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ENERGY DEMAND MANAGEMENT AND SOCIAL NORMS – THE CASE STUDY IN POLAND

Bernadeta Gołębiowska
Anna Bartczak
Mikołaj Czajkowski

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Energy demand management and social norms – the case study in Poland

Bernadeta Gołębiowska*, Anna Bartczak and Mikołaj Czajkowski

Faculty of Economic Sciences, University of Warsaw
** Corresponding author e-mail: bgolebiowska@wne.uw.edu.pl*

Abstract: The study aims to investigate the impact of social norms and the financial motivation on the disutility of Polish households from energy management. We analyzed consumers' preferences for the new Demand-Side Management (DSM) programs. We applied a choice experiment (CE) framework for various electricity contracts that implied external control of electricity usage. Based on the hybrid model, we proved that people with higher descriptive social norms about electricity consumption are less sensitive to the level of compensation and more responsive to the number of blackouts. People who stated they would sign the contract because of the financial reasons are less sensitive to the external control of electricity consumption. They are less inclined towards the status quo option. Poland's energy policy focuses on energy efficiency, and reduction of greenhouse gas emissions. This study may contribute to understanding the decisions of households and provide insights into the DSM option in Poland.

Keywords: choice experiment; demand-side management; electricity, social norms, willingness to accept

JEL codes: C25, D19, D91, Q41, Q48

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1. The introduction

Electricity use is increasing exponentially since the Industrial Revolution, affecting the long term sustainability of our planet. Climate change policies focus on the reduction of electricity consumption. However, the electricity demand is expected to grow what requires more coordination in the power system (Pablo-Romero, et al. 2017). Household energy conservation is both a challenge and an opportunity for researchers, and decision-makers. Energy management is the proposition mitigate climate change mitigation and energy security. According to the estimation form 2018 (World Bank 2018), increased efficiency and energy savings on households level would reduce total energy demand by 15%.

Energy is a key factor for economic growth, development, and well-being, and the power systems need to continuously maintain a balance between electricity supply and demand. A power deficit is a typical technical problem that is often experienced during peak load. It occurs when the production and import of electricity cannot cover consumption. When peak demand is high, there is a risk of power shortage. This challenge to the grid often results in supply-side measures, such as investing in power plants to satisfy the demand, as well as higher tariffs for consumers. Researchers have proposed various solutions to this problem, including time-of-use pricing, load control, education, increasing consumers' awareness of energy costs and environmental pollution, and providing the information about the current use (feedback). These measures are known as demand-side management (DSM).

DSM reduces the risk of blackouts and could reduce CO_2 emissions (Gellings, 1985). It modifies electricity demand through behavioral change by making consumers more aware of their electricity use (Owens, Driffil, 2008, Devine-Wright, Devine-Wright, 2004). To date, DSM analysis has focused only on economic factors, and this approach overlooks the psychological factors that may have a dominant influence on the effectiveness of specific DSM mechanisms and programs. In particular, analyses have not considered the involvement of consumers and the consequences of their choices.

According to research the key determinant of our actions and feelings is the comparison with others (Festinger 1954). Research shows that the activation of social norms plays an important role in the electricity consumption decisions (Horne, Kennedy 2017, Dolan, Metcalfe 2015). There is a need to better understand the impact of social norms on people's decisions about electricity consumption. This study contributes to understanding the role of social norms and personal norms in making decisions about electricity contracts. We develop the hybrid model analyzing the relationship between norms, financial motivation and preferences for DSM programs.

The innovative part of the study is referring to The Theory of Planned Behavior of Ajzen (1985). Researchers highlight the need for references to social norms as soon as behavioral change is analyzed (see e.g.: Alcott 2011, Horne and Kennedy 2017, Kažukauskas et al. 2017). The cognitive, motivational, and contextual factors affect energy consumption, consequently much more attention should be given to the behavioral aspects of the decision- making process (see e.g. Clark et al. 2003; Whitmarsh 2009, Guo et al. 2018). The Theory of Planned Behavior provides a clear structure for the model and explains factors influencing people's behavior. Social norms are the main part of the theory. The model is also flexible and can further extension if significant variables are identified. Researchers proved that there is a tension between extrinsic incentives and intrinsic motivation (Pellerano et al. 2017, Titmuss 1970, Gneezy et al. 2012, Dolan, Metcalfe 2015). We assumed that people motivated by financial incentives are more sensitive to the level of compensation. In light of this, we verify the following hypotheses:

1. Consumers who believe that other people control their own electricity use and save energy (descriptive social norm) are less sensitive to the attributes' levels and to the level of compensation for restrictions.

2. Consumers who think that controlling electricity use and saving energy are socially approved behaviors (injunctive social norms) are less sensitive to the attributes' levels and to the level of compensation.

3. Consumers who feel morally obligated to control electricity consumption (personal norm) are less sensitive to the attributes' levels and to the level of compensation.

4. People who would sign the contract because of financial motivation are more sensitive to the level of compensation for restrictions.

This study analyzes the preferences related to the DSM of Polish household's electricity use. As far as we know, this is the first study investigating the impact of social norms and financial motivation on preferences toward electricity DSM. We use a discrete choice experiment (CE) to examine the value consumers in Poland put for the change of their electricity use habits (e.g. shifting consumption in time). The theoretical basis for the CE analysis is given by the random utility theory (McFadden 1981). This study provides the government and the electricity providers the necessary information on the preferences toward services concerning electricity.

2. Study background

Poland faces many environmental problems caused by its heavy reliance on coal and a rising trend in energy demand. The falloff of air quality caused by industry, traffic, and coal stoves has had terrible impacts on Polish health and quality of life. 36 of the 50 most polluted cities in Europe, are in Poland (World Bank 2018). In Poland, there are power shortages and difficulties with balancing supply and demand. Moreover, increasing the consumption of electricity during peak hours can lead to a situation where demand exceeds the capacity of the system. According to the SAIDI (System Average Interruption Duration Index) and SAIFI (System Average Interruption Frequency Index) scores, the Polish consumers lose the electricity supply more often than most European countries, and the time of blackouts is longer (RAP 2018). This turned environmental research interest on renewable energy sources and energy management.

The country's progress toward sustainability requires in-depth analyses of possible solutions. The Polish Energy Policy focuses on energy efficiency, long-term energy security, greenhouse gas emissions reduction, and decarbonization in the transport system (Ministry of Energy 2018). The energy security is often attained by building new power plants which requires significant investments. Generation companies should be well equipped and forced to keep the generation facility capable of meeting the demand. There are three approaches to prevent the occurrence of power deficit:

- technical - reducing voltage, switching off the power supply, using of some DSR (Demand Side Response) reaction mechanisms,
- economic - use of some DSR mechanisms, e.g. tariffs with a critical price rate,
- psychological - DSR mechanisms in which marketing and consumers' reaction to particular stimuli plays a very important role (Billewicz 2011).

One of the methods to control the demand for electricity is Demand Side Management (DSM) (Gellings 1985). DSM creates a greater flexibility in the energy consumption and conduces achieving environmental targets through controlled demand. Balancing is about managing the supply in the wake of demand. Residential consumers have the potential for balancing supply and demand in real-time since the domestic sector makes up a large share of total electricity consumption. Research proves that DSM is an effective strategy to run energy systems (see e.g. Sergici and Faruqui 2010, Vine 2013, Gelazanskas and Gamage 2014; Jabir et al. 2018).

Open questions include whether households know all the opportunities and whether they are willing to engage in the sustainable development of the electric power system and improvement of its efficiency. The power system could be made more secure and efficient by engaging consumers and encouraging them to change their daily routines. One possibility for achieving this goal is to

design electricity contracts that put restrictions on electricity consumption. For example, households may be willing to change their use for monetary compensation. Research about preferences for electricity services could help guide recommendations for the politicians and companies responsible for introducing smart technologies, such as smart meters, in Poland. Our aim in this paper is to shed light on the preferences for electricity attributes in Polish households.

3. Literature review

The behaviorists assume that people's behavior is determined by the game between intrapersonal factors (e.g., values, attitudes), interpersonal factors (e.g., social comparisons, social norms), and external ones (e.g., financial incentives) (Gifford et al. 2011). Saving electricity can be triggered by three types of motivations:

- intrinsic motivation - behaviour that is motivated by internal rewards,
- extrinsic motivation – an action is taken to earn external rewards or avoid punishment,
- reputation or image motivation.

Financial incentives is effective in behavior control, but the effect depends on the amount paid. Extrinsic motivations may take a form of non-financial rewards: competitions and the goal setting.

Veblen claimed that consumption is used to gain and signal social status (Veblen, 1899). Consumption means a potential element of waste (waste of effort, time and of goods). Public information can motivate individuals to save electricity by appealing to their desire for social approval. Reputation motivation occurs when visibly prosocial behavior acts as a signal of virtuousness, creating a positive reputation.

Using feedback information to change daily habits means requires adequate motivation for households. People could benefit from "green reputation" therefore making pro-environmental behavior visible stimulate "green" behavior. Visibly of prosocial behavior acts as a signal of virtuousness, creating a desirable reputation. Sharing information about electricity consumption can motivate individuals to save electricity by appealing to their need for social approval. In a study by According to literature people tend to imitate the behavior of others so the social proof is important in human decision making (Cialdini 1993).

Providing consumers with feedback on how their use of electricity compares with similar households in their neighborhood has been proved to reduce electricity consumption in higher-than-average users (Allcott 2011, Cooney, 2011). According to literature, it is enough to motivate consumers to reduce their electricity usage. Providing information on the electricity usage of average neighbor can promote energy savings (Dolan, Metcalfe 2015). Households might purchase

less energy-consuming appliances as substitutes or try to reduce the time of using such appliances when possible. Feedback help consumers to understand their routines that generate load profiles and take energy-saving actions. Feedback messages about electricity consumption with normative elements were more effective in changing behavior (Dolan, Metcalfe 2015).

Feedback literature shows 1 – 23,3 % saving, depending on the information and context. Review of studies by Vine et al. (2013), reports 5 – 20 % reduction in electricity consumption after feedback. In the appendix A, we summarize studies about the effect of feedback on electricity consumption.

Competition between consumers can lead to electricity-saving (Alrowaily 2012). Making the competition result visible in a social network (like Facebook) plays a crucial role - encourages them and needed support. According to Gölz and Hahnel (2016) electricity use after receiving feedback results from a combination of goals rather than a single motivation. Consumption is influenced by the willingness to: reduce costs, have fun, learn to save electricity, control and avoid inconvenience.

Electricity saving behaviors is stimulated by the awareness of the external effects of electric power production. Providing the consumers information about savings measures increases the willingness to reduce electricity usage in households (Ek, Söderholm, 2010). Schleich and co-workers found that feedback was effective in reducing electricity consumption in households from 30 -70 percentile of usage. For households above or below this range, it has no impact (Schleich et al. 2013).

Stimulating reflections about every day habits can encourage knowledge spillovers from one household to another and make additional reductions in households' electricity consumption. Consumers would limit the use of using certain appliances if they knew that they need more electricity than others (Vassileva et al. 2012).

We can explain the changes in electricity consumption using the Social Norms Theory. Sociologists claim that electricity usage is collective behavior: "behavior is social in the sense of being oriented to socially-sanctioned goals" (Lutzenhiser 2009:29). Studies show that norms regulate household energy consumption (see e.g. Harries et al. 2013; Horne and Kennedy 2017). Individuals could use the information on the usage of a similar household as a benchmark (Thaler, and Sunstein 2008).

There is a distinction between two types of norms: social (descriptive and injunctive norm) and personal (Stern 2005). Beliefs about to what extent other people reduce their electricity use – descriptive social norms – can trigger one's willingness to do the same. It increases the perception that changing habits to reduce electricity usage is a desirable activity. The fact of living in society may result in the individual's obedience to a certain social influence. According to the study by

Loock et al. (2013), the injunctive feedback reduces consumption while descriptive feedback leads to increased consumption consumers below the average electricity consumption.

Personal norms are the closest determinant to behavior (Ibtissem 2010). They represent the moral obligation to adopt certain The adoption of a pro-social behavior depends on the enhancement of self-transcendent values. Sanctions and rewards, related to personal norms, are attached to the concept of self. This way, conformism to personal expectation forms pride, self-esteem, security and every other favorable auto-evaluation. Contrarily, non-conformism to personal norms induces a sentiment of guilt (Tangney 2007). Personal norms predict intentions, and in turn, are predicted by social norms. Social norms could be adopted as personal to the extent of identification with the group from which the norm comes.

People prefer to present themselves to others as caring about the environment. The results by Horne and Kennedy (2017) suggest that people have more positive impressions of those who care about reducing carbon emissions as compared to others who want to reduce their electricity bill (Horne, Kennedy, 2017). Reductions in carbon emissions are supported by both social norms and individual values. Cherchi showed that social conformity effects are highly significant in explaining the demand for electric vehicles (Cherchi 2017). Injunctive social norms can boost the demand for electric vehicles. According to literature providing information on the electricity usage of average neighbor is enough to motivate consumers to reduce their electricity usage (Dolan, Metcalfe 2015). In the study carried out in Ecuador, giving social comparison messages for households, reduced electricity consumption above the referential neighbor by around 1% (Pellerano 2017). The effect of social comparison could be more effective than incentives such as being socially conscious, conserving resources, even saving money (Nolan et al., 2008). Feedback information can be as powerful motivators as monetary reward (Lossin, et al. 2016).

Financial motivation has two effects on the behavior: direct - price effect, and indirect psychological effect. Economists expect that higher financial incentives result in more effort and are more effective in changing behavior. However, they can weaken the intrinsic motivation needed to take action. These two kinds of motivation may work in opposite directions. Some papers authors argue that price effect supersedes incentivized behavior. For example, giving financial rewards for students may signal the task is difficult, or that the agent is not prepared enough to achieve the goal. Titmuss (1970) was the first economist analyzing the crowding-out effect. He found that financial incentives for blood donators could result in a reduction in the number of people who donate.

Social norms may affect the impact of financial incentives (Heyman, Ariely 2004). Dolan and Metcalfe found that large monetary rewards worked online in changing electricity consumption over four months but the effect was completely removed when information on social norms was

included (Dolan, Metcalfe 2015). Furthermore, the impact of the monetary incentive is reduced by the information with the social norm.

There is a tension between extrinsic incentives and intrinsic motivation. We need more research on the interactions between intrinsic and extrinsic incentives. In this study, we analyze the impact of descriptive social norms and the impact of financial motivation on the preferences for electricity contracts including DSM.

4. Materials and methods

The discrete The CE method was applied to elicit people's preferences for electricity contracts that implied external control of electricity consumption. The CE method is grounded in the consumer theory of Lancaster (Lancaster, 1966), which states that goods can be described in terms of their attributes. If we observe people's choices between goods, we can deduce which attributes are the most important to them and what their preferences are. We can estimate a marginal rate of substitution (MRS) between the attributes. The MRS between a monetary and a nonmonetary attribute is equivalent to a marginal willingness to pay (WTP) or a willingness to accept (WTA) the change in the non-monetary attribute.

The econometric analysis builds on hybrid choice models (Ben-Akiva et al. 2002). This modeling technique has been applied in the transportation literature largely (e.g., Morikawa et al. 2002; Hess et al. 2012; Daziano and Bolduc 2013; Motoaki and Daziano 2015) with a growing number of applications in environmental economics research (e.g., Dekker et al. 2012; Hess and Beharry-Borg 2012; Adamowicz et al. 2014; Hoyos et al. 2015; Mariel et al. 2015; Mariel and Meyerhoff 2016; Czajkowski et al. 2017; Czajkowski et al. 2017; Pakalniete et al. 2017; Taye et al. 2018; Boyce et al. 2019; Zawojska et al. 2019).

A hybrid choice model is a structural model that allows incorporating latent constructs (e.g., perceptions) into a random utility framework. The main advantage of this approach is that while latent variables are imperfectly inferred from measurement (indicator) variables, the use of a structural model allows accounting for measurement error and hence avoiding bias associated with incorporating indicator variables directly into a choice model (e.g., as indicators with choice attributes; Budziński and Czajkowski 2017).

The discrete choice component of a hybrid model relies on the random utility framework (McFadden 1974), under which, people choose the alternative maximizing their utility. Formally, the utility that person obtains from chosen alternative in the choice task t is defined in the following equation:

$$U = X_{ijt}\beta_i + \varepsilon_{ijt}, \quad (1)$$

A respondent's utility level consists of deterministic and nondeterministic components. The deterministic elements relate to the observed characteristics of the alternative, and the nondeterministic components relate to unobserved characteristics. Specifically, X stands for the levels of attributes associated with available alternatives, and the stochastic component ε, relates to the factors that influence the individual's utility, unobserved by the econometrician. βi stands for individual-specific parameters to be estimated; thus express the preferences towards the alternative's characteristics. Following common practice, we assumed that the parameters of the attributes were normally or lognormally distributed (based on model fit).

Following the method provided by Bahamonde-Birke et al. (2017), we assume that the parameters β depend on the unobservable latent variables. We determine a vector of respondent-specific latent variables by LVi (in our case, this vector consists: personal norms, descriptive social norms, and injunctive social norms). The relation between the latent variables and the nonmonetary preference parameters can be illustrated by the following:

$$\beta i = \Lambda' \, LVi + \beta i^*, \tag{2}$$

where Λ stands for a matrix of coefficients to be estimated and βi^*, has a multivariate normal distribution with a vector of means and a covariance matrix to be estimated.

The latent variables in our model capture respondents' social norms (descriptive, injunctive), personal norms, and financial motivation. These unobservable factors may be in relation to individuals' preferences, but they cannot be measured directly and objectively, as is possible with income, education, sex. Instead, our survey included social norms (descriptive, injunctive), personal norms indicators questions. Answers to the indicator questions were expected to be determined by the person's underlying attitudes, which are latent variables. Measurement equations, then, model the self-reported measures of the social norms, attitudes, and motivation as functions of the latent variables. This relationship can be formulated as follows:

$$Ii = LVi\Gamma + \eta i \tag{3}$$

where Ii are indicator variables, which are related through equation (3) to the corresponding LV that they contribute to measuring; Γ is a matrix of coefficients; and ηi ,corresponds to a vector of error terms assumed to have a multivariate normal distribution with an identity covariance matrix, and zero means.

The responses to the attitudinal questions related to social norms were collected with the use of 7-point Likert scales (see Table 1). An absolute interpretation of the Likert-scale answers is commonly imposed in the psychometric literature. In the measurement component of our model –

in order to capture the ordinal nature of the response scale, without imposing any restrictions - we used an ordered probit for the indicator variables. This method also allowed assigning (potentially) different weights to each of the possible answer to the indicator statements. This helps to avoid misinterpretation of the responses and potential biases that result from using, for example, linear regressions (Greene 2017)[1]. Secondly, we measure each of the latent variables with the use of several belief and attitudinal questions. In previous studies, the answers to the questions corresponding to the latent variables often were added up, following possible reverse coding, as necessary (e.g., Gosling et al., 2003). However, our framework include the situation when some of the questions are more efficient than others in measuring a specific latent variable. Thereby, each latent variable enters the measurement equations of each relate indicator question, with a different coefficient, hence taking into consideration an independent relationship. At last, all elements of the model are estimated jointly—the model is estimated using a full information log-likelihood function. Numerous studies have utilized a two-step methodology in which, for instance, singular factor scores are determined first and afterward interacted with utility function parameters in a subsequent step (e.g., Nunes and Schokkaert 2003; Milon and Scrogin 2006). Our model is statistically more efficient by estimating both steps simultaneously.

The full-information likelihood function is presented in equation (4):

$$L_i = \int P(y_i / X_i, \beta_i, \Lambda, \Gamma)\, P(I, \Lambda, \Gamma)\, f(\beta i^*) d(\beta i^*) \quad (4)$$

where *yi* represent individual *i's* choices. The random disturbances of β are not directly observed, then they must be included out of the conditional likelihood. The simulated maximum likelihood method could be used to approximate the multidimensional integral. We used 10,000 Sobol draws with a random linear scramble to simulate the log-likelihood function (Czajkowski and Budziński 2019).[2]

Survey structure and data collection

The Polish polling agency conducted the computer-assisted web interviews in December 2018. The quota sample included 1,000 respondents and was representative of the Polish population

[1] Numerous studies assume linear relationships between responses (i.e., the equivalent distance between response scales). For instance, they apply 1 to "I disagree strongly", 2 to "I disagree moderately", and so on. This is a strong assumption to force as the differences between the categories are much subtler. Despite there could be almost no distinction between "I disagree strongly" and "I disagree moderately," there could be more noteworthy difference between "Neither agree nor disagree" and "Agree a little". Using the ordered probit model utilizes an ordinal scale to interpret the scores provided by respondents, flexibly sets the thresholds between neighboring answers.

[2] The models presented in this paper were estimated using a DCE package developed in Matlab and available from github.com/czaj/DCE. The code and data for estimating the specific models presented in this study, as well as supplementary results, are available following this link: http://czaj.org/research/supplementary-materials.

with respect to education, location, age, and sex[3]. In the sample, the average household size equaled 3.18, while the average for the whole country was 2.69 in 2017. The mean net monthly income was 3,791.25 PLN (mean net income in Poland was 3,261.34 PLN in 2018) (GUS, 2018).

The survey consisted of the following sections.

1. The respondents (selected by the polling agency to provide representativeness) gave information on the last electricity bill. They were informed about how their electricity usage per person per year differed from the electricity usage per capita in their place of residence (social comparison).
2. The respondents were informed that the electricity companies want to engage consumers in the power system to reduce the costs (DSM). Participants were informed that if they accept the annex to the contract, they would receive a compensation for participating in the DSM program, and that the compensation would be given in every billing period: "The monthly electricity bill will be reduced by compensation for your household." Then, the participants were asked to choose between various contracts limiting using electricity when they want (choice experiment part).
3. The next part of the study focused on social-psychological constructs: personal norms, descriptive and injunctive social norms, beliefs about saving energy and beliefs about the effects of climate change. The indicators for norms were based on the answers on the Likert scale to the questions for norms scales (Table 1).

Table 1. Norms scale

Please, answer the question with the 7-point scale								
The scale	strongly disagree 1	disagree 2	somewhat disagree 3	neither agree or disagree 4	somewhat agree 5	agree 6	strongly agree 7	don't know 0
Personal norms	I feel obliged to save electricity no matter what other people do							
	I feel guilty when wasting electricity							
	I worry about lowering electricity consumption only when saving can reduce electricity bill							

[3] The detailed characteristics of the sample in: Gołębiowska, B., Bartczak, A., & Budziński, W. (2019). Impact of social comparison on DSM in Poland. University Of Warsaw Faculty of Economic Sciences Working Papers. (No. 2019-10). https://www.wne.uw.edu.pl/files/6115/6501/8862/WNE_WP295.pdf

	My household should not be blamed for environmental problems related to electricity consumption
Injunctive social norms	People should control electricity use
	People should care for the environment
	People should save electricity
	People should care for the security of the power system in Poland
Descriptive social norms	Most people save electricity
	Most people are interested in the security of the power system in Poland
	Most people care for the environment
	Most people control electricity use

The theory of Values Beliefs Norms is the theoretical framework of the questionnaire. We made use of the results by Ibtissem (2010) to choose the questions for social norms' scales and personal norms' scale. The "don't know" was treated as a missing value in the model.

4. At the end of the questionnaire, respondents were asked about their sociodemographic characteristics, such as education, income and so forth. The questionnaire, the attributes, and their levels were determined through focus groups, pilot study, and consultation with experts.

Choice attributes and experimental design

The final design included 24 choice sets blocked into four subsets (4 blocks × 6 choice sets). Each participant was asked to make six choices. Each choice set contained two electricity contracts and an SQ option (status quo - current electricity contract). Alternatives described two measures of external control of household electricity and information dissemination. Attributes were based on the study by Broberg and Persson (2016). The contracts presented in the experiment specify control of electricity usage from 9:00–10:00 a.m. and from 5:00–8:00 p.m. weekdays, typical peak hours in Poland. The reference level is "no control." The random external control attribute in the contracts refers to the situation in which the electricity system is affected by production disruptions and sudden changes in the demand (there are price fluctuations in the wholesale market). Distribution of information allows sharing the data (e.g., to improve the quality of supply, offer personalized services). The final design was a result of focus groups, interviews, and consultations with experts from an electricity supply sector. Table 2 shows all attributes, detailed descriptions, and levels.

Table 2. Attributes and their levels

Attribute	Description of the study	Levels
External control of domestic electricity in weekdays	"During these hours you are not allowed to use the dishwasher, the electric oven, and the laundry machine."	lack (SQ); 6am-9am; 5pm-8pm; 6am-9am and 5pm-8pm
External control in extreme cases	"During certain days there are extreme situations on the energy market. You will be notified one day ahead that the domestic electricity will be turned off for max 4 hours. Extreme situations are more or less random and will be limited to a certain number of days per year."	lack (SQ); 3; 7; 10
Distribution of information	"Information from your electricity meter can be communicated to third-party to improve the quality of services."	no (SQ); yes
Compensation (PLN per month)	"A new contract is related to monthly monetary compensation."	0 (SQ); 5; 10; 20; 30; 50; 60

Note: Nominal exchange rate in 2018: 1 Euro = 4.28 PLN.

We created choice sets with NGene software using a Bayesian D-efficient design with fixed priors. The priors follow the results from a pilot study, S-estimate was used for efficiency measurement (Bliemer, Rose 2011). Choice cards were given in a random order to avoid ordering effects day et al., 2012). In total each participant faced six choice sets (see: Figure 1).

	Contract A	Contract B	Current situation
External control of domestic electricity weekdays	6am-9am	5pm-8pm	lack
External control in extreme cases	max 7 days	lack	lack
Distribution of information	no	yes	no
Compensation (PLN per month)	10	50	0
Choice	□	□	□

Figure 1. Example of choice set

5. Results

5.1 The motivation to accept DSM

Respondents were asked what motivated them to agree on the new contract (multiple choice questions). Table 4 shows the answers.

Table 4. The reasons for accepting the contract.

What motivated you to accept the contract?	Share (%)
improving the stability of the power system in Poland	38.3
reduction of environmental pollution	52.3
increasing the energy security of the state	39.9
reduction of electricity production costs	65.4
a sense of social responsibility	31.6
receiving monetary compensation	50.4
reduction of greenhouse gas emissions	22.4

Half of the sample declared that receiving monetary compensation was the reason for signing the contract.

5.2. The willingness to accept DSM[4]

In Table 5 we report the median willingness to accept changes in electricity contracts (WTA per month).

Table 5. Median WTA per month[5]

	Main effects
Attributes	**MWTA (€)**
External control of electricity in extreme cases	0.96***
Distribution of information	- 1.29
External control of electricity on weekdays, 6 am-9 am	0.09
External control of electricity on weekdays, 5 pm-8 pm	6.46***
External control of electricity on weekdays; 6 am-9 am & 5 pm-8 pm	10.08***

Note: Nominal exchange rate in 2018: 1 Euro = 4.28 PLN

[4] See: Gołębiowska, Bartczak, Budziński, 2019

[5] Econometric approach is presented in: Gołębiowska, Bartczak, Budziński, 2019

We assume the number of days of external control of electricity in extreme cases have a linear effect on the choice. On average, consumers require 0.96 € of compensation (3.9% of the typical bill per month) per day of "extreme occasions". The control of electricity usage during the evening peak hours need 6.46 € of compensation (25.9% of the typical bill per month), while control in the morning and the evening hours requires 10.08 € of compensation (40.4% of the typical bill per month). External control result in the discomfort of not being able to use certain appliances during peak hours. People seems to be more flexible in the morning – they do not need compensation for control from 6 am to 9 am.

5.4 Hybrid models

5.4.1. Model I. Personal norm, descriptive social norms and injunctive social norms

The first estimated hybrid model tested the hypothesis about the impact of injunctive social norms, descriptive social norms and personal norms on consumers' preferences for DSM.

Tables 6 present the results of the hybrid model used to estimate the parameters of the respondents' utility functions. The parameters for the attributes were assumed to follow the normal distribution, apart from the parameter for blackouts, that was assumed to follow the lognormal distribution. The coefficients do not have direct interpretation, but their signs indicate whether an increase in a particular attribute is perceived as good or bad on average. Their relative values reflect their relative importance. In order to investigate the effect of the social norms, we include interaction with all attributes of latent variables reflecting three types of norms: personal norms, injunctive social norms, and descriptive social norms.

Table 6. The results of the hybrid choice model linking respondents' social norms perceptions with their economic preferences for electricity supply attributes

Discrete choice component					
	Dist.	**Mean**	**St. dev.**	**Personal norms**	**Injunctive norms**
Status quo (alternative specific constant)	n	**-0.2549****	**2.6473*****	-0.1207	-0.0194
		(0.1208)	(0.1313)	(0.2375)	(0.2041)
-Blackout no.	l	**-3.7620*****	**1.6645*****	-0.1285	0.1211
		(0.2911)	(0.2810)	(0.2569)	(0.1864)
Usage information shared	n	**0.1281*****	**0.4902*****	-0.0003	**0.1351***
		(0.0463)	(0.0978)	(0.0913)	(0.0757)
Electricity reduction - 6-9am	n	-0.0200	**0.6777*****	-0.0175	-0.0048
		(0.0680)	(0.1159)	(0.1296)	(0.1069)
Electricity reductions -	n	**-0.4682*****	**0.5629*****	-0.0193	-0.1871

5-8pm		(0.0787)	(0.1532)	(0.1689)	(0.1339)
Electricity reductions - 6-9am and 5-8pm	n	**-0.4739*** ** (0.0830)	**0.6891*** ** (0.1564)	0.3089 (0.1952)	-0.1913 (0.1511)
Compensation (10 PLN)	n	**0.1978*** ** (0.0169)	**0.3021*** ** (0.0222)	0.0449 (0.0308)	0.0396 (0.0261)
Measurement equations					
		Personal norms	**Injunctive norms**		**Descriptive norms**
I feel obliged to save		**1.3560*** ** (0.1872)			
I feel guilty when wasting		**0.9729*** ** (0.0963)			
I worry when saving can reduce the bill		**0.2407*** ** (0.0504)			
My HH should not be blamed		**0.4627*** ** (0.0541)			
Should control el. use			**1.8779*** ** (0.1230)		
Should save el.			**1.8631*** ** (0.1251)		
Should care for env.			**1.8455*** ** (0.1257)		
Should care for en. security			**1.4834*** ** (0.0888)		
Most people save					**1.4155*** ** (0.0852)
Most people interested in security					**1.2196*** ** (0.0733)
Most people case for env.					**1.4041*** ** (0.0849)
Most people control el. use					**1.5556*** ** (0.1011)
Model diagnostics					
LL at convergence		-22,380.75			
LL at constant(s) only		-25,438.81			
McFadden's pseudo-R^2		0.1202			
Ben-Akiva-Lerman's pseudo-R^2		0.4299			
AIC/*n*		7.4999			
BIC/*n*		7.6328			
n (observations)		6,000			
r (respondents)		1,000			
k (parameters)		119			

Notes: ***, ** and * indicate significance at the level of 1%, 5%, and 10%, respectively. Standard errors (s.e.) are given in brackets. For the lognormally distributed attribute parameters the estimates of the underlying normal distribution are provided. Ordered probit threshold parameters are skipped for brevity; full estimation results are available in the online supplement to this paper.

Overall, the model is highly significant. The sign and size of the alternative-specific constant indicate that respondents on average preferred signing new electricity contracts compared to the SQ.

The interactions of means with latent variables enable to verify the hypothesis about the impact of norms on consumers' preferences. The interaction terms for personal norms are no-significant. Consumers who feel morally obliged to control electricity consumption (personal norm) are not more willing to accept new contracts (DSM) and need the same compensation for the restrictions on electricity use as other respondents. When it comes to the effect of the injunctive social norms on the preferences, we found just one interaction term significant at 10% level. Consumers who think controlling electricity use and saving energy is socially approved behavior, are more sensitive to information sharing. They gain more satisfaction from information sharing.

When it comes to the effect of the descriptive social norms on preferences, three interaction terms - with the number of blackouts, the external control in the evenings and compensation – are significant at 5%, 1% level. Consumers who believe other people control their electricity use and save energy are more sensitive to the number of blackouts and less sensitive to the compensation (DSM).

5.4.2. Model II. Descriptive social norms and financial motivation

In the next step of our analysis, we decided to incorporate other factor affecting consumers' choices – financial motivation. We computed the hybrid model to examine the impact of descriptive social norms and financial motivation on preferences.

Table 7 present the results of the hybrid model used to estimate the parameters of the respondents' utility functions. In order to investigate the effect of the descriptive social norms and financial motivation, we include interaction with all attributes of latent variables reflecting the descriptive social norms and financial motivation.

Table 7. The results of the hybrid choice model linking respondents' descriptive social norms perceptions and financial motivation with their economic preferences for electricity supply attributes

	Dist.	Mean	St. dev.	Descriptive norm	Financial motivation
Status quo	n	**-0,4877*** **	**2,3349*** **	-0,0257	**0,7786*** **
(alternative specific constant)		(0.1265)	(0.1988)	(0.1338)	(0.2863)
-Blackout no.	l	**-3,9834** **	**1,6269*** **	**-0,3322***	**1,6311*** **

		(0.3563)	(0.3176)	(0.1810)	(0.4073)
Usage information shared	n	**0,1855***** (0.0513)	**0,4086***** (0.1127)	0,0413 (0.0509)	0,0684 (0.0906)
Electricity reduction - 6-9am	n	-0,0529 (0.0763)	**0,6712***** (0.1189)	0,0665 (0.0789)	**- 0,3851***** (0.1249)
Electricity reductions - 5-8pm	n	**-0,5170***** (0.0864)	0,0968 (0.3659)	0,1241 (0.0916)	**- 0,9410***** (0.1378)
Electricity reductions - 6-9am and 5-8pm	n	**-0,7883***** (0.1111)	0,0100 (0.1873)	0,1249 (0.1130)	**- 1,6921***** (0.1556)
Compensation (10 PLN)	n	**0,1868***** (0.0173)	**0,2684***** (0.0282)	**-0,0292*** (0.0177)	-0,0437 (0.0324)

Measurement equations	
	Financial motivation
Signing the contract because of monetary compensation	**-0,1819***** (0,0629)
Model diagnostics	
LL at convergence:	-11562,88
LL at constant(s) only:	-13488,06
McFadden's pseudo-R^2:	0,1427
Ben-Akiva-Lerman's pseudo-R^2:	0,4341
AIC/n:	4,0562
BIC/n:	4,1235
n (observations):	5730
r (respondents):	955
k (parameters)	58

Overall, the model is highly significant. The sign and size of the alternative-specific constant indicate that respondents on average preferred signing new electricity contracts compared to the SQ.

We choose the descriptive social norms to the ultimate hybrid model because the DSM program proposed in the experiment requires the engagement of a big group of end-users, otherwise, the program cannot be effective in peak load reduction. People who believe that others take care of energy security and control energy use are expected to be more willing to sign new contracts.

When it comes to the effect of the descriptive social norms on preferences for DSM, we found just two interaction terms significant at 10% level. People who perceive descriptive social norms about electricity consumption - higher descriptive social norms as measured on the survey - are more sensitive to the number of blackouts. They are less sensitive to compensation.

Financial motivation is proved to influence consumers' preferences. Respondents who stated they sign contracts because of financial reasons revealed lower responsiveness to the changes in attributes' levels (apart from the blackouts). They are less inclined towards the status quo option.

Surprisingly, the level of compensation seems to have a non-significant impact on the probability of signing a new contract. People, who stated they would sign the contract because of the financial reasons, react to the change in compensation in the same degree as those who didn't state financial motivation.

6. Discussion

In this study, we examined the impact of social norms and the effect of financial motivation on the acceptance of contracts that decrease the flexibility of electricity usage. So far, this type of energy management, has not been implemented in Poland. We referred to the theory of planned behavior, which states that intentions, norms, and perceived control shape behaviors. To our knowledge, this article is the first to analyze the impact of social norms, personal norms, and financial motivation on consumers' preferences toward electricity DSM.

Households could contribute to the security and efficiency of the electric power system, but only if people engage in the management. We need to better understand the determinants of people's acceptance of DSM programs. Receiving compensation was the motivation for signing contracts for half of the sample. More people chose the reduction in electricity production costs (65%) and the reduction of environmental pollution (52%) as the motivator. Furthermore, people who stated that they would sign the contract because of financial reasons had the same responsiveness to the level of compensation as the rest of the sample. This result suggests that some people would sign a contract because of the monetary compensation, but they were not more sensitive to the compensation level (compared with the rest of the sample). The level of compensation does not seem as important for people with financial motivation as expected. Respondents who stated that they sign contracts because of financial reasons revealed lower responsiveness to the changes in attributes' levels (apart from the blackouts). They were less inclined towards the status quo option. Lower discomfort attached to the restriction on the electricity consumption suggests that these respondents were more flexible (this contradicts the fourth hypothesis). People who were not motivated by financial motivation were less willing to sign the contract (positive sign of the status quo alternative-specific constant). All this shows that people who are less flexible in changing the consumption prefer the status quo option, even if the compensation is offered.

Perhaps lower compensation for accepting new contracts would have similar effects on peoples's choices:

- Those motivated by money are not more sensitive to the level of compensation.
- People who are less flexible – prefer the status quo option, they are not motivated by the compensation.

Researchers have highlighted norms and values should be considered when we examine behavioral change or related policies (Allcott 2011, Horne and Kennedy 2017, Black et al. 1985, Ibtissem 2010, Kaiser et al. 2005). Cognitive, motivational, and contextual factors affect electricity consumption; thereby, we included behavioral aspects into the decision-making process. According to the literature, beliefs about the extent to which other people save/reduce their electricity use—descriptive social norms—can trigger individual's willingness to do the same. These beliefs increase the perception that changing habits to save electricity is a desirable activity (see: Loock et al.). In our study, we showed that people with higher descriptive social norms as measured on the survey were less sensitive to the level of compensation (the first hypothesis is partially confirmed). We could therefore deduce that these people were motivated by the descriptive social norm. Nonetheless, the impact of descriptive social norms on the consumers' flexibility is not clear (only one interaction term with non-financial attribute – the number of blackouts - was significant).

Surprisingly, we found no impact of the personal norms on people's choices (the third hypothesis has not been confirmed). The injunctive social norms were found to have little impact on people's preferences (the second hypothesis has not been confirmed). It would be interesting to examine people's choices among electricity contacts with no compensation. According to research social influence has an impact on the level of electricity consumption. Probably norms are more important factor when we analyze revealed preferences – real choices about electricity contracts. Pellerano et al. (2017) showed that a tension exists between intrinsic and extrinsic motivation. Adding monetary incentives to reduce electricity usage did not lead to increased savings. In this intervention, for consumers who considered saving energy as a pro-social behavior (that serves to reduce climate risks, and pollution) adding extrinsic motivators changed the frame from social to financial, and pushed out the effect of the social comparison. Financial incentives diminish the extent to which the voluntary contribution signals prosociality to oneself. Authors suggest that the first channel through which messages affect consumption is the desire to avoid moral costs.

In some cases, financial incentives stand in contradiction with other motivations motivations (Gneezy et al. 2012). Paying people for voluntary contributions weakens established social norms, which makes individuals more focused on the private value of the behavior. Moreover, monetary rewards could change the perception of the task, with unexpected effects on behavior. The monetary reward changes the framing of the decision from social to private benefit. Financial motivators added to normative messages not only fail to enhance the effect of the social norms, but can actually weaken it.

Social norms are important when explaining the amount of consumption. We deduce that they are less meaningful when it comes to the choices about electricity contracts, especially if

people are motivated primarily by money. It would be interesting to verify research hypotheses in other countries, especially where DSM programmes are more popular.

The demand for electricity in the residential sector is characterized by low flexibility. Currently used tariffs do not motivate people to save money by changing their habits in the use of electricity (Billewicz, 2011). DSM makes the demand for electricity more flexible, thus it helps attain environmental goals thanks to controlled consumption. It is a key aspect of the future energy system scenarios. The effectiveness of DSM mechanisms is, in fact, the effectiveness of their impact on people and the activation of consumers to the appropriate response to the stimuli. Consumers' engagement in the power market through DSM improves economic efficiency and reliability of the system and reduces the need to invest in new generation and transmission facilities. The results of our study could enable designing electricity contacts that put restrictions on consumption. We showed that most consumers would sign contracts because of financial incentives, and the impact of social norms and personal norms is weak. However, the literature shows that feedback information with social norms could be as effective as monetary incentives. We expect a significant impact of social norms on consumers' choices if there is no compensation offered. It would be beneficial to examine the interaction between intrinsic and extrinsic motivation. The proposed model and research tools may be used to conduct similar analyzes in other countries.

Declarations:

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Consent for publication: Not applicable

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References

Adamowicz, W.; Glenk, K.; Meyerhoff, J. Choice modelling research in environmental and resource economics. In: Handbook of Choice Modelling. Edward Elgar, Cheltenham, UK, 2014.

Ajzen, I., 1985. From intentions to actions: A theory of planned behavior. In Action control (pp. 11-39). Springer, Berlin, Heidelberg.

Allcott, H., 2011. Social norms and energy conservation. J. Public Econ., 95(9–10), 1082–1095.

Alrowaily, M. A. Energy monitoring through social networks, 2012. Doctoral dissertation, University of Waikato. Hamilton.

Anderson, K., Song, K., Lee, S., Krupka, E., Lee, H., & Park, M., 2017. Longitudinal analysis of normative energy use feedback on dormitory occupants. Applied energy, 189, 623-639.

Ayers, I., Raseman, S. and Shih, A., 2009. Evidence from two large field experiments that peer comparison feedback can reduce residential energy usage. NBER Working Paper Series, Working Paper 15386.

Bahamonde-Birke, F. J.; Kunert, U.; Link, H.; de Dios Ortúzar, J., 2017. About attitudes and perceptions: finding the proper way to consider latent variables in discrete choice models. Transportation, 44(3): 475-493.

Billewicz, K. Skuteczność DSR–między bodźcem a reakcją. Przegląd Elektrotechniczny, 2012, 88.9a.

Black, J., Stern P. C. & Elworth J., 1985. Personal and contextual influences on household energy adaptations. Journal of Applied Psychology. 70, 1, 3-21.

Bliemer, M. C., & Rose, J. M., 2011. Experimental design influences on stated choice outputs: an empirical study in air travel choice. Transportation Research Part A: Policy and Practice, 45(1), 63-79.

Broberg, T., & Persson, L., 2016. Is our everyday comfort for sale? Preferences for demand management on the electricity market. Energy Economics, 54, 24-32.

Boyce, C.; Czajkowski, M.; Hanley, N., 2019. Personality and economic choices. Journal of Environmental Economics and Management, 94:82-100.

Budziński, W., and Czajkowski, M. Addressing measurement error and endogeneity in hybrid choice models. In: 23rd Annual Conference of the European Association of Environmental and Resource Economists, April 3-5, Athens Greece 2017.

Cherchi, E., 2017. A stated choice experiment to measure the effect of informational and normative conformity in the preference for electric vehicles. Transportation Research Part A: Policy and Practice, 100, 88-104.

Cialdini, R., B., Influence: The Psychology of Persuasion, William Morrow & Co., New York, 1993.

Clark, C.,F., Kotchen, M.,J. Moore, M.,R., 2003. Internal and external influences on proenvironmental behaviour: Participation in a green electricity program. J. Environ. Psychol., 23(3), 237–246.

Cooke, D., 2011. Empowering Customer Choice in Electricity Markets, Information Paper, October 2011, International Energy Agency (IEA)

Cooney, K., 2011. Evaluation Report: Opower SMUD Pilot, Year 2. Navigant Consulting.

Czajkowski, M.; Hanley, N., and Nyborg, K., 2017. Social Norms, Morals and Self-interest as Determinants of Pro-environment Behaviours: The Case of Household Recycling. Environmental and Resource Economics, 66:647-670.

Czajkowski, M.; Vossler, C. A.; Budziński, W.; Wiśniewska, A., and Zawojska, E., 2017. Addressing empirical challenges related to the incentive compatibility of stated preference methods. Journal of Economic Behavior and Organization, 142:47-63.

Czajkowski, M., Budziński, W., 2019. Simulation error in maximum likelihood estimation of discrete choice models. Journal of Choice Modelling 2019, 31: 73-85.

Day, B. & Bateman, I. & Carson, R. & Dupont, D. & Louviere, J. & Morimoto, S. & Scarpa, R. & Wang, P., 2012. Ordering Effects and Choice Set Awareness in Repeat-Response Stated Preference Studies. Journal of Environmental Economics and Management. 63. 73-91. 10.1016/j.jeem.2011.09.001.

Daziano, R.A.; Bolduc, D., 2013. Incorporating pro-environmental preferences towards green automobile technologies through a Bayesian hybrid choice model. Transportmetrica A: Transport Science, 9(1): 74-106.

Dekker, T., Hess, S., Brouwer, R., Hofkes, M. Implicitly or explicitly uncertain? International Choice Modelling Conference, Sydney, Australia, 2012.

Delmas, M. A., & Lessem, N., 2014. Saving power to conserve your reputation? The effectiveness of private versus public information. Journal of Environmental Economics and Management, 67(3), 353-370.

Devine-Wright, H. and Devine-Wright, P., 2004. "From demand-side management to demand-side participation: tracing environmental psychology of sustainable electricity system evolution", Journal of Applied Psychology, 6 (3-4), pp. 167-177.

Dolan, P., & Metcalfe, R., 2015. Neighbors, knowledge, and nuggets: two natural field experiments on the role of incentives on energy conservation.

Ek, K., & Söderholm, P., 2010. The devil is in the details: Household electricity saving behavior and the role of information. Energy Policy, 38(3), 1578-1587.

Festinger, L., 1954. A theory of social comparison processes. Human Relations, 7: 117–40.

Gelazanskas, L., & Gamage, K. A., 2014. Demand-side management in smart grid: A review and proposals for future direction. Sustainable Cities and Society, 11, 22-30.

Gellings CW., 1985. The concept of demand-side management for electric utilities. Proc IEEE 1985;73:1468–70.

Gifford, R., Kormos, C., and McIntyre, A., 2011. Behavioral Dimensions of Climate Change: Drivers, Responses, Barriers, and Interventions, Wiley Interdisciplinary Reviews: Climate Change (2:6), pp. 801-827.

Gneezy, Uri, Stephan Meier, Pedro Rey-Biel, 2012. When and Why Incentives (Don't) Work to Modify Behavior. Journal of Economic Perspectives, 25: 191-209.

Gołębiowska, B., Bartczak, A., & Budziński, W., 2019. Impact of social comparison on DSM in Poland. University Of Warsaw Faculty of Economic Sciences Working Papers. (No. 2019-10). https://www.wne.uw.edu.pl/files/6115/6501/8862/WNE_WP295.pdf.

Gosling, S. D.; Rentfrow, P. J., and Swann, W. B. J., 2003. A very brief measure of the Big-Five personality domains. Journal of Research in Personality, 37(6):504-528.

Gölz, S., & Hahnel, U. J., 2016. What motivates people to use energy feedback systems? A multiple goal approach to predict long-term usage behavior in daily life. Energy Research & Social Science, 21, 155-166.

Greene, W. H. Econometric Analysis. 8 Ed., Pearson, Upper Saddle River, NJ 2017.

Guo, Z.; Zhou, K.; Zhang, C.; Lu, X.; Chen, W.; Yang, S., 2018. Residential electricity consumption behaviour: Influencing factors, related theories and intervention strategies. Renew. Sustain. Energy Rev. 2018, 81, 399–412.

Harries, T.; Rettie, R.; Studley, M.; Burchell, K., Chambers, S., 2013. Is social norms marketing effective? A case study in domestic electricity consumption. Eur. J. Marketing 2013, 47(9), 1458–1475.

Heyman, J., & Ariely, D., 2004. Effort for payment: A tale of two markets. Psychological science, 15(11), 787-793.

Hess, S., and Beharry-Borg, N., 2012. Accounting for Latent Attitudes in Willingness-to-Pay Studies: The Case of Coastal Water Quality Improvements in Tobago. Environmental and Resource Economics, 52(1): 109-131.

Hess, S., Hensher, D., Daly, A., 2012. Not Bored Yet – Revisiting Respondent Fatigue in Stated Choice Experiments. Transportation Research Part A: Policy and Practice 2012, 46(3), 626-644.

Horne, C., & Kennedy, E. H., 2017. The power of social norms for reducing and shifting electricity use. Energy Policy, 107, 43-52.

Hoyos, D.; Mariel, P.; Hess, S., 2015 Incorporating environmental attitudes in discrete choice models: An exploration of the utility of the awareness of consequences scale. Science of the Total Environment, 505: 1100 - 1111

Ibtissem, M. H., 2010. Application of value beliefs norms theory to energy conservation behavior. Journal of Sustainable Development, 3(2), 129.

Jabir, H., Teh, J., Ishak, D., & Abunima, H., 2018. Impacts of Demand-Side Management on Electrical Power Systems: A Review. Energies, 11(5), 1050.

Kahle L.R. Social values and social change: Adaptation to life in America, New York, In: Kažukauskas, A.; Broberg, T.; Jaraite, J. Social comparison in real time: A field experiment of residential electricity and water use. CERE Working Paper, 2017: 8. https://ideas.repec.org/p/hhs/slucer/2017_008.html?

Kaiser F.G., Hubner G. & Bogner F.X., 2005. Contrasting the theory of planned behavior with the value-belief-norm model in explaining conservation behaviour. Journal of applied social psychology, 35, 10, 2150-2170.

Kažukauskas, A., Broberg, T., & Jaraite, J., 2017. Social comparison in real time: A field experiment of residential electricity and water use. CERE Working Paper, 2017: 8. Available online: https://poseidon01.ssrn.com/delivery.php?ID=530112070066074003088008074099078022009056033020093009075021092091004073125005124023004010006016122030040068027103002120125097056014025055017123083070070016065124001017015016100071004016084114089012091117109098014116080119109093007105118094089123026071&EXT=pdf (accessed 23.09.2018).

Lancaster, K., J., 1966. A New Approach to Consumer Theory. The Journal of Political Economy, Vol. 74, No. 2, pp. 132-157.

Loock C, Staake T, Thiesse V., 2013. Motivating Energy-Efficient Behaviour With Green Is: An Investigation Of Goal Setting And The Role Of Defaults. MIS Quarterly Vol. 37 No. 4:1313-1332.

Lossin, F., Loder, A., & Staake, T., 2016. Energy informatics for behavioral change. Computer Science-Research and Development, 31(3), 149-155.

Lutzenhiser, L., 2009. Behavioural Assumptions Underlying California Residential Sector Energy Efficiency Programs. University of California: California Institute for Energy and Environment. Broadway

Mariel, P.; Meyerhoff, J., Hess, S., 2015. Heterogeneous preferences toward landscape externalities of wind turbines–combining choices and attitudes in a hybrid model. Renewable and Sustainable Energy Reviews, 41, 647-657.

Mariel, P., and Meyerhoff, J., 2016. Hybrid discrete choice models: Gained insights versus increasing effort. Science of The Total Environment, 568:433-443.

McFadden, D., 1974. Conditional Logit Analysis of Qualititative Choice Behaviour. In: Frontiers in Econometrics, P. Zarembka, ed., Academic Press, New York, NY, 105-142.

McFadden, D., 1981. Econometric models of probabilistic choice. Structural analysis of discrete data with econometric applications.

Milon, J. W., and Scrogin, D., 2006. Latent preferences and valuation of wetland ecosystem restoration. Ecological Economics, 56(2):162-175.

Ministry of Energy, 2018. ENERGY POLICY OF POLAND UNTIL 2040 (EPP2040). Warsaw. 2018

Morikawa, T.; Ben-Akiva, M.; McFadden, D., 2002. Discrete choice models incorporating revealed preferences and psychometric data. In Advances in Econometrics (pp. 29-55). Emerald Group Publishing Limited.

Motoaki, Y., Daziano, R. A., 2015. A hybrid-choice latent-class model for the analysis of the effects of weather on cycling demand. Transportation Research Part A: Policy and Practice, 75: 217-230.

Nolan, J., M., Schultz, P., W., Cialdini, R., B., Goldstein, N., J., and Griskevicius, V., 2008. Normative Social Influence Is Underdetected," Personality and Social Psychology Bulletin, Vol. 34, No. 7, pp. 913-923.

Nunes, P. A. L. D., and Schokkaert, E., 2003. Identifying the Warm Glow Effect in Contingent Valuation. Journal of Environmental Economics and Management, 45(2):231-245

Owens, S. and Driffil, L., 2008. "How to change attitudes and behaviors in the context of energy", Energy Policy, 36, pp. 4412-4418.

Pablo-Romero, M. D. P., Pozo-Barajas, R., & Yñiguez, R., 2017. Global changes in residential energy consumption. Energy Policy, 101, 342-352.

Pakalniete, K.; Aigars, J.; Czajkowski, M.; Strake, S.; Zawojska, E., and Hanley, N., 2017. Understanding the distribution of economic benefits from improving coastal and marine ecosystems. Science of The Total Environment, Vol. 584–585, 29-40.

Pellerano, J. A., Price, M. K., Puller, S. L., & Sánchez, G. E., 2017. Do extrinsic incentives undermine social norms? evidence from a field experiment in energy conservation. Environmental and Resource Economics, 67(3), 413-428.

Regulatory Assistance Project (RAP): Report on the Polish Power System. Version 2.0 Study commissioned by Agora Energiewende 2018. Available online: https://www.agora-energiewende.de/fileadmin2/Projekte/2018/CP-Polen/AgoraEnergiewende_report_on_the_Polish_power_system_WEB.pdf (accessed 13.03.2019).

Schleich, J., Klobasa, M., Gölz, S., & Brunner, M., 2013. Effects of feedback on residential electricity demand—Findings from a field trial in Austria. Energy Policy, 61, 1097-1106.

Sergici S., Faruqui A., 2010, Household response to dynamic pricing of electricity: a survey of 15 experiments. Journal of Regulatory Economics, vol. 38, issue 2, pp. 193-225

Tangney J. P., Stuewig J. and Mashek D. J., 2007. Moral emotions and moral behavior, Annual Review of Psychology, 58, 345-372.

Taye, F.; Vedel, S. E.; Jacobsen, J. B., 2018. Accounting for Environmental Attitude to Explain Variations in Willingness to Pay for Forest Ecosystem Service Using the New Environmental Paradigm. Journal of Environmental Economics and Policy, 7(4): 420-440

Thaler, R.H., Sunstein, C. R., 2008. Nudge: Improving Decisions about Health, Wealth and Happiness, Yale University Press, London.

Titmuss, Richard M., 1970. The Gift Relationship. London: Allen and Unwin.

Vassileva, I., Wallin, F., & Dahlquist, E., 2012. Understanding energy consumption behavior for future demand response strategy development. Energy, 46(1), 94-100.

Veblen, T., 1899. The theory of leisure class. In: The Collected Works of Thorstein Veblen. Vol. 1, Routledge, London, 1994.

Vine, D., Buys, L., & Morris, P., 2013. The effectiveness of energy feedback for conservation and peak demand: a literature review. Open Journal of Energy Efficiency, 2(1), 7-15.

Whitmarsh, L., 2009. Behavioural responses to climate change: Asymmetry of intentions and impacts. J. Environ. Psychol., 29(1), 13–23.

World Bank. Tracking SDG7: The Energy Progress Report 2018; World Bank Publications; The World Bank Group: Washington, DC, USA, 2018; pp. 156–159.

Zawojska, E.; Bartczak, A.; Czajkowski, M. 2019. Disentangling the effects of policy and payment consequentiality and risk attitudes on stated preferences. Journal of Environmental Economics and Management, 93: 63-84.

The appendix A. The effect of feedback on electricity consumption – results from studies

Table 8. The effect of feedback on electricity consumption – results from studies

Authors	Intervention	Sample	Results
McClelland, Cook (1980)	feedback	101 families	12% saving
Hutton (1986)	feedback and information	3 cities	4-5% savings in 2 out of 3 cities
Dobson, Griffin (1992)	feedback	100 households	12.9% savings
Ek, Söderholm (2010)	information	1200 Swedish households	results indicate that costs, environmental attitudes, and social interactions are all important determinants of electricity saving activities
Loock, Staake, Landwehr (2011)	feedback	220 customers	injunctive feedback always reduces consumption, descriptive feedback leads to increased consumption for below-average consumers
Carroll, Lyons, Denny(2014)	feedback	Ireland	1.8% reduction in electricity usage
Delmas, Lessem, (2014)	real-time feedback, public information about usage	66 rooms in the residence halls, Los Angeles	private information alone was ineffective, public information combined with private information motivated a 20% reduction in electricity consumption
Dolan, Metcalfe (2015)	information with descriptive and injunctive norms	569 households (1) 2,142 households (2), London	6% reduction – the impact of descriptive social norms, large financial rewards worked very well online in reducing consumption, with a 0.35σ change, the large effect of financial incentives is completely removed when information on social norms are added online
Gölz, Hahnel, (2016)	energy feedback systems	108 participants Freiburg, Germany	energy feedback usage behavior is shaped by a combination of pre-set goals rather than a single motivation
Lossin, Loder, Staake, (2016)	individual feedback	17,500 randomly selected customers	signup rates to participate in ICT based programs: for the monetary incentive group - 4.96%, for the non-monetary incentive group - 3.92%
Pellerano, Price, Puller, Sánchez (2017).	normative messaging and financial incentives	27,634 households, U.S.	social comparison message reduced electricity use above the referential neighbor by 1%, adding extrinsic financial incentives to reduce consumption does not lead to increased conservation
Anderson, Song, Lee, Krupka, Lee, Park (2017)	normative messaging campaign	Seoul, South Korea, 495 students	individuals with a high concern for social norms consumed 14% less; individuals with a low concern for social norms had treatment effect of 5%; after the intervention had been withdrawn, individuals used 1.2% less energy per week

Schleich, Faure, Klobasa (2017)	feedback	Linz, Austria; 775 and 750 (control); households	5.5% savings in weekdays, 5.1% in weekend days
Horne, Kennedy (2017)	vignette experiments, modified trust game	U.S. residents N1=334 (study 1), N2=506, N3=102	participants both value reducing carbon emissions and expect that others support reductions
Kendel,Lazaric, Maréchal (2017)	feedback (less and more detailed)	141 households from Southern France	13-23.3% reduction in electricity consumption
Weber, Puddu, Pacheco (2017)	feedback	France, 62 households followed over 18 months	information feedback had no significant impact on load shifting, households who received feedback decreased electricity usage
Thampanishvong (2015)	Feedback, energy-saving hints	Thailand, 161 households	6% of reduction

University of Warsaw
Faculty of Economic Sciences
44/50 Długa St.
00-241 Warsaw
www.wne.uw.edu.pl