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Overview of dual process behavioural models and their implications on decision-making of private dwellers regarding deep energy renovation

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Abstract

Understanding both rational and heuristic thinking is important for explaining pro-environmental behaviour. Theoretical findings regarding dual process models can be useful to explain and influence decisions of private owners in the context of energy renovation.

The existing building stock has a big potential in contributing to the reduction of energy consumption. Even though surveys show that dwellers acknowledge the importance of energy efficient buildings and the technologies to achieve nearly zero energy buildings (nZEBs) are accessible, many dwellers prefer minor interventions or the status-quo rather than a deep energy renovation of their dwelling.

The present paper will explain the gap between intention and action with the use of dual process models (DPMs), consisting of a rational, central processing of the information (System 2) and a heuristic, peripheral one (System 1). We will focus on the peripheral System 1 that represents the heuristic, intuitive, fast and not so rational thinking that works as a shortcut for the rational processing of information. Dual process behavioural models will be classified according to the triggers of the heuristic shortcuts. An important aspect is the fragile balance between the two systems that is influenced by the need for cognition and need for affect. An overview of behavioural insights in heuristic thinking that might influence decisions regarding house renovation will be presented. The hypothesis verified with the use of a questionnaire is that positive arguments of the house owners in favour to renovate are mostly rational and the negative arguments are mostly heuristic.

Based on theoretical and empirical findings on dual process models, implications for policy making and informational campaigns concerning deep energy renovation will be proposed.

Keywords: Energy renovation, behavioural change, heuristic thinking, nudges, energy efficiency

1. Introduction

Europe is characterized by a 50% rate of owner-occupied dwellings and many countries including Belgium have even higher rates of over 70% (BPIE, 2011). Therefore in order to reduce residential energy consumption it is important to understand the mechanisms behind individual dwellers' behaviour. The present paper will focus on decision making aspects of private owners regarding deep energy renovation. These one-off decisions are different from daily energy use, where habits and curtailment prevail. When we refer to deep energy renovation we intend energy efficiency measures that aim to achieve a Nearly Zero Energy Building (nZEB). It implies investments in: insulation (wall, floor, roof insulation, energy efficient glazing); energy efficient HVAC technologies; systems on renewable energy (PV, solar panels, geothermal heat pumps).

The existing approaches for the uptake of energy renovation can be divided in two main categories: the one based on neo-classical economics' assumptions and the one based on environmental consciousness. The first approach considers the householder as *homo economicus*, who in his pursue of utility maximization, is able to choose rationally between the multitude of available energy efficiency measures. Nevertheless this approach has the limitation of considering individuals more or less as 'computers' with unlimited cognitive abilities and complete emotional self-control (Thaler & Sunstein, 2008). The Utility maximization model states that eventually the wrong estimations will be corrected with experience, yet the renovation decisions are usually one off and irreversible.

Whereas the first approach is based on financial arguments (extrinsic motivation), the second approach addresses the environmental consciousness of the individuals (intrinsic motivation). Energy related behaviour is explained with values, attitude formation, personal norms and self-efficacy (Perlaviciute & Steg, 2014), (Owens & Driffill, 2008). Various public and NGO informational campaigns have the purpose to relate energy consumption to environmental impact.

The vast majority of dwellers acknowledge the importance of energy efficiency. According to the Flemish Energy Agency VEA more than 90% of Flemish consider energy saving as rather to very important (VEA, 2013). Yet the figures of environmental consciousness resist to translate into action. Large-scale surveys (Bartiaux, et al., 2006), (Ceulemans & Verbeeck, 2015) document the gap between self-reported intentions and the actual energy efficiency measures undertaken.

Consequently, filling the intention-action gap with information regarding monetary or environmental benefits proved to have a lower impact than expected. Both approaches are based on the assumption that dwellers are exclusively rational in their reasoning. In reality decisions are systematically affected by the *"self-control problems, unrealistic optimism, and limited attention"* characteristic to humans (Sunstein, 2014). People tend to escape the slow and cognitive processing of the information with the use of a shortcut called heuristic or bias (Darnton, 2008). Figure 1 illustrates two ways of thinking: **the rational (System 2)** and the

heuristic (System 1). System 2 is the slow and deliberative, while System 1 is fast, automatic and intuitive. These two routes process the information concurrently, hence the models are called Dual Process Models (DPMs).

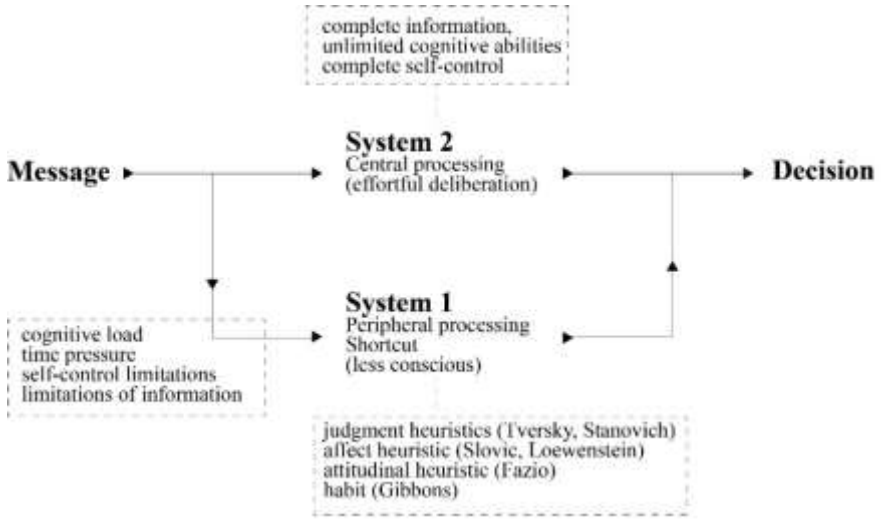

Figure 1 Scheme Dual Process Models

Certain DPMs constitute the theoretical background of the nudges – "*any aspect of the choice architecture that alters people's behaviour in a predictable way"* (Thaler & Sunstein, 2008). The raising interest towards nudges as a policy measure in various fields including energy efficiency provides a vast literature (Momsen & Stoerk, 2014), (Sunstein, 2014), (Behavioral Insights Team, 2011). These mostly contain applied behavioural insights without exploiting the mechanisms and models behind these biases. On the other hand, reports comprising all the behavioural models (Darnton, 2008), (Chatterton, 2011) do not consider the dual process models separately since their purpose is to give a general framework.

The present paper will give an overview of exclusively DPMs, from the perspective of their implications to energy renovation. The second chapter contains a classification of the DPMs and the balance between the rational and heuristic thinking. Part 3 details heuristics and biases of the System 1 that might be applicable in the context of energy renovation. In order to verify if dwellers' arguments regarding energy renovation are mostly rational or heuristic, a questionnaire was elaborated. The target of the questionnaire are the private owners in Flanders and it will be presented in chapter 4. In conclusion will be proposed implications for public policy based on the findings of the survey.

2. Overview of the existing dual process models

2.1 Classification of the DPMs

Starting from 1950s on, research in the field of psychology provides empirical evidence of the dual processing of information as a reaction against the ever increasing belief in rational decision making in economic models. An overview of the existing DPMs is given here below

and summarized in **Error! Reference source not found.**. Insights into how these models apply to energy renovation, is offered in chapter 3.

Certain DPMs focus on decisions taken under uncertainty, time pressure and cognitive load, when people tend to avoid the difficult cognitive deliberation with the use of a fast, intuitive shortcut (Darnton, 2008). This principle is the theoretical basis of behavioural economics, with Simon Herbert's model **Bounded Rationality** (Simon, 2000); Tversky and Kahneman´s **Judgment Heuristic** (Kahneman, Slovic, & Tversky, 1982) and **System 1⁄ System 2** of Stanovich and West (Stanovich & West, 2000). When considering different alternative energy renovation measures, dwellers usually face difficult technical information. Besides the complexity of the information and the variety of possible solutions, the problem of uncertainty persists. There is little consensus on which option is more suitable or cost effective for a particular dwelling, since the sustainability of a technology in its complete life-cycle is strongly context dependent. For example the efficiency of solar technologies depends on the micro-climate conditions, proper installation; the sustainability of biomass technologies depends on the availability and origin of the biomass, etc. Under these circumstances the effortful analysis of the information is often shortcut by a cognitive bias.

Other two models that stipulate the central (cognitive) and the peripheral (less conscious) processing of the messages are the **Elaboration Likelihood Model** of Petty R. E. and Cacioppo J. and the **Mode Model** of Fazio. These models underline the importance of attitude and motivation when facing effort demanding information (Darnton, 2008). Other factors for heuristic thinking are emotions and perceived risks. According to Slovic's **Affect Heuristic Theory**, "perceived risks and perceived benefits may be inversely related in people's minds" (Finucane, Alhakami, Slovic, & Johnson, 2000). Similarly, **Risk as Feelings Model** of Loewenstein G. F. stipulates a direct path between emotion and behaviour (Darnton, 2008). The characteristics of the individuals that include 'need for affect' will be explained in part 2.2.

Table 1 Classification of the Dual Process Models

Main trigger of System 1	*Model, theory*	*Authors*	*Year*
Uncertainty, time pressure, heavy cognitive load	*Concept of bounded rationality*	*Herbert S.*	*1955*
	Judgment heuristic	*Tversky A. Kahneman D.*	*1974*
	System 1/ System 2 cognition	*Stanovich K.E, West R.F.*	*2000*
Motivation	*Elaboration likelihood model*	*Petty R.E., Cacioppo J.*	*1986*
	Mode model	*Fazio R.H.*	*1986*
Emotions	*Affect heuristic*	*Slovic P.*	*2000*
	Risk as feelings model	*Loewenstein G.F.*	*2001*
Habit	*Theory of interpersonal behaviour*	*Triandis H.*	*1977*
	Prototype/willingness model	*Gibbons F.X., Gerard M.*	*2003*

Finally, for certain DPMs habit is the main trigger of the shortcut from the rational thinking. Models such as **Interpersonal Behaviour** of Triandis (Chatterton, 2011) and Gibbons´ **Prototype⁄ Willingness Model** describe frequently repeated actions that become automatisms. These models might be useful to explain the daily energy use of the dwellers, but are not appropriate for one-off decisions on energy renovation.

2.2 Balance between the rational and heuristic systems

The main feature of DPMs is the concurrent possibility of processing certain information in a slow, rational way (System 2) or in a fast, intuitive, heuristic way (System 1). Understanding the factors influencing this delicate balance is rather significant for policy making. If the arguments of an informational campaign are exclusively rational, it is important to verify if the target processes the information in a cognitive way.

One of the factors influencing the balance between the two systems is the way the message is formulated. Complex information is one of the main triggers of heuristic thinking. In the same line of thought, the BIT (Behavioural Insights Team) states the importance of simple and salient information in their EAST (Hallsworth, et al., 2014) and MINDSCAPE Methods (Dolan, Hallsworth, Halpern, King, & Vlaev). Elaborated in collaboration with the British Government, these methods aim to apply behavioural insights in public policy measures.

According to Baldwin, the 'First Degree nudge' has the purpose to enhance reflective decision-making and avoid an existing heuristic (Baldwin, 2014). If the information is easy, attractive and salient, it is more likely to be processed rationally. Besides the accessibility, the message framing should avoid possible existing biases. The 'Second' and 'Third Degree' nudges use an existing or a newly induced bias towards a predictable outcome, addressing System 1 (Baldwin, 2014).

At the same time, the balance between the systems depends on the individual's characteristics. Apart from intellectual capabilities of processing complex information, there are other parameters measuring the availability to engage in this processing, such as need for closure, need for cognition and need for affect. Due to heterogeneity of the population, the impact of nudges is not uniform, occurring the risk to "*discriminate against vulnerable parties*" (Baldwin, 2014).

Need for closure

Need for closure is defined by Kruglanski as "desire for a firm answer to a question, any firm answer as compared to confusion or ambiguity" (Kruglanski, Mannetti, & Pierro, 2006). In their urge for clarity, people with high level of need for closure are more likely to use the bias as a shortcut. In these cases it is important to implement the 'First Degree Nudge'. By simplifying complex messages, it is more likely to avoid existing biases and redirect towards rational thinking.

	First Degree Nudge (avoid existing bias)	*Second Degree Nudge (use existing bias)*	*Third Degree Nudge (induce new bias)*
Need for closure	*high*	*high*	*high*
Need for cognition	*low*	*low*	*low*
Need for affect	*low*	*high*	*high*

illustrates the characteristics of individuals that are more likely to be receptive to the three types of nudges.

Need for cognition

Contrary to the need for closure refers the 'need for cognition' to an individual's tendency to "engage in and enjoy effortful cognitive endeavours" (Cacioppo, Petty, & Kao, 1984). The higher the need for cognition, the higher is the probability that the individual will process even difficult information rationally via System 2, avoiding the bias. On the contrary, individuals with low need for cognition are more prone to avoid difficult cognitive processing and are more likely to be influenced by 'Second Degree' and 'Third Degree' nudges, see

	First Degree Nudge (avoid existing bias)	*Second Degree Nudge (use existing bias)*	*Third Degree Nudge (induce new bias)*
Need for closure	*high*	*high*	*high*
Need for cognition	*low*	*low*	*low*
Need for affect	*low*	*high*	*high*

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Need for affect

Difficult to process information is not the only trigger of heuristic thinking. The dwelling is a home, not merely a physical house. The existing state of the dwelling is associated with warmth, family, pleasant memories. These emotional bounds can be an important impediment in assessing in a rational way the economic benefits of the renovation. For this reason messages or images promoting energy renovation should associate nZEB with warmth, coziness and well-being, and not only with convenience and technology.

The balance between a cognitive and an emotional evaluation depends as well on the individual's motivation to "approach or avoid emotion-inducing situations", also called his 'need for affect' (Maio & Esses, 2001). People with high need for affect and low need for cognition are less likely to process the information in a cognitive way since the two parameters are related.

Table 2 Impact of the three types of nudges depending on individual's characteristics

	First Degree Nudge (avoid existing bias)	*Second Degree Nudge (use existing bias)*	*Third Degree Nudge (induce new bias)*
Need for closure	*high*	*high*	*high*

Need for cognition	*low*	*low*	*low*
Need for affect	*low*	*high*	*high*

3. Applying behavioural insights from the dual process models to energy renovation

While System 2 thinking implies slow and deliberative thinking, System 1 is characterized by shortcuts: heuristics and biases. These are intuitive estimations of probability of the outcome that allow taking fast decisions. While in everyday practice these intuitive shortcuts might be useful in increasing the efficiency of small decisions, they can be dangerous in taking important decisions such as the ones regarding energy renovation. Previous research in behavioural economics has shown that System 1 thinking generates the heuristic assessment of probability and as a result systematic errors that can be predicted (Ariely, 2008), (Tversky & Kahneman, 1974). The present chapter presents relevant heuristics and biases in the context of deep energy renovation decisions. Some of them served as assumptions for the elaboration of the questionnaire described in Chapter 4.

Availability heuristic: the probability of an event or the frequency of an object is assessed by the ease with which it can be, recalled (Kahneman, Slovic, & Tversky, 1982). If the event is present in the memory, the bias is due to '*retrievability*' (Tversky & Kahneman, 1974). Often the choice of a certain renovation measure is based exclusively on its familiarity (already known information or singular cases from friends) or on its salience (PV panels have high visual impact, certain technologies have more coverage in media, etc.). The bias of *'imaginability'* regards the objects and events that are not present in the memory. For example, the aesthetical advantages of the refurbishments the architect describes are easier imagined than the energy efficiency measures' benefits such as thermal comfort, humidity control, etc.

Representativeness heuristic explains how people assess the probability of events merely based on the "*degree to which A resembles B"* (Tversky & Kahneman, 1974) ignoring important factors such as sample size and base rate frequency of the outcome. An example of representativeness heuristic is the way dwellers assess what is responsible for a high energy consumption (and respectively a high energy bill). They might overestimate the impact of their occupancy patterns and underestimate the importance of the characteristics of the dwelling. Everyday actions such as heating, cooking and showering *resemble* other activities such as buying groceries or dining out. All these actions are regarded as expenses depending mostly on the dweller's lifestyle. This way, the bill on the heating is associated more with the temperature chosen and less with the insulation of the dwelling. The characteristics of the dwelling are perceived as external factors such as prices on the menu that you have to accept if you opt to dine out. This heuristic might be an explanation for the distrust in the energy performance certificate of the dwelling. It is calculated for standard occupancy, while people expect the certificate to reflect their actual energy consumption.

Adjustment and anchoring: in order to estimate a certain value, people start from an initial value called '*anchor*' and try to adjust it accordingly. It is a good strategy for assessing

subjective utility if not for the heuristic aspect according to which *"*different starting points yield different estimates*"* (Kahneman, Slovic, & Tversky, 1982). This is one of the reasons why framing of the message is highly influential.

The overall probability of a series of events is different from the probability of the elementary events of which it consists. The latter works as an anchor and people *"*tend to overestimate the probability of conjunctive events and underestimate the probability of disjunctive events*"* (Tversky & Kahneman, 1974). The renovation process is a concatenation of '*conjunctive'* events. In order to achieve the final result, all the elementary events have to take place, such as obtaining the renovation permit, etc. The success rate of each phase is very high, but the overall probability of the sequence is much lower. Often dwellers overestimate the overall success rate and underestimate the difficulty of the renovation process. It may lead to excess of optimism in initial planning and disappointment during the process.

On the contrary perform the *disjunctive* series of events, such as the risk of malfunctioning of the building' systems. In this case it is enough that one of the indispensable elements of the chain breaks in order to block the entire system. The probability that each element will malfunction is very low, the overall probability is higher but once again, the initial low probability works as an *'anchor'*. Therefore people underestimate the risk of malfunctioning of the systems and neglect their duly inspection and maintenance.

Satisfice bias: people aim for a satisfactory result, rather than an optimal result**Invalid source specified.**. When confronted with too many options and too complex information, often people rush for the 'good enough' renovation measure and avoid seeking 'the best' option (Frederiks, Stenner, & Hobman, 2014). People with a high level of need for closure are more likely to incline for the first *'satisficing'* option that is encountered. Moreover, satisfice bias might be related to **status quo bias** if the existing state of the dwelling is perceived as 'good enough' and, as a consequence, renovation is discarded altogether.

Social norms: the decisions are heavily influenced by others' opinions or others' undertaken decisions (Frederiks, Stenner, & Hobman, 2014), (Ariely, 2008), (Behavioral Insights Team, 2011). Social norms might explain the choice for under optimal, lock-in technologies. These solutions give the confirmation, recognition that these are the best technical, ecological solutions ("there must be a reason why everybody chooses it"). Besides it spares the hassle to compare multitude of available solutions in order to find the solution that best fits your particular dwelling.

Discount the future: smaller benefits in the present overweight bigger benefits in the future (Behavioral Insights Team, 2011). Time affects as a dimmer thus future savings on the utility bills resulting from energy efficiency investments are less appealing.

Endowment effect: people value more the things they own, not due to their characteristics, but merely because they own them (Ariely, 2008). This bias might be the explanation why people resist to change old appliances and boilers with energy efficient ones.

4. Questionnaire on rational and heuristic thinking in energy renovation

1.1		I would place wall insulation because…	Positive	Behavioural Model/ Insight
	A	I want to live in a warm, comfortable house	H+	Affect heuristic (Slovic)
	B	I want to save money on heating	R+	Expected utility
	C	It is good for the environment	R+	Values: Schematic Causal Model of Environmental Concern (Stern)
	D	Everybody does it	H+	Social norms: Structuration Theory (Giddens)

1.2		I would not place wall insulation because…	Negative	Behavioural Model/ Insight
	A	I like my house the way it is now	H-	Affect heuristic by Slovic; Sunk cost fallacy, mental accounting
	B	I prefer spending money on interior design instead	H-	Mental accounts
	C	It doesn't make a big difference, my energy	R-	Self-efficacy: Social Cognitive Theory (Bandura)
	D	It is too expensive	R-	Expected utility

Figure 2 Example of questionnaire item with the explanation of the behavioural models (not visible to respondents) 1.1 Arguments in favour of insulation 1.2 Arguments against insulation

In the context of rational and heuristic thinking, a survey was undertaken to assess the way people process information regarding deep energy renovation. We verified if arguments in favour are mostly rational $\Sigma(R+) > \Sigma(H+)$ and the ones against are mostly heuristic $\Sigma(H-) > \Sigma(R-)$.

These two hypotheses are based on the hemispheric asymmetry theory. According to Schwartz' study from 1979 "*when subjected to positive affects, people tend to move the eyes to the right and when subjected to negative affects – to the left"* (Cacioppo & Petty, 1983). More clues supporting these hypotheses resulted from a focus group on behavioural insights in energy renovation organized in April 2015 with municipal officials in the context of Werfgoed Living Lab. Among arguments in favour of renovation were listed "*to reduce the footprint*" (ecological values, beliefs), "*house increases in value*" (expected utility); while among arguments against the renovation were listed "*a lot of cluster, noise, dust*" (affect heuristic), "*I like how my house looks now*" (endowment effect, status quo bias).

Before conducting the survey among Flemish owners interested in renovation, a pilot test was undertaken among 1983 employees of Hasselt University. The response rate was of 15.28% — 303 responses, out of which 248 were complete. The sample is not representative to the population due to high level of education and preponderance of the age group between 20 and 40 years.

The survey was structured in five topics: wall insulation, energy efficient windows, efficient boiler, solar panels and solar water heater. On each measure two questions were presented to respondents: with arguments in favour and against the uptake, see Figure 2. These were based on the most frequently reasons cited by Flemish private owners in large scale surveys (VEA, 2013), (Ceulemans & Verbeeck, 2015). Each question included four options, with two rational arguments (based on values, beliefs, Expected Utility) and two heuristic arguments (based on biases such as endowment bias, affect heuristic, social norms). The description of the behavioural models were not visible to respondents who had to rank the four options of the question. For our analysis we have assigned to ranking a score from 4 to 1 and for each respondent we have summed up the two rational options and the two heuristic ones.

For each measure the responses of the dwellers who installed it were analysed separately with the ones who did not or who are renters. For both categories of dwellers the hypothesis was confirmed for positive arguments, where prevail the rational thinking $\Sigma(R+) > \Sigma(H+)$, see Table 3. For negative arguments the results vary according to the measure. For wall insulation, PV panels and solar water heater still rational arguments prevail $\Sigma(H-) < \Sigma(R-)$, even if with a smaller difference than the positive reasons; while for efficient windows and boilers the rational and heuristic thinking are balanced $\Sigma(H-) = \Sigma(R-)$. It is important to underline that the latter measures are the most popular with respectively 74,6% (N=189) of respondents declared to have placed efficient windows and 59,7% (N=189) efficient boiler. Since these are stated reasons against the measure, the more a dweller acknowledges his own biases, the more likely he will install the measure.

If we compare the responses of the owners who have placed a certain measure with the ones who did not, we find a similar pattern according to the group of measures. Regarding efficient windows and boiler, the former group of dwellers are more rational in their positive attitudes. This underlines once more the necessity of 'First Degree nudge' that aims to enhance the rational thinking and avoid existing biases.

Table 3 Results of the paired t-test

	Owners who installed the measure				*Owners who did not install the measure*			
	Positive		*Negative*		*Positive*		*Negative*	
	mean Δ		*mean Δ*		*mean Δ*		*mean Δ*	
Wall insulation	*1.29***	H_1	*1.17***	H_2	*1.30***	H_1	*1.68***	H_2
Efficient windows	*3.18***	H_1	*0.27*	H_0	*2.69***	H_1	*0.15*	H_0
Efficient boiler	*3.08***	H_1	*-0.11*	H_0	*2.56***	H_1	*0.04*	H_0
PV panels	*2.80***	H_1	*1.07***	H_2	*2.47***	H_1	*1.82***	H_2
Solar water heater	*2.77***	H_1	*2.38***	H_2	*2.04***	H_1	*1.80***	H_2

Δ = Rational-Heuristic (min -4, max 4); H_1 $\Sigma(R+) > \Sigma(H+)$; H_0 $\Sigma(R-) = \Sigma(H-)$; H_2 $\Sigma(R-) > \Sigma(H-)$

A different trend shows the uptake of PV panels. In their negative attitudes, owners who installed them are more heuristic than the ones who did not. It suggests again that the dwellers who acknowledge their heuristics are more likely to undertake the measure. On the other hand, it might be explained by the fact that in the past the PV panels were heavily subsidized, and the social norms played a more important role in decision than the cost.

5. Conclusions

The traditional measures have proven to have a low impact in the uptake of deep energy renovation. New policy instruments that take into account the human limitation, such as nudges, are being tested in various fields including energy efficiency.

The preliminary results of the survey show that positive rational arguments prevail over heuristics, while negative ones are more balanced, depending on the measure. Since biases are already present especially in negative attitudes, there are two main strategies: to avoid them

('First Degree nudge') or to use them in the right direction ('Second Degree nudge'). Framing complex information regarding renovation in simple terms might redirect towards cognitive thinking. If unavoidable, existing biases can be used in a predictable direction. For example a right anchor would be nZEB levels and not the building stock average; right social norm would be the positive statistics (how many dwellers have placed a certain measure).

Since the survey contains stated preferences, it has the limitation of revealing only how people acknowledge they think. It is not likely for a person to admit or even realise his own heuristic thinking. Nevertheless, the survey reveals different patterns among positive and negative attitudes; among measures with a higher or a lower uptake; and in a lower degree, among owners who have placed the measures compared to the ones who did not.

Finally, in the elaboration of nudges have to be taken into account the heterogeneity of the population. Until now, the application of behavioural economics in policy making was mainly a simplified application of biases, ignoring the underlying dual behavioural models. The characteristics of the individual, such as 'need for closure', 'need for cognition' and 'need for affect' influence the balance between the two systems of thinking and might determine an asymmetric impact of the nudges.

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