
Reward	0.301	0.278	1.082	ns
Ratio of personal benefit to collective benefit	1.386	0.346	4.011	***
Concern	-0.611	0.137	-4.475	***
Punishment by concern	0.368	0.184	1.996	*
Reward by concern	0.353	0.187	1.883	+

Notes. *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$ + $p \leq 0.1$.

Appendix D. – Demographic data: Studies 2a & 2b

	Study 2a	Study 2b
Gender*	47.1% Male, 52.9% Female	43.8% Male, 55.1% Female; Missing: 1.1%
Age	3.4% below 20 years; 31.1% between 20 and 30; 17.6% between 31 and 40; 20.2% between 41 and 50; 23.5% between 51 and 65; 4.2% above 65 years	2.8% below 20 years; 20.7% between 20 and 30; 21.6% between 31 and 40; 22.2% between 41 and 50; 28.4% between 51 and 65; 4.3% above 65 years
Place of residence	41.2% city; 57.1% countryside 1.7% missing	41.2% city; 58% countryside 0.8% missing
Renting vs. home-ownership	62.2% rent; 37% home-ownership; 0.8% missing	63.9% rent; 35% home-ownership; 1.1% missing
Household size	24.4% 1 person household 38.6% 2 person household 11.8% 3 person household 24.4% 4 or more person-household 0.8% missing	22.2% 1 person household 34.6% 2 person household 19% 3 person household 22.2% 4 or more person-household 2% missing
Highest level of education	0.8% primary school 5.9% some high-school 56.3% professional school 14.3% high-school degree 17.6% university 5.1% other	1.7% primary school 2.5% some high-school 50.9% professional school 9.4% high-school degree 30.1% university 5.4% other
Monthly net-income	32.8% below 5,000 CHF 49.6% 5,001–10,000 CHF 6.7% 10,001–15,000 CHF 4.2% 15,001–20,000 CHF 4.2% above 20,000 CHF 2.5% missing	28.4% below 5,000 CHF 46% 5,001–10,000 CHF 15.3% 10,001–15,000 CHF 3.7% 15,001–20,000 CHF 4.3% above 20,000 CHF 2.3% missing

Appendix E. – Full moderated mediation Models: Studies 2a & 2b

	Ratio of personal benefit to collective benefit (mediator)							
	Study 2a $R^2 = 0.03$, $F(5, 113) = 0.72$, $p > .1$				Study 2b $R^2 = 0.05$, $F(5, 346) = 3.37$, $p < .01$			
	B	SE	t-value	p	B	SE	t-value	p
Constant	0.860	0.037	40.720	***	0.769	0.024	32.146	***
Concern	-0.017	0.022	-0.802	ns	-0.019	0.014	-1.394	ns
Punishment	0.032	0.053	0.614	ns	0.085	0.034	2.520	*
Punishment by concern	-0.007	0.032	-0.203	ns	0.009	0.014	0.464	ns
Reward	0.030	0.053	0.576	ns	0.111	0.034	3.263	***
Reward by concern	-0.007	0.031	-0.224	ns	0.005	0.015	0.312	ns

	Intention to join the DR program (dependent variable)							
	Study 2a $R^2 = 0.22$, $F(6, 112) = 5.34$, $p < .001$				Study 2b $R^2 = 0.12$, $F(4, 347) = 11.80$, $p < .001$			
	B	SE	t-value	p	B	SE	t-value	p
Constant	3.977	0.575	6.916	***	2.624	0.318	8.265	***
Concern	-0.542	0.140	-3.862	***	-0.300	0.091	-3.294	***
Ratio self-to-collective interest	0.672	0.608	1.105	ns	1.944	0.357	5.444	***
Punishment	0.401	0.342	1.172	ns	0.527	0.227	2.323	*
Punishment by concern	0.110	0.210	0.524	ns	-0.144	0.134	-1.076	ns
Reward (control)	0.332	0.342	0.971	ns	0.182	0.229	0.796	ns
Reward by concern (control)	0.287	0.203	1.410	ns	-0.212	0.128	1.650	+

Notes. *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$; + $p \leq 0.1$.

Appendix F. – Wording of the measurements

Construct	Items
<i>Intention to join the DR program</i>	How likely are you to join the Flex program? How inclined are you to join the FLEX-program? How willing are you to join the FLEX-program?
<i>Loyalty towards the energy provider</i>	I will be a customer of my energy provider in the future. The chances of me staying with my energy provider are very high. The probability that I will try other energy services and products from my energy provider is very high. If someone asks me, I will speak positively of my energy provider. I would recommend my energy provider to a friend.
<i>Personal benefit</i>	I personally benefit if I join the FLEX-Program.
<i>Collective benefit</i>	Through joining the FLEX-Program, I create benefit for society. Joining the FLEX-Program is good for the environment.
<i>Concerns regarding the automated DR programs</i>	To what extent do you fear the following when thinking about joining the FLEX program? I will lose control over my household appliances. I cannot control what happens to my consumption data, and I am afraid that my consumption data will be abused.
<i>Perceived fairness of the offer to join the DR program</i>	Unfair—fair Wrong—right Unreasonable—reasonable

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