What is missing in research on non-monetary incentives in the household energy sector?

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Abstract

Based on current research, the impact of non-monetary incentives on energy consumption and green-energy uptake in the household sector remains unclear. Studies often only provide tests for combinations of measures and consider short time intervals. We provide a systematic survey of the literature, point to several shortcomings in existing published studies and make recommendations for future research aiming to inform policy and other decision makers.

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1. Introduction

Non-monetary incentives are an important tool in the transition towards a sustainable energy system. It seems to be a well-established fact that such incentives can complement monetary incentives to reduce energy consumption and to increase green energy uptake (Abrahamse and Steg, 2013; Allcott and Mullainathan, 2010; Asensio and Delmas, 2015; Ebeling and Lotz, 2015). Non-monetary incentives are often related to the concept of "nudges" (Thaler and Sunstein, 2009), defined by Sunstein as "liberty-preserving approaches that steer people in particular directions, but that also allow them to go their own way" (Sunstein, 2014, p. 583). By now, many countries in the global North and South such as the U.S., UK, India, Peru, Singapore as well as supra-national institutions such as EU, UN, World Bank established so-called behavioural insight units exploring the applicability of nudges to support policy goals in various areas including health, education, and energy (World Bank 2015). Some nudges and corresponding non-monetary incentives function well because they are built on general behavioural tendencies of humans, such as status-quo bias and loss aversion. Such non-monetary incentives seem to be low-cost, easy-to-implement and therefore an effective contribution to combating resource overuse and climate change.

How effective are non-monetary incentives in the household energy sector? We found a great variety of measures in the literature, ranging from social norms or symbolic rewards to feedback giving and information on behavioural consequences. A report by Sunstein (2014) quotes "ten important nudges," among them default settings and social norms atop the list. But how should policy and other decision makers decide when implementing an energy reduction plan? Certainly, relative cost-effectiveness comparing nudges and traditional policy instruments such as financial incentives is a very important criterion (Benartzi et al., 2017). But at least equally relevant is the effectiveness of a measure to reduce actual energy consumption in the first place. In this regard, not all non-monetary incentives are equally effective and some may turn out to be non-effective at all. Some incentives may be effective in other domains, mitigating e.g. food waste, calorie intake or risky driving but they may not be effective in the

household energy sector. As Sunstein (2014, p. 585) claims "empirical tests, including randomized controlled trials, are indispensable."

An ideal study carried out to answer the question of the effect of non-monetary incentives on household energy reduction would use a randomized experimental design and aim at estimating the causal effect of a particular non-monetary incentive on the specific energy-related behaviour under consideration (Shadish et al., 2001). Researchers would conduct the experiment in such a way that subjects are not aware of taking part in a research study. An ideal study would further be conducted over a long timespan, and (next to the target behaviour) it would measure behavioural changes in other energy-related domains. It would also consider different socioeconomic, regional or country contexts.

Using a covert research design does prevent experimenter demand effects (Zizzo, 2010) – in other words, potentially biased results due to the presence of a researcher. Moreover, there is the risk of a "Hawthorne effect" that attention alone, i.e. being part of a research study, may account for a decrease of household's energy consumption (Schwartz et al., 2013). Taking longer timespans into account is necessary to find out how effective incentives are over time. Further, considering different domains of behaviour allows testing of rebound effects or moral licensing (Gillingham et al., 2013; Greening et al., 2000; Khan and Dhar, 2006). Individuals and households might increase energy consumption in one domain due to energy-saving behaviour in another domain, where the latter was caused by a non-monetary incentive. Analysing the effects of non-monetary incentives across socioeconomic contexts, regions and countries indicates the external validity of study results. Since climate change, energy-saving behaviour and renewable energy production are global issues and there also exists remarkable heterogeneity within countries, it seems desirable to know to what extent non-monetary incentives work in different cultural, regional and socioeconomic contexts.

2. Quantitative review data

It is clear that ideal studies fulfilling all these criteria are hard to find. To shed light on the actual state of knowledge, we conducted a quantitative review of the literature about the effectiveness of non-monetary incentives in the household energy sector. We carried out a literature search based on databases (Web of Science, Google Scholar, etc.), various journals *(Journal of Environmental Psychology*, *Energy Policy*, etc.), and reference lists of papers. Search keywords included (combinations of) the terms nudge, nudging, green nudges, energy, electricity, social norm, default, feedback, and information. We only considered (quasi-)experimental studies dealing with effects of non-monetary incentives/nudges on energy consumption and choice of energy source mix. This means that all studies under consideration make use of the advantages of an experimental design. With one exception, we limited the search to papers published in English and included all papers without constraints regarding year of publication. We thus focus on crucial methodological aspects and important research needs.

3. Results

Almost half of the treatments fail to single out the effect of a particular incentive

We found 40 papers, mainly published after 2012 (n = 30, 75%). These papers reported on 45 studies, of which 42% used fully randomized experimental designs, and 45% used quasi-experimental designs where random assignment of subjects or households was not possible. Fewer studies relied on survey experiments such as stated choice experiments (11%) and other methods, such as an online tool (2%). While fully randomized experimental designs might be preferable, quasi-experimental studies are also able to separate effects of different incentives on energy-related behaviour.

The scale of the studies varied remarkably. Sample sizes ranged between n = 37 and n = 2,516,089 individuals or households; the median sample size amounted to n = 431 individuals/households.

The 45 studies we reviewed included 67 treatment groups, not counting control groups (see Table 1, and suppl. material for more information on studies and incentives). It turns out that information

treatments, feedback mechanisms and descriptive as well as injunctive social norm treatments have been tested considerably more often than incentives such as social competition, default rules, framing, and symbolic rewards. Looking at studies that tested one incentive per treatment, we found that the feedback mechanism and descriptive social norms were tested most often, followed by default rules and information.

Of 67 treatments, 37 tested one non-monetary incentive as a stimulus, and 30 combined at least two incentives (with a total of 72 non-monetary incentives as part of multiple incentives treatments). Therefore, in almost half of the treatments it was not possible to separate the effects of non-monetary incentives because they combined different incentives in the treatment condition. For example, providing subjects at the same time with feedback and descriptive norm information may result in a decrease in electricity consumption. While such integrated approaches – programs combining multiple incentives – can provide very valuable insights (Banerjee et al., 2015), it is not clear in a strict sense whether this effect is due to the feedback, the descriptive norm or the combination of both incentives. Regarding treatments testing one incentive, i.e. no combination of incentives in a single treatment, Table 1 shows in the last column the proportion of treatments that (according to the studies' authors) showed a statistically significant effect on the outcome at hand. A striking insight is that all studies testing default rules revealed a significant effect. Descriptive norms worked out in two thirds of the treatments, and other non-monetary incentives seemed to work in half of the treatments. While it is difficult to conclude which non-monetary incentive is especially effective for specific behavioural domains (see also Elberg Nielsen et al. 2016), it is noteworthy that the studies testing default rules mainly investigate green electricity uptake and that descriptive norm studies with significant positive effects mainly refer to electricity saving. However, when interpreting the values in Table 1, the low absolute number of treatments has to be borne in mind.

Table 1. Overview of type of non-monetary incentive and the number of studies testing one or more incentives

Incentive/nudging type	n, combined incentives	n, one incentive only	Share sign. pos. effect
Information	19	4	2/4
Descriptive social norm	14	9	6/9
Feedback	13	9	3/7[#]
Injunctive norm	13	–	–
Social competition	6	–	–
Goal setting	4	–	–
Moral suasion	2	2	1/2
Default rules	1	5	5/5
Framing	–	2	1/2
Priming	–	1	0/1
Mental accounting	–	1	0/1
Off-setting	–	1	0/1
Decoy choice	–	1	0/1
Symbolic rewards	–	1	1/1
Indirect information	–	1	1/1
TOTAL n	**72**	**37**	

Note: Share sign. pos. effect refers to treatments testing one incentive for which the studies' authors report a statistically significant difference at least at the 5%-level. [#] We count seven studies because two out of nine studies had no control group for the feedback treatment. In these two studies, the feedback treatment was designed as control group.

Furthermore, 60% of the studies employed an overt research approach, in which subjects were aware of being part of a research study or experiment; the remaining 40% used a covert approach. Overt studies are prone to experimenter-demand effects (Zizzo, 2010) and the possibility that a respondent's awareness of taking part in a research studies affected the results cannot be ruled out. A noteworthy, randomized controlled study by Schwartz et al. (2013) found an energy reduction "effect" of 2.7% simply by informing customers that they take part in a study on energy use. After the "intervention" households adjusted to the pretreatment consumption level. It therefore seems important to investigate a potential bias in this regard.

Reported effects might be prone to a cultural bias

Of the studies reported in the 40 papers, 45% were conducted in the US. Considerably fewer studies were carried out in Germany (n = 4), the UK (n = 4) and the Netherlands (n = 2). Compared to the US (n = 18) and Western European countries (n = 17), overall fewer studies were found for Asia (n = 5), and none for Africa and South America. Thus, the overwhelming majority of studies were bound to Western culture.

Given the limited geographical coverage of current research, results might be prone to a cultural bias. While survey research shows that green nudges are accepted by citizens in the US and many European countries (Reisch and Sunstein, 2016; Sunstein, 2016), it cannot be ruled out *a priori* that, like cultural differences related to social norms, cooperation and punishment (e.g., Gächter and Herrmann, 2009), cross-country differences exist regarding the effects of descriptive and injunctive norms as well as default options in the energy sector.

Most studies do not consider temporal stability and rebound effects

One of the most crucial questions is whether effects of non-monetary incentives are stable over time (Abrahamse and Steg, 2013). However, most studies only cover effects over a couple of weeks. There are indications that effects of non-monetary incentives get considerable weaker over time (Agha-Hossein et al., 2014; Brandon et al., 2017; Haakana et al., 1997; Schultz et al., 2015; van Dam et al., 2010) and it is therefore important to take longer timespans into account.

It has been supposed that rebound effects and moral licensing can outweigh the benefits of non-monetary incentives (Gillingham et al., 2013; Greening et al., 2000; Khan and Dhar, 2006). Whether consciously or unconsciously, subjects might perceive higher energy consumption levels legitimate given their prior green choices. For example, Tiefenbeck et al. (2013) found an increase of 5.6% in electricity consumption following a decrease in water consumption by 6% caused by feedback on water usage. However, such studies have been conducted in insufficient numbers; this indicates a clear research need to evaluate the effectiveness of non-monetary incentives.

4. Where to go from here

Based on the current state of knowledge, it is hard to tell how effective non-monetary incentives and green nudges are. This is not only a question of the number and scope of studies, or of how research results are presented; it is also due to limitations in experimental design and study set-up. In the following, we would like to point out some needs and recommendations for future research (see Table 2).

Table 2. Overview of research needs and recommendations

Methodological aspect	State of knowledge	Research needs / recommendations
Estimating the causal effect of a non-monetary incentive	45% of treatments combine two or more incentives	Conducting research to single out effects of a particular incentive
Considering the external validity of findings	Most studies conducted in U.S. (45%) and Western Europe (43%)	Increasing applications in other country contexts, especially outside the US and Europe
Avoiding biased results due to experimenter demand effects	60% use an overt approach	Conducting more covert studies and studies on experimenter demand effects
Investigating the stability of effects over time	Most studies cover a couple of weeks	Increasing the number of long-term studies
Estimating rebound effects and moral licensing	Hardly any study takes potential rebound effects and moral licensing into account	Considering other domains of energy-related behaviours in addition to the target behaviour

We recommend that future research aims to separate the effectiveness of specific incentives and to compare single incentives with combinations of incentives. Furthermore, large-scale field experiments that have high external validity can be complemented by laboratory experiments that have high internal validity (e.g., Ghesla, 2017). The latter help to uncover the cognitive mechanisms of *why* individuals react to non-monetary incentives. Regarding the measurement of the effectiveness of non-monetary incentives, Benartzi et al. (2018) suggest that studies should calculate and report the relative effectiveness of interventions in terms of money spent for each kWh of electricity saved. This also helps to compare the effectiveness of non-monetary incentives and traditional policy measures as a policy tool.

More research is needed in countries other than the U.S., Germany and the UK. This is worthwhile and necessary, also in the light of the growing importance of non-monetary incentives in development policy (World Bank 2015). It is important to stress that cultural differences between countries such as values and norms are only one aspect that might be crucial for transferring research results from one context to another. Other factors include legal structures, market structures, and price conditions.

Knowledge on the validity and reliability of research findings can be improved by taking experimenter demand effects, temporal stability and rebound effects into account. An additional aspect could be to analyse who is carrying out the research in terms of subject area, private or public sector organizations, etc. and how this might affect research results (see Schmidt, 2017). While from a scientific point of view conducting covert studies is preferable to overt studies, this also has to be evaluated against ethical criteria such as informed consent as well as new data protection laws in Europe. Another aspect, facilitating the evaluation of effects of non-monetary incentives, is the need to apply existing standards on reporting experimental results (Abrahamse and Steg, 2013). These standards regarding treatment effects include "direction, magnitude, degrees of freedom and exact p level, even if no significant effect is reported" (American Psychological Association, 2009, p. 248).

Further, similar to other research areas, research on non-monetary incentives might be prone to a publication bias. This would be the case if the publication of a study depends on the direction and significance of its findings (Dickersin, 1990). For example, there might be a tendency to publish positive results and to not consider negative ones. While there exist statistical methods to adjust for publication bias in meta-analyses, a simple prevention would be that all researchers have to register their studies before conducting them (Rothstein et al., 2005).

Research taking these needs and recommendations into consideration will provide a better understanding of the exact benefits of non-monetary incentives in the household energy sector, which can then inform (political) decision-making. Finally, but no less importantly, there is the highly debated issue of distorted preferences or the unethical use of non-monetary incentives by private companies or state authorities. Although the energy sector may be less prone to manipulation, in general there remains the problem of possible misuse, particularly with nudges targeting

unconscious/automatic processes. This problem certainly deserves more attention (Hausman and Welch, 2010; Schubert, 2017).

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Supplementary material

Table S1. Description of non-monetary incentives

Incentive/nudging type	Description
Feedback	Real-time energy usage feedback in kWh (e.g. Smart Metering studies, Degen et al., 2013 Eco-driving behaviour studies). (Dogan et al., 2014)
Information	Energy information labels (Newell and Siikamäki, 2013) (with CO2 comparison and/or money comparison) or energy counselling (Degen et al., 2013) or energy-saving tips (common and/or personalized) (for an overview see Abrahamse et al., 2005; Fischer, 2008).
Descriptive social norm	Communicating a descriptive social norm – that is, what the majority actually does. Feedback of energy usage and comparison to a similar household (similarity based on geography proximity or usage composition), combined with energy usage feedback in kWh. (Allcott, 2011; Cialdini and Goldstein, 2004)
Injunctive norm	Communicating an injunctive norm – that is, what ought to be done. Combined with a descriptive social norm and administered to combat descriptive norm boomerang effect. (Allcott, 2011)
Social competition	Feedback in form of household energy usage in kWh in comparison to a similar household. Comparing competing household's energy usages where the lowest energy usage wins.
Default rules	Giving a standard choice concerning energy package or energy usage that is activated if consumer does not make an effort to communicate another choice. (Ebeling and Lotz, 2015; Egebark and Ekström, 2016; Johnson and Goldstein, 2004; Pichert and Katsikopoulos, 2008)
Moral suasion	Moral suasion for collective environmental responsibility or collective responsibility against future generations. Moral suasion in form of an appeal to action, e.g. "Lights out!".
Goal setting	Setting a prior household energy usage goal with a post measurement to compare if goal was reached.
Framing	Influencing the decision outcome by over-emphasizing certain information of a decision frame. One identical decision can be framed in different ways through emphasizing the possible losses or wins of the decision outcome. (Michalek et al; Sunstein, 2011; Tversky and Kahneman, 1981)
Priming	Influencing the decision outcome by presenting a stimulus prior to decision making. (DeLamater, 2014; Lindenberg and Steg, 2007; Michalek et al.)
Mental accounting	Prior re-filling of ethical mental account of participants to favour the decision of green energy uptake. (Momsen and Stoerk, 2014; Thaler, 1999)
Off-setting	Consumers had the possibility to off-set part of their household energy usage (could be described as a nudge that promotes more energy usage instead of lowering it).
Decoy choice	Adding another choice option that brings consumer no gain but adds noise to the choice by irritating consumer with a greater number of choice possibilities.
Symbolic rewards on community level	Non-monetary rewards for lowest energy usage on the community level (for example, media attention and/or an award).
Indirect information	Educating schoolchildren with energy tips thus indirectly nudging parents with energy tips to reduce their household energy usage.

Note: References refer to the reference list in the main text.

Table S2. Number of studies per country

Country	n	%
US	18	45
Germany	4	10
UK	4	10
Netherlands	2	5
Switzerland	2	5
Japan	2	5
Sweden	2	5
Austria	2	5
Finland	1	2.5
Israel	1	2.5
South Korea	1	2.5
Singapore	1	2.5
TOTAL	**40**	**100**

Table S3. Methods

Method	Number	Percent
Experiments = treatment and control group(s), with randomization		**42 %**
Experiment	4	
Control trial	3	
Field experiment	7	
Natural field experiment	2	
Laboratory experiment	3	
Quasi-experiment = treatment and control group(s), without randomization		**45 %**
Field experiment	13	
Natural (field) experiment	5	
Online experiment	1	
Virtual environment experiment	1	
Survey experiment		**11 %**
Online survey	2	
Online choice experiment	2	
Paper survey	1	
Other		**2 %**
Online website	1	
TOTAL	**45**	**100 %**

Note: We report results for n = 45 studies in 40 papers, where four papers include different studies and methodologies.

Table S4. Overview on number of treatment groups for each paper (not counting control groups)

Number of papers	Number of treatments per paper
25 papers	1 treatment group
8 papers	2 treatment groups
4 papers	3 treatment groups
2 papers	4 treatment groups
1 paper	6 treatment groups
TOTAL PAPERS 40	**TOTAL TREATMENTS 67**

Notes: N = 40 papers; N = 67 treatment groups (control groups not counted. Treatment group definition = one or more non-monetary incentives/nudges applied).

Table S5. Combinations of incentives in multiple-incentive treatments

Nudge combination	Number
Feedback + Information	4
Feedback + Information + Goal setting	1
Feedback + Social competition	2
Feedback + Social competition + Injunctive norm	1
Feedback + Social competition + Monetary incentive	1
Feedback + Social competition + Moral suasion	1
Feedback + Monetary incentive	1
Feedback + Injunctive norm	1
Descriptive social norm + Information	5
Descriptive social norm + Injunctive norm	2
Descriptive social norm + Information + Injunctive norm	6
Descriptive social norm + Information + Injunctive norm + Social competition	1
Goal setting + Default rules	1
Goal setting + Feedback + Injunctive norm + Information	1
Goal setting + Information	1
Moral suasion + Injunctive norm	1
TOTAL TREATMENTS	**30**

Note: For the sake of completeness, monetary incentives are listed here as they are combined with non-monetary incentives, but are not counted towards the number of all non-monetary incentives.

Table S6. Overview of sample size

Descriptive statistics								
	N studies	Mean	Standard deviation	Minimum	Maximum	25.	Percentiles 50. (Median)	75.
Sample Size	45	80,752.02	383,727.3	37	2,516,089	189	431	1,669

Note: Where one study involved more than one sample, the biggest sample size was taken.

Table S7. Overview of studies considered in the quantitative review

Paper title	Authors	Year	Topic	(Number treatment group) Interventions	Country	Sample size	Method	Covert or overt	Key findings
Promoting energy conservation in master-metered apartments through group financial incentives	McCelland, L.; Cook, S. W.	1980	Energy saving (gas) in the household	(1) Feedback + Information	U.S. (campus housing)	101	Field experiment	Covert	The nudging combination of feedback plus information lead to 12% energy savings
The effect of feedback and focused advice on household energy consumption	Haakana, M; Sillanpää, L.; Talsi, M.	1997	Energy saving (water, heat, electricity)	(1) Feedback + Information as video; (2) Feedback + Information in writing; (3) Feedback	Finland	105	Randomized field experiment	Overt	Feedback as single nudge had a positive but not significant effect during a short period of time
The constructive, destructive, and reconstructive power of social norms	Schultz, P. W.; Nolan, J. M.; Cialdini, R. B.; Goldstein, N. J.; Griskevicius, V.	2007	Electricity saving in the household	(1) Descriptive social norm + Information; (2) Descriptive social norm + Information + Injunctive norm	U.S.	290	Field experiment	Overt	The nudge of descriptive feedback shows a boomerang effect that reduces energy usage for over-average consumption households and increases consumption for less than average consumption households
The effect of tailored information, goal setting, and tailored feedback on household energy use, energy-related behaviors, and behavioral antecedents	Abrahamse, W.; Steg, L.; Vlek, C.; Rothengatter, T.	2007	Reducing direct and indirect energy use with an internet based tool	(1) Feedback + Information + Goal setting	Netherlands	189	Randomized experiment	Overt	The nudging combination of feedback plus goal setting plus tailored information lead to 5.1% energy savings (in comparison to control group)

Paper title	Authors	Year	Topic	(Number treatment group) Interventions	Country	Sample size	Method	Covert or overt	Key findings
Green defaults: Information presentation and pro-environmental behavior	Pichert, D.; Katsikopoulos, K. V.	2008	Green electricity uptake	(1) Default rules	Germany	Study 1: 1,669; study 2: 150,000; study 3: 225; study 4: 88	Study 1: natural experiment; study 2: natural experiment; study 3: randomized laboratory experiment; study 4: randomized laboratory experiment	Study 1: covert ; study 2: covert; study 3: overt; study 4: overt	Changing the grey default by establishing a green default or just by implementing a neutral choice situation results in significant higher percentage in customers choosing green electricity
Normative Social Influence is Underdetected	Nolan, J. M.; Schultz, P. W.; Cialdini, R. B.; Goldstein, N. J.; Griskevicius, V.	2008	Electricity saving in the household	(1) Descriptive social norm + Information; (2) Information; (3) Moral suasion	U.S.	371	Randomized experiment	Overt	Only the nudging combination of descriptive social norm plus information had a positive and significant effect
Response-relapse patterns of building occupant electricity consumption following exposure to personal, contextualized and occupant peer network utilization data	Peschiera, G.; Taylor, J. E.; Siegel, J. A.	2010	Electricity saving in the houshold with home energy monitors	(1) Feedback; (2) Feedback + Social competition	U.S. (campus housing)	37	Randomized field experiment	Overt	The only group that significantly reduced their electricity use when compared to the control group was the study group that could view peer network utilization. Feedback was not significant
Social norms and energy conservation	Allcott, H.	2011	Electricity saving in the household	(1) Descriptive social norm + Information	U.S.	600,000	Natural experiment	Covert	Energy-savings of 2% were gained

Paper title	Authors	Year	Topic	(Number treatment group) Interventions	Country	Sample size	Method	Covert or overt	Key findings
The influence of reference frame and population density on the effectiveness of social normative feedback on electricity consumption	Loock, C.-M.; Landwehr, J.; Staake, T.; Fleisch, E.; Pentland, A.	2012	Electricity saving in the household	(1) Descriptive social norm + Information + Injunctive norm	Austria	322	Field experiment	Overt	Reference groups that are close in terms of geographical proximity are more effective than more distant reference groups
Is social norms marketing effective? A case study in domestic electricity consumption	Harries, T.; Rettie, R.; Studley, M.; Burchell, K.; Chambers, S.	2012	Electricity saving in the household with home energy monitors	(1) Feedback; (2) Descriptive social norm	UK	316	Randomized control trial	Overt	Both types of treatments led to reductions in consumption of about 3%, but effects are not significant
Smart Metering, Beratung oder Sozialer Vergleich	Degen, K.; Efferson, C.; Frei, F.; Goette, L.; Lalive, R.	2013	Electricity saving in the household	(1) Feedback; (2) Information; (3) Descriptive social norm	Switzerland	5,000	Randomized experiment	Overt	Information was the only treatment reducing electricity consumption significantly
Nudging energy efficiency behavior: The role of information labels	Newell, R. G.; Siikamäki, G.	2013	Purchase of energy efficient appliances	(1) Information	U.S.	1,214	Online choice experiment	Overt	Information nudge had a positive significant effect
Energy conservation nudges and environmentalist ideology: Evidence from a randomized residential electricity field experiment	Costa, D. L.; Kahn, M. E.	2013	Electricity saving in the household	(1) Descriptive social norm + Information	U.S.	48,058	Randomized field experiment	Covert	The nudging effect of descriptive social norm plus information depended on political preference

Paper title	Authors	Year	Topic	(Number treatment group) Interventions	Country	Sample size	Method	Covert or overt	Key findings
Neighbours, knowledge, and nuggets: two natural field experiments on the role of incentives on energy conservation	Dolan, P.; Metcalfe, R.	2013	Energy saving (gas) in the household	(1) Feedback; (2) Descriptive social norm; (3) Descriptive social norm + Injunctive norm; (4) Descriptive social norm + Injunctive norm + Information	UK	569	Randomized natural field experiment	Covert	Descriptive social norms have a significant effect and reduce consumption by around 6% (0.2 standard deviations). The effect is the largest on the day that information is received, and then decreases. No control group; the feedback treatment was thought off as the control group
Does absolution promote sin? The conservationist's dilemma	Harding, M.; Rapson, D.	2013	Moral licensing and electricity saving in the household	(1) Off-setting	U.S.	748	Natural experiment	Covert	The nudge off-setting increased energy usage post-adoption by 1–3%
For better or for worse? Empirical evidence of moral licensing in a behavior energy conservation campaign	Tiefenbeck, V.; Staake, T.; Roth, K.; Sachs, O.	2013	Moral licensing and energy saving (water and electricity)	(1) Descriptive social norm	U.S.	154	Field experiment	Overt	The descriptive social norm had a positive effect on its' aim to reduce water consumption. It also, however, had an unintended effect of increasing electricity consumption by 5.6%
The short-run and long-run effects of behavioral interventions: Experimental evidence from energy conservation	Allcott, H.; Rogers, T.	2013	Electricity conservation programme (OPOWER) in households	(1) Descriptive social norm + Information	U.S.	234,000	Randomized natural field experiment	Covert	The nudging combination has an immediate effect that decays after two weeks but through regular treatment recovers and is stable over time

Paper title	Authors	Year	Topic	(Number treatment group) Interventions	Country	Sample size	Method	Covert or overt	Key findings
Political ideology affects energy efficiency attitudes and choices	Gromet, D. M.; Kunreuther, H.; Larrick, R. P.	2013	Adaptation of energy-efficient technology and political polarization in the US	(1) Information	U.S.	Study 1: 657; study 2: 210	Study 1: online survey; study 2: online choice experiment	Study 1: overt; study 2: overt	The nudge information has a positive and significant effect
Motivating energy-efficient behavior with green IS: An investigation of goal setting and the role of defaults	Loock, C.-M.; Staake, T.; Thiesse, F.	2013	Electricity saving in the household with home energy monitors	(1) Goal setting + Default rules	Austria	1,791	Online website tool	Covert	The nudge combination of goal setting plus default rules (resulting in default goal settings) have a significant and positive effect
Public praise vs. private pay: Effects of rewards on energy conservation in the workplace	Handgraaf, M.J.J.; Van Lidth de Jeude, M.A.; Appelt, K.C.	2013	Electricity saving in the workplace*	(1) Feedback + Monetary incentive; (2) Feedback + Social competition + Monetary incentive; (3) Feedback + Injunctive norm; (4) Feedback + Social competition + Injunctive norm	Netherlands	83	Field experiment	Overt	The nudging combination with public social rewards was the most promising
Community-based incentives for environmental protection: the case of green electricity	Jacobsen, G. D.; Kotchen, M. J.; Clendenning, G.	2013	Subsidizing environmental protection	(1) Symbolic rewards on community-level	U.S.	12,300	Field experiment	Covert	The nudge symbolic rewards has a significant and positive effect of 22% more uptake of green electricity

Paper title	Authors	Year	Topic	(Number treatment group) Interventions	Country	Sample size	Method	Covert or overt	Key findings
The influences of financial and non-financial factors on energy-saving behaviour: A field experiment in Japan	Mizobuchi, K.; Takeuchi, K.	2013	Electricity saving in the household	(1) Descriptive social norm; (2) Monetary incentive	Japan	236	Randomized field experiment	Overt	The nudging treatment monetary incentive leads to a significant saving rate of 5.9% and the descriptive social norm leads to a significant saving rate of 8.2%
From intention to action: can nudges help consumers to choose renewable energy?	Momsen, K.; Stoerk, T.	2014	Green electricity uptake	(1) Priming; (2) Mental accounting; (3) Framing; (4) Decoy; (5) Descriptive social norm; (6) Default rules	Germany	475	Online survey	Overt	Default rules was the only treatment with significant effect increasing green electricity uptake by 44.6%
Nonprice incentives and energy conservation	Asensio, O. I.; Delmas, M. A.	2014	Electricity saving in the household	(1) Feedback + Moral suasion + Social competition; (2) Feedback + Social competition	U.S. (campus housing)	118	Randomized field experiment	Covert	The nudging combination of feedback plus moral suasion plus social competition lead to 8% energy savings versus control group
Feeling the green? Value orientation as a moderator of emotional response to green electricity	Nilsson, A. ; Hansla, A.; Biel, A.	2014	Green electricity uptake	(1) Framing	Sweden	655	Paper Survey	Overt	The nudge framing has a significant and positive effect
Promoting energy conservation with implied norms and explicit messages	Bator, R. J.; Tabanico, J. J.; Walton, M. L.; Schultz, P.W.	2014	Electricity saving in the workplace (university setting)*	(1) Moral suasion	U.S.	308	Randomized field experiment	Covert	The nudge moral suasion has a significant and positive effect on promoting energy-saving behaviour
Domestic uptake of green energy promoted by opt-out tariffs	Ebeling, F.; Lotz, S.	2015	Green electricity uptake	(1) Default rules	Germany	41,952	Randomized experiment	Covert	Green default increased green energy purchase by a factor of 10

Paper title	Authors	Year	Topic	(Number treatment group) Interventions	Country	Sample size	Method	Covert or overt	Key findings
Providing persuasive feedback through interactive posters to motivate energy-saving behaviors	Agha-Hossein, M. M.; Tetlow, R. M.; Hadi, M.; El-Jouzi, S.; Elmualim, A. A.; Ellis, J.; Williams, M.	2015	Electricity saving in the workplace*	(1) Feedback	UK	Study 1: 600; Study 2: 130	Study 1: Field experiment; study 2: Field experiment	Study 1: covert; study 2: covert	Using interactive feedback to promote energy-saving behaviour (taking stairs instead of elevator and turning off the light) had a significant small but short-lasting effect
Does active choosing promote green energy use? Experimental evidence	Hedlin, S.; Sunstein, C. R.	2015	Green electricity uptake	(1) Default rules	U.S.	1,037	Online experiment	Overt	The nudge default rules has a positive and significant effect, but so does active choosing, which led to a higher enrolment in the green program than either green energy defaults or standard energy defaults (automatic enrolment in standard energy)
An experimental study on motivational change for electricity conservation by normative messages	Komatsu, H.; Nishio, K.-I.	2015	Electricity saving in the household	(1) Feedback; (2) Descriptive social norm; (3) Descriptive social norm + Injunctive norm	Japan	3,033	Randomized control trial	Overt	The nudge descriptive social norm has a positive and significant effect compared to the control group (which was actually a feedback nudge treatment)
To make people save energy tell them what others do but also who they are: a preliminary study	Graffeo, M.; Ritov, I.; Bonini, N.; Hadjichristidis, C.	2015	Intentions about electricity saving in the household	(1) Descriptive social norm	Israel	334	Randomized laboratory experiment	Overt	The nudge descriptive social norm has a significant and positive effect

Paper title	Authors	Year	Topic	(Number treatment group) Interventions	Country	Sample size	Method	Covert or overt	Key findings
Using in-home displays to provide smart meter feedback about household electricity consumption: A randomized control trial comparing kilowatts, cost, and social norms	Schultz, P. W.; Estrada, M.; Schmitt, J.; Sokoloski, R.; Silva-Send, N.	2015	Electricity saving in the household with home energy monitors	(1) Feedback; (2) Descriptive social norm	U.S.	431	Randomized field experiment	Overt	The nudge descriptive social norm has a significant energy reduction of 9% in the first week and 7% during first three months
The value of adding ambient energy feedback to conservation tips and goal-setting in a dormitory	Karp, A.; McCauley, M.; Byrne, J.	2015	Electricity saving in the household (university setting)	(1) Goal setting + Feedback + Injunctive norm + Information; (2) Goal setting + Information	U.S.	128	Field experiment	Overt	The nudging combination of goal setting plus feedback plus injunctive norm plus information reduced electricity consumption while the control group increased electricity consumption
Overcoming salience bias: How real-time feedback fosters resource conservation	Tiefenbeck, V.; Goette, Lorenz; Degen, Kathrin; Tasic, Vojkan; Fleisch, Elgar; Lalive, Rafael; Staake, Thorsten	2016	Electricity saving behaviour (shower water)	(1) Feedback	Switzerland	620	Field experiment	Covert	Real-time feedback reduced resource consumption for the target behaviour significantly
Lights, building, action: Impact of default lighting settings on occupant behaviour	Heydarian, A.; Pantazis, E.; Carneiro, J. P.; Gerber, D.; Becerik-Gerber, B.	2016	Electricity saving in the workspace*	(1) Default rules	U.S.	160	Virtual environment experiment	Overt	The nudge default rules has a positive and significant effect

Paper title	Authors	Year	Topic	(Number treatment group) Interventions	Country	Sample size	Method	Covert or overt	Key findings
Competition and norms: A self-defeating combination?	Alberts, G.; Gurguc, Z.; Koutroumpis, P.; Martin, R.; Muûls, M.; Napp, T.	2016	Energy saving (electricity, heat) in the household (university setting)	(1) Descriptive social norm + Injunctive norm + Information; (2) Descriptive social norm + Injunctive norm + Information + Social competition	UK	89	Randomized control trial	Overt	The nudging combination of descriptive social norm plus injunctive norm plus information lead to 22% less energy consumption
I saw the sign: Promoting energy conservation via normative prompts	Bergquist, M.; Nilson, A.	2016	Electricity saving behaviour in the public space*	(1) Moral suasion + Injunctive norm	Sweden	384	Field experiment	Covert	Dual injunctive prompts were better at promoting energy conservation than single injunctive prompts
Nudges from school children and electricity conservation: Evidence from the "Project Carbon Zero" campaign in Singapore	Agarwal, S.; Rengarajan, S.; Sing, T. F.; Yang, Yang	2017	Electricity saving in the household	(1) Indirect information	Singapore	8,070	Field experiment	Covert	The nudge indirect information has a significant and positive effect (1.8% reduction in electricity usage compared to control group)
Longitudinal analysis of normative energy use feedback on dormitory occupants	Anderson, K.; Song, K.; Lee, S. H.; Krupka, E.; Lee, H.; Park, M.	2017	Electricity saving in the household (university setting)	(1) Feedback + Information; (2) Descriptive social norm + Injunctive norm + information	South Korea	495	Field experiment	Overt	The duration of the treatment positively influenced the long-term durability of the effect

Paper title	Authors	Year	Topic	(Number treatment group) Interventions	Country	Sample size	Method	Covert or overt	Key findings
Do the effects of social nudges persist? Theory and evidence from 38 natural field experiments	Brandon, A.; Ferraro, P. J.; Lista, J. A.; Metcalfe, R. D.; Price, M. K.; Rundhammer, F.	2017	Electricity conservation programme (OPOWER) in households	(1) Descriptive social norm + Injunctive norm + Information	U.S.	2,516,089	Natural field experiment	Covert	The nudging combination of descriptive social norm plus injunctive norm plus information lead to 35–55% energy reduction

Note: * These studies focus on energy saving behaviour, similar to studies in a household setting, but investigate behaviour in a workplace setting or public space.

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