The Role of Behavioural Economics in Energy and Climate Policy

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Abstract

This article explores how behavioural economics can be applied to energy and climate policy. We present an overview of main concepts of behavioural economics and discuss how they differ from the assumptions of neoclassical economics. Next, we discuss how behavioural economics applies to three areas of energy policy: (1) consumption and habits, (2) investment in energy efficiency, and (3) provision of public goods and support for pro-environmental behaviour. We conclude that behavioural economics seems unlikely to provide the magic bullet to reduce energy consumption by the magnitude required by the International Energy Agency's "450" climate policy scenario. However it offers new suggestions as to where to start looking for potentially sustainable changes in energy consumption. We believe that the most useful role within climate policy is in addressing issues of public perception of the affordability of climate policy and in facilitating the creation of a more responsive energy demand, better capable of responding to weather-induced changes in renewable electricity supply.

Keywords behavioural economics, energy economics, energy demand, energy efficiency, private provision of public goods

JEL Classification D03, D10, Q40, Q58

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1. Introduction

While energy efficiency and conservation have been important tenets of energy policy for decades, concerns about climate change have put these issues at the forefront of policy dialogue. International Energy Association (IEA 2010) estimates that by 2020, about 34% of the global decrease in carbon emissions in a "450 scenario" (limiting the long-term concentration of greenhouse gases in the atmosphere to 450 ppm CO_2-eq) compared to the reference scenario should stem from direct end-use energy-efficiency measures. This goal calls for a step change in how individuals consume energy and make energy-efficiency purchases. Energy consumption, energy-efficient investment, and pro-environmental actions involve consumer decision making and behaviour. These aspects have generated increased interest in designing policy interventions that target energy demand, and interest in assessing the responsiveness of consumer behaviour to these interventions. Behavioural economics can provide new perspectives that can inform policy design on how individuals evaluate options, make decisions, and change behaviour.

It is important to point out that energy policy is not just about climate change, but also about security of energy supply and about the affordability of energy. Climate policy significantly interacts with both of these elements of energy policy via the introduction of expensive and intermittent renewable electricity and heat. If consumer behaviour can be changed to reduce energy demand or to make energy demand more responsive in time and space to weather-induced shortages of energy, it could be a significant contribution to facilitating the introduction of climate policy–induced renewable energy. By contrast,

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failure to address public concerns about the security of supply or affordability implications of climate policy may jeopardize the achievement of ambitious carbon emissions reduction targets.

Behavioural economics uses insights from psychology to increase the explanatory power of economics. According to neoclassical economics, agents maximize expected utility using exponential discounting, and they have access to information that they can assess freely and completely. While this is a parsimonious representation of how economic decisions are made, experimental settings and empirical observations indicate that behaviour deviates systematically from what traditional models would predict. Some of the puzzles that traditional economics struggles to explain are the following: why are returns on equity much higher than returns on bonds (equity premium puzzle); why are there untapped opportunities to reduce (energy) expenditure through increased (energy) efficiency (efficiency gap); and why do individuals indulge in immediate gratification, knowingly compromising their long-run well-being (substance abuse)? Behavioural economics challenges one or more of the assumptions of the neoclassical economics, and offers an alternative way to model decision making. These alternative models often better match empirical observations and have higher predictive power than models based purely on neoclassical assumptions.

While traditional economics assumes individuals always behave rationally, behavioural economists often stress the "irrational" aspect of decision making, often referred to as "behavioural failures". These behavioural failures may make individuals act against their own long-term interest. Thaler and Sunstein (2008) argue that if individuals do not always choose what is best for them in the long run, it is welfare-enhancing for policy makers to ensure that the set of choices that individuals face is such that a long-term, welfare-maximizing outcome becomes more likely. This may be done through proper framing choices, setting appropriate (limited if necessary) choice sets and providing appropriate "default options". In essence, individuals are "nudged" towards a welfare-maximizing outcome, even if their freedom to choose is still respected. Thaler and Sunstein (2003) called this approach "libertarian paternalism". Libertarian paternalism would argue for policy interventions in the face of behavioural failures, even if market failures are absent.

Traditionally, economics has focused on how changes in prices affect behaviour. Research in behavioural economics and psychology has demonstrated that non-pecuniary interventions compare favourably to monetary interventions in changing consumer behaviour. It was also shown that judiciously applied pecuniary interventions increase the impact of monetary interventions if used in combination. This has increased interest in research in behavioural economics as a guide for policy making in areas as diverse as public health, finance, and law. That behavioural economics can inform decision making in energy policy has increasingly been recognized by policy makers and researchers (Allcott and Mullainathan 2010; DEFRA 2010; OFGEM 2011).

In order to realize energy savings and emissions reductions necessary to address climate change, decision makers have to consider tapping into behavioural transformation strategies. Behavioural Economics provides insights that can inform this effort. Behaviours that are relevant to household energy consumption encompass three broad areas (1) energy consumption, curtailment, and habits; (2)

energy efficiency investments; and (3) contribution to public goods (i.e. green energy) and pro-environmental behaviour. These three aspects of energy consumption are interrelated; for example, pro-environmental attitudes may make efficiency investments more likely, and these investments may reduce energy consumption in the long run. However, these topics differ in terms of the decision making and behaviours involved, and warrant separate reviews.

The rest of this paper is organized as follows. Section 2 presents the major concepts that distinguish behavioural economics from neoclassical economics. Sections 3, 4, and 5 form the heart of the paper and discuss how behavioural economics relates to energy consumption and policy. Three broad areas related to energy are discussed: energy consumption, curtailment, and habits (section 3); energy efficiency investments and purchases (section 4); pro-environmental behaviour and public goods (section 5). Section 6 provides concluding remarks.

2. Behavioural Economics vs. Neoclassical Economics

The main departures from neoclassical economics proposed by behavioural economics can be grouped under four main areas: (1) time-varying discount rates, (2) prospect theory and importance of reference points, (3) bounded rationality, and (4) pro-social behaviour and fairness. Below we briefly discuss each of these areas.

2.1. Time-Varying Discount Rates

Experiments show that individuals use a higher discount rate over a longer time horizon than over a shorter time horizon (Thaler 1981; Benzion et al. 1989; Holcomb and Nelson 1992). To deal with this apparent anomaly, behavioural economics proposes hyperbolic discounting. Under hyperbolic discounting, individuals have higher discount rates for short horizons, but low discount rates for long horizons (Laibson 1997). This implies that people will be farsighted when planning if both costs and benefits occur in the future. However, they will make short-sighted decisions if costs or benefits are immediate (Camerer and Loewenstein 2004). Some of the manifestations of the time-inconsistent preferences are inability to lose weight, stop smoking, and save enough for retirement (Wilkinson 2007).

If individuals have time-varying discount rates, at some point in the future their preferences change. Preferences between two future rewards can reverse in favour of a more proximate reward, if the time to both rewards diminishes. An individual may prefer $110 in 31 days over $100 in 30 days, but prefer $100 now over $110 tomorrow. (Frederick et al. 2004). This is inconsistent with exponential discounting used by neoclassical economics in expected utility models. If agents were to discount future utilities exponentially, time preferences would not reverse, because the delay of 30 days is shared between the two options. Time-varying discount rates could explain the tendency to procrastinate. When given a choice between performing 5 hours of an unpleasant task today and 5 ½ hours of an unpleasant task tomorrow, most people choose the second option and delay the task. On the other hand, when given a choice of 5 hours of unpleasant work in a month, versus 5 ½ hours of unpleasant work in a month and a

day, most people take the first option. However, if an individual decides to do the work in a month, when the day comes, he or she would again prefer to delay it until the next day (O'Donoghue and Rabin 2000).

Some individuals may be aware of their tendency to procrastinate, and may value the opportunity to make a commitment. The fact that people value commitment devices has been demonstrated empirically. Ashraf et al. (2006) show that when given the choice of depositing money in a savings account from which they can draw freely and a bank account that pays the same interest rate but restricts when funds can be withdrawn, some individuals choose the latter option. Individuals who chose commitment saving accounts increased saving rates by 82%. Traditional economics finds it hard to explain why some people would choose an illiquid asset over a liquid asset, even if they pay the same interest rate.

2.2. Prospect Theory and Importance of Reference Points

In standard economic theory, an individual's preferences among different commodity bundles depend on wealth and prices, but are independent from the composition of their current endowment (assets) or their current consumption. Prospect theory, developed by Kahnemann and Tversky, states that welfare changes should be evaluated according to certain reference points (Kahnemann and Tversky 1979). The following are some of the manifestations of the important reference points for welfare evaluation.

Loss aversion. Traditional economics assumes that individuals are risk averse or risk neutral but place the same value on losses and gains of equal amount. Kahnemann and Tversky (1979) argue that valuation of losses is the mirror image of valuation of gains and refer to this phenomenon as the *reflection effect*. Decision-making will exhibit the reflection effect when the individual is risk-averse in the face of potential gains, but risk-seeking in the face of potential loss. It has been demonstrated empirically that individuals tend to value losses more than gains. This is found in contingent valuation studies that show that willingness to accept (WTA) is typically higher than willingness to pay (WTP) (Shogren and Taylor 2008). Shefrin and Statman (1985) demonstrated that investors hold on too long to the stocks that lost value, but are eager to sell the stocks that gained in value, and argue that this is due to reluctance to sell at a loss.

Endowment effect. This refers to the extra value that individuals attach to goods they already own or services they already receive. In essence, the endowment point is the reference point, and agents have a kink in the valuation around this point (Thaler 1980). Heberlein and Bishop (1986) found that hunters were willing to pay $31 for a particular hunting permit but were not willing to let go of the same permit for less than $143.

Status-quo bias. Individuals tend to stick to the default option chosen for them. For example, in countries where organ donation is conducted under presumed consent (i.e. consent by default, unless explicit opposition was registered by donor), participation rates are 25%–30% higher than in countries where donation is conducted under informed consent (i.e. no consent is presumed unless it was made

explicit) (Abadie and Gay 2006). Samuelson and Zeckhauser (1988) showed that when new healthcare options were offered to Harvard University faculty, new faculty members were more likely to choose them, but older faculty members were unlikely to modify their current plans.

2.3. Bounded Rationality

Bounded rationality refers to the phenomenon that agents are rational but have cognitive constraints in processing information (Simon 1986). Therefore they deviate from rationality in certain circumstances. Some of the manifestations of bounded rationality are the following: (1) choice overload, (2) heuristic decision making, and (3) failure to assess statistical probabilities.

Choice overload refers to the difficulty individuals have in making a choice when presented with too many options. Studies show that more shoppers make a purchase of a jam when they are presented with 6 choices than when they are presented with 24 choices (Iyngar and Lepper 2000). Traditional economics struggles to explain this tendency, and assumes that more choices are always preferred to fewer choices.

Heuristics are shortcuts to decision making, such as via a rule of thumb. Traditional economics assumes that individuals use concepts of statistical sampling and statistical rules (e. g. Bayes' rule) for updating probabilities of future events in the face of new evidence (Camerer and Loewenstein 2004). Experiments demonstrate that individuals often make choices in a way that departs from the Bayesian assessment that they are supposed to make under traditional economics. This departure may be systematic (biased) rather than idiosyncratic. Individuals may categorize purchases under different categories and have different discount rates for these categories. For instance, higher one-off expenditures may be categorized under a separate mental account and have different discount rates than multiple smaller expenditures. Thaler (1999) showed that an individual's willingness to spend earned income, windfall income, or saved income is not the same, even if money can be used interchangeably. This contradicts the assumption of traditional economics that money is fungible. Heath and Soll (1996) suggest that mental accounting can explain why individuals make apparently suboptimal consumption choices.

There is some indication that consumers do not correctly process statistical information and probabilities. They are swayed by vivid and *salient* information more than by simply convincing, statistically correct information. Research shows that individuals overstate small probabilities of catastrophic losses or large gains. Julien and Salanie (2000) find that on horseraces, there is bias towards betting on "longshots", implying that gamblers like to gamble, but they are disproportionally afraid of small chances of losing when they bet on heavy "favourites". Cook and Clotfelter (1993) find that Lotteries are popular because players are more sensitive to large jackpots than to the probability of winning.

2.4. Pro-Social Behaviour and Fairness

Neoclassical economics assumes that an agent makes choices that depend only on his or her own monetary payoff and consumption (Pesendorfer 2006). However, in experimental games and empirical studies, it has been demonstrated that individuals seem to value fairness and often act pro-socially. Kahneman et al. (1986) show that consumers have strong feelings about the fairness of a firm's short-run price decisions, and suggest that this prevents firms from exploiting their full monopoly power. Individuals often act pro-socially, contribute to charities, and engage in pro-environmental behaviour, even if this imposes costs on them. Behavioural economics challenges the view that economic agents are purely selfish.

If individuals are not as selfish as traditional economics has assumed, this unselfishness has important implications for understanding the private provision of public goods. According to neoclassical economics, individuals care only about their own consumption of public goods but do not directly benefit from their own contribution, nor are they directly affected by other people's consumption or contribution (Bernheim and Rangel 2007). Traditional economics claims that people will have a tendency to free ride, and that public goods will be underprovided unless provisions are mandated through taxation. Furthermore, only very wealthy are predicted to make voluntary contributions, and as population increases contributions should converge to zero. These assumptions provide testable hypotheses that are contradicted by empirical evidence (Andreoni 2006; Bernheim and Rangel 2007). Behavioural economics provides an alternative view to help explain why and when individuals make private provision of public goods.

Two behavioural explanations relate to people's attitudes towards providing for public goods. First, individuals are not purely selfish, but place value on social goods. In essence, they value not only their own consumption, but also the consumption of others (they are other-regarding). Public goods may still be underprovided, but this is because individuals think it is not fair that they bear the burden for their provision at the expense of others. Ostrom (1998) finds that in public goods games (i.e. experiments where individuals are given the opportunity to contribute to the provision of a public good) most individuals are conditional co-operators – they will contribute, if they are sure that others will do the same. Second, individuals contribute to the social good because of the "warm-glow" effect. Warm-glow effect refers to the idea that individuals might participate in public goods (such as a green-electricity program) because it makes them feel good (either because they feel better about themselves, or because they care about what others think of them), but not necessarily because they care about the public benefit per se (Andreoni 1990; Bernheim and Rangel 2007). In essence, besides valuing their own consumption of public goods, individuals value having contributed to public good provision.

The motivations for providing for public goods are hard to test empirically. As a result, "warm glow" is often treated as a reduced form of deeper underlying processes (social norms, social signalling, reciprocity, altruism, etc.). Disentangling these processes is challenging and their representation may vary among different policies and contexts (Bernheim and Rangel 2007). Nevertheless, different

underlying motivations may have different policy implications. If an individual would provide for public goods only with the assurance that others do not free ride (i.e. showing a concern for fairness), then increased contribution by others will increase the likelihood of his or her contribution. If, on the other hand, an individual contributes as a status symbol (e.g. because of a desire for a warm glow or prestige), then provision by others may decrease the likelihood of his or her contribution. In this case, a monetary incentive for contributing may crowd out the altruistic incentive to contribute.

Researchers indeed find that monetary rewards sometimes crowd out intrinsic motivation, especially if the monetary rewards are small. For example, when a small monetary payment was offered for blood donation, blood donations actually decreased (Titmuss 1987[1971]). It was also found that volunteers perform better when they are not compensated than when they receive small monetary compensations (Gneezy and Rustichini 2000). These findings are hard to reconcile with traditional economics, but can be explained by behavioural economics, as they take away from the warm-glow satisfaction of giving.

3. Energy Consumption, Curtailment, and Habits

In this section we discuss topics that involve repetitive or continuous efforts to reduce energy consumption or to change energy-use habits. The policy interventions discussed in this section focus primarily on promoting energy curtailment in the household energy sector. In addition, we discuss how changing the tariff or billing structure affects energy consumption patterns.

3.1. Rate Structure: Flat vs. Dynamic Tariffs

The marginal cost of producing electricity varies through the day, and the wholesale electricity price is high during the time of peak electricity usage. Traditionally, residential electricity customers faced flat electricity tariffs, and were insulated from fluctuating wholesale electricity prices through the day. If electricity demand becomes “flatter”, utilities will save on energy costs by minimizing usage of peaking plants, which are usually less efficient and produce more carbon emissions. Further down the line, having a smoother demand will result in reduced investments for building peaking plants. Cost savings can eventually be recycled back to the consumers.

Recently, policy makers and utilities have been looking at the potential of introducing tariffs that vary by the time of usage. Some possible variable tariffs are the following: (1) time-of-use tariffs (TOU), when customers face different tariffs according to the time of day; (2) critical peak pricing (CPP), when customers face higher tariffs during certain critical peak times through the year; (3) peak-time rebate, when customers pay flat electricity tariffs but receive rebates if the electricity usage is reduced compared to a certain benchmark at critical times through the year; (4) real-time pricing, when customers’ electricity tariffs fluctuate in real time according to the wholesale electricity prices.

Time-varying tariffs require advanced (smart) meters that can measure consumption in real time. The United Kingdom, Italy, and the state of California in the USA have legislated large-scale deployment of

smart meters, with other jurisdictions planning to follow their lead (Faruqui and Sergici 2009). Extensive research is underway by policy makers, utilities, and academics to gauge the potential for demand-side response (DSR) to time-varying tariffs. The value of DSR hinges on the potential of customer behavioural response and is an area that can draw important insights from behavioural economics. Below are some of the concepts from behavioural economics that are relevant to the decision to implement variable rates.

- *Endowment effect.* Bill payers currently enjoy the benefit of being insulated from variable rates during the day. Proper design and marketing of the dynamic tariffs will be critical for overcoming consumers' resistance to changing the cost-benefit structure of the way they consume electricity. Individuals are attached to their routines and daily habits and may be inflexible to modify them, or demand high compensation to do so.

- *Status-quo bias.* Research shows that when presented with a utility bill with a default choice, most consumers will not change it (Brennan 2006). Those who object to having the dynamic tariff either as a default or mandatory option, mention distributional considerations. They argue that most households will remain on the default plan even if it is not optimal for their consumption patterns. Vulnerable households, such as the elderly and disabled, will not be able to vary their load and will be losers under the dynamic tariffs, if that is set as a default (Felder 2010).

- *Time-varying discount rates.* Introducing dynamic tariffs raises concerns about short-term cost versus the "lag" in long-term gain (Simhauser and Downer 2011). Dynamic pricing will result in a "rate shock", as bills of some consumers will skyrocket in the near term, before behavioural adjustments, or before households acquire enabling technologies or replace old appliances with ones that better accommodate varying tariffs. Even if the long term costs of smart meter infrastructure proves to be beneficial, the long term may be really long (Hanser 2010). Since individuals tend to have higher discount rates for the future, they may not think that the costs are worth the benefits, especially if the savings are initially small or nil.

- *Loss aversion.* If individuals value (negatively) losses more than they value gains, rate increases during peak periods may have to be compensated with larger rate decreases during off-peak periods.

- *Concern for Fairness.* Opponents of mandatory dynamic tariffs cite fairness considerations towards the vulnerable. It is argued that vulnerable households (elderly, disabled, and poor) will not be able to shift consumption to off peak, since they have minimal electricity consumption to begin with and are often homebound. On the other hand, proponents for the dynamic tariffs state that it is not fair that "peaky" households are being subsidized by "less peaky" households through flat tariffs (Faruqui 2010).

High electricity bills are salient and raise vociferous opposition that results in a media outcry. Moving customers en mass to dynamic prices may bring adverse consequences and may result in a strong political backlash. Alexander (2010) gives examples of large-scale TOU tariff rollouts in the USA that did not meet expectations:

- Central Maine Power Company had implemented a mandatory TOU structure in the 1980s. However, in the 1990s, the TOU rate structure was changed to reflect higher peak electricity costs, but the increased bills caused consumer opposition, and TOU rates were made voluntary.

- Puget Sound Energy of Washington state implemented mandatory TOU pricing for residential customers in 2001. However, the program actually resulted in higher bills under the new rate structure. The program was halted in 2002.

Alexander (2010) suggests that having a peak time rebate (PTR) is a more attractive option compared to mandatory CPP or TOU. A PTR scheme would leave the underlying rate structure unchanged, but provide rebates or credit to those customers who reduce usage during critical peak hours. A rebate option should be viewed as "carrot only" rather than "stick only" (Maine Public Utilities Commission 2007; Alexander 2010). With CPP, "peaky" customers will see their rates increase if they do not change behaviour. If consumers focus more on the downside risk of higher bills than the upside potential, they will dislike CPP. More consumers would choose to take advantage of PTR than volunteer for CPP. Letzler (2007) argues that an incentive compatible rebate addresses the heuristics of consumer decision making better than CPP.

In 2008, Baltimore Gas & Electric (BGE) conducted a dynamic pricing pilot which showed that consumers responded to PTR as well as to CPP. As a result, BGE abandoned CPP and conducted a trial of only PTR in 2009. Faruqui and Sergici (2009) review 15 pilot experiments with dynamic pricing of electricity. Across the range of experiments studied, TOU rates induced a drop in peak demand that ranged between 3% and 6%, and CPP induced a drop in peak demand that ranged between 13% to 20%. When combined, the drop in peak demand was in the 27% to 44% range.

3.2. Billing and Payment Methods

How customers pay their utility bills may have implications for how they consume energy. This was demonstrated by a study of consumption and meter top-up behaviour of the households in Northern Ireland that use prepayment meters (Brutscher 2011a,b). Brutscher (2011a) shows that consumers with prepayment meters tend to consume more electricity. Households tend to purchase relatively small amounts of top-ups, and adjust to increases in tariffs by increasing their number of top-ups, rather than by increasing the amount. However, exogenous increases in minimum top-up amount result in decreased energy use. This suggests that consumers perceive costs differently according to how large they are. They have different mental accounts for larger purchases, and are more aware of the

consumption after they have made a large top-up. Increasing minimum top-up amount would therefore likely result in decreased energy consumption.

Brutscher (2011b) finds that low-income households use electric heat rather than oil because they have liquidity constraints—heating oil requires bulk purchase, whereas electricity meters can be prepaid in small amounts. As oil heating is more efficient and cheaper in the long run, this could be explained by time-varying discount rates, which prevent individuals from saving for bulk heating oil purchase. If the bulk purchase necessary for heating oil involves saving money for a future large purchase, the money being saved will be subject to temptation to make alternative purchases with more immediate gratification. If individuals have higher discount rates for the far future than for the near future, they will repeatedly succumb to temptation, even if they are aware that saving money will buy them a more efficient source of fuel in the long run. A heat stamp program (where consumers buy nonfungible credits towards future purchases of oil) is a potential solution for this behavioural failure. Heat stamp programs, currently operating in various communities in Northern Ireland, lets consumers gradually collect stamps that they can redeem for the bulk oil purchase.

3.3. Non-pecuniary Incentives to Conserve Energy

Non-pecuniary interventions have been attempted to elicit reductions in energy consumption, often in combination with monetary incentives and information provision. Where interventions were combined with monetary incentives, consumption feedback, or energy-saving information, it is hard to disentangle the effects of these interventions.

Competition has been effective in incentivizing individuals to reduce energy consumption. McClelland and Cook (1980) studied the effect of competition between master-metered residential buildings at the University of Colorado, USA. The buildings, where occupants were not individually metered, were competing on which building would save more electricity. Contestants received information on how to save electricity and feedback on savings of their usage, as well as the usage of the other groups. The winning building received a reward of $80. The contest groups used 6.6% less electricity than control groups. However, the savings decreased with time, suggesting that the effect of the reward was short-lived. Four buildings and 228 families participated in the study.

Pallak and Cummings (1976) studied whether they could induce reduction in energy consumption through soliciting public *commitment.* The study was carried out in Iowa City, USA. People who signed a public commitment showed lower rates of increase in gas and electricity use than those who signed a private commitment or those in the control group.

Energy savings can also be motivated by assisting consumers with *goal setting*. Becker (1978) gave households a relatively difficult goal (20%) or a relatively easy goal (2%) to reduce electricity use. All households received information on which appliances used more electricity, but only some households received consumption feedback. Only the households that had the difficult goal and received feedback

had a significant change in electricity consumption (15% savings). This study involved 100 families that lived in identical townhouses in central New Jersey, USA.

Most of the research conducted on non-pecuniary incentives has involved small samples, and it is not clear if these interventions are scalable. Most of the studies do not monitor interventions for a prolonged period of time, and it is not certain if habits were changed or behaviours eventually returned to pre-intervention norms. Where follow-up studies were conducted, it was typically found that the behavioural changes were not sustained. It is worth noting that in the Former Soviet Union countries, where price signals were ideologically frowned upon, prizes were used extensively to promote energy saving via goal setting, competition, and public appeals. However, anecdotal evidence suggests that these incentives, even if initially heeded, became eventually ineffective where price signals were absent.

3.4. Influence of Social Norms on Household Energy Consumption

Social norms affect individual actions through providing guidelines as to what is acceptable or "normal" behaviour. Some behavioural interventions aim to influence consumer energy consumption through increasing awareness of social norms. A number of studies have attempted to change energy consumption of households through providing them with the consumption information of their peers, as an indicator of social norms.

Nolan et al. (2008) left door hangers at 271 homes in San Marcos, California, USA, with different, randomly assigned energy conservation messages. Door hangers that compared a given household's energy demand to that of their neighbours led to 10% more energy demand reduction than door hangers that gave only energy conservation tips. Schultz et al. (2007) left door hangers in 286 homes in the same city. Residents who had lower energy consumption than average increased consumption (the "boomerang effect"). However, this effect was eliminated when a smiley face was drawn next to their energy consumption. The author postulates that the smiley face was interpreted as a normative signal and resulted in behavioural change.

While the above studies were based on small sample sizes, their findings were consistent with the results of a program run by OPOWER, one of the largest randomized field experiments in history. OPOWER mailed home energy report letters to customers, comparing their energy usage to that of their neighbors. These letters also gave customers energy conservation tips. OPOWER ran a program for 23 utilities, including 6 of the largest 10 utilities in the USA and 600,000 households. The study found that the intervention reduced average energy demand by 1.11% to 2.78% from the baseline usage (Allcott and Mullainathan 2010).

It is not clear if the behavioural changes resulting from these interventions can be sustained in the long run, or if the novelty of the social comparison would eventually wear off. Costa and Kahn (2010) analyzed the OPOWER data and found, in fact, that the program effects were heterogeneous: while the electricity conservation "nudge" of providing feedback to households on their own and peers' home

electricity usage works with political liberals, it backfires with political conservatives. The large-scale OPOWER experiment gained considerable media publicity and was hailed by leading policy makers as a testament that behavioural economics should motivate viable policy alternatives. However, Loewenstein and Ubel (2010) cautioned against being overly reliant on these types of interventions, pointing out that the energy savings they generated were very small. They stated that traditional mechanisms, such as a carbon tax would be far more effective even if politically more difficult to implement, as they would increase the price of carbon in line to its true cost.

3.5. Influence of Information Provision

Providing energy-saving information and energy-consumption feedback is successful in eliciting behavioural changes. The residential electricity market has traditionally suffered from asymmetric information. Traditional electricity meters provide cumulative consumption information and individuals do not always know which appliances consume most electricity and when. New technologies, such as smart appliances and smart meters provide innovative ways to access consumption information. Having access to disaggregated consumption information through a variety of media (i.e. the Internet) makes electricity consumption more tractable and easier to manage. Information asymmetry is typically assumed to be a market failure, and is studied under the paradigm of traditional economics. However, behavioural economics finds that not only is the information important, but also the way it is presented or framed.

If the communication of information takes into account the behavioural failures and heuristic decision making of consumers, messages can be crafted to solicit a sharper behavioural response. Since individuals are affected more by salient information rather than simply accurate information, then visual cues and vivid descriptions are important. For example, Thaler and Sunstein (2008) found that when the energy company in Southern California gave its customers an “Ambient Orb” that glowed in red when energy consumption was high (salient signal), orb users reduced peak energy demand by 40%. With large-scale deployment of new technologies that provide innovative ways of communicating information, providing appropriate vivid cues will become increasingly important. If consumers are affected by losses more than gains, the effective message should stress money wasted by missing the opportunity to save energy rather than emphasizing energy-saving behavioural change. The former formulation provides the same information but is more effective, although less welcomed, especially by elderly and vulnerable customers.

The credibility and trustworthiness of information sources makes a difference. Craig and McCann (1978) showed that when consumers received identical letters giving energy conservation advice but on different letterheads, the letter from the local energy commission had higher impact than the letter from the local utility. In communication, simple, salient, and personally relevant information is more effective than detailed, technical, and factual information (Wilson and Dowlatabadi 2007).

3.6. Choice of Electricity Suppliers or Tariffs

The unregulated monopolist does not have the incentive to keep prices down. Competition between suppliers results in lower prices if the buyers are able to shop for the best deal and change suppliers. However, there are indications that when presented with many suppliers, consumers do not switch. If consumers do not shop around for the best suppliers, opening markets that were formerly regulated can reduce welfare, if the incumbent supplier increases prices above those that were set by regulators (Brennan 2006). Behavioural economics explains this phenomenon by status quo bias, and/or information overload.

Traditional economics often assumes that information is costless and freely available. But when allowing for cost of searching and obtaining information, traditional economics would explain consumers' unwillingness to choose suppliers by the fact that search is costly (electricity bills are notoriously hard to read) and that the product (electricity) is homogenous. Wilson and Waddams Price (2005) provide the behavioural explanation that consumers are irrational and fail to switch. This has implications for the offering of more choices to energy consumers, which might be facilitated by the deployment of smart meters. Having more choices implies more opportunities for mistakes to be made by customers by selecting inappropriate suppliers for their needs. It may also reduce switching from incumbents due to information overload.

4. Energy-Efficient Investments and Purchases

Increasing energy efficiency can play a significant role in reducing overall energy consumption and associated emissions. Efficiency investments involve one-time, large monetary costs but result in cost savings over the long run through lower energy consumption. It has been shown that efficiency improvements could result in substantial long-run cost savings. However the "energy efficiency gap" puzzle remains. The gap normally refers to the difference between the observed level of energy efficiency and what is considered optimal energy use (Jaffe et al. 2004). Sometimes the energy efficiency gap is illustrated by comparing the market discount rate and the "implicit discount rate" imputed from appliance purchase decisions, taking into account cost of appliances and their energy efficiency (Hausman 1979). Studies have shown that the implicit discount rate is between 25 and 100 percent (Sanstad et al. 2006; Train 1985). Below we discuss behavioural explanations of the energy efficiency gap and effectiveness of policy interventions that aim to tackle it.

4.1. Behavioural Explanations for the Energy Efficiency Gap

It is not costless to assess how a new technology fits into one's home, or to find a reliable supplier and installer. Furthermore, future energy prices and future savings are uncertain. The transaction costs of new technology adoption can still be significant, so that the "purchase price" is only the lower bound of adoption cost (Jaffe and Stavins 1994). Below we discuss some of the behavioural explanations of the efficiency puzzle.

- *Time inconsistency.* Individuals have a high discount rate for future cost savings, but a small discount rate for large initial investment outlay. Alternatively, individuals may want to invest in energy efficiency but are procrastinating, or do not have the discipline to save money to pay for the initial investment.

- *Endowment effect.* Households are attached to the appliances they currently own, and are not willing to replace them, even if it is efficient to do so. This can partly be rationalized by the certainty that the new equipment works, against the risk of problems in installation or operation.

- *Salience.* Yates and Aronson (1983) suggest that individuals place disproportional weight on vivid and observable factors. This tendency may result in placing too much emphasis on initial investment costs, and underinvestment in energy efficiency. They recommend giving salient examples of energy savings and state that energy-saving advice should demonstrate the experience of a "highly efficient household" for the message to be better retained.

- *Heuristics.* Kempton and Montgomery (1982) use a survey and find that consumers use simple heuristics to assess their energy consumption, which leads to systematic underinvestment in energy efficiency. They conclude that this is the example of bounded rationality, when people adapt known methods to solving new problems, even if the known methods are not optimal for the new situation. This may be the optimal strategy, as it avoids the effort of analyzing the new situation (Simon 1955). For example, families used current energy prices to calculate expected savings from efficiency investment, thus not taking into account future price increases. When comparing consumption over the years, households compared their highest utility bills to estimate their consumption totals. Kempton et al. (1992) shows that consumers systematically miscalculate payback periods for air conditioners, and this leads to overconsumption of energy.

4.2. Incentives for Energy-Efficient Investments

Since energy efficiency investments are subject to market and behavioural failures, policy makers and utilities have devised various incentives to overcome them. Behavioural economics can shed light on which efficiency-promoting incentives are more effective. Since high upfront costs appear to discourage efficiency investments, policy makers often attempt to incentivize these investments through tax credits or efficiency programs administered by utilities.

Income tax credits or deductions have been used in the USA as an instrument to encourage energy-efficient investments. However evidence of their effectiveness is mixed. The U.S. Energy Tax Act of 1978 (ETA78) provided a federal tax credit for residential energy-efficiency investments and encouraged investment in solar, wind, and geothermal energy technologies. Carpenter and Chester (1988) conducted a survey with over 5,000 respondents from the USA. Around 89% of the respondents were

aware of ETA78's federal tax credit, but only around one-third of them filed this claim. Out of those who did file the claim, 94% were going to make the investment even without tax incentives (free riding). However, Hassett and Metcalf (1995) found that tax credits do encourage efficiency investments—a change of 10 percentage points in the tax price of the investment increases probability of investment by 24%. Williams and Poyer (1996) found that tax credits have a significant effect in improving energy conservation, even with free riders. They suggest that this may be due to spillovers, as some households make the investment because of the tax credit, but then fail to file for the credit when it comes time to file their taxes. This explanation is consistent with time-varying discount rates and tendency to procrastinate.

In summer 2011, the UK government ran a pilot trial of the "Green Deal"—a scheme to encourage homeowners to upgrade their buildings by installing energy-saving improvements at no upfront cost. Repayments for these investments would be made via a charge paid from savings made on a customer's energy bills. The trial took place in the London borough of Sutton, and involved 400 households that responded to the advertisement. Of the 126 households that eventually received home energy audits, only 60 signed up for the scheme, even if the subsidy represented 40%. The households that did sign up for the scheme indicated that financial incentives were not the primary motivation (BioRegional 2011).

Studies show that even when a utility offered to subsidize 93% of the cost of home insulation, consumer take-up varied from 1% to 20%, depending how the subsidy was communicated to the consumer (Stern et al. 1985). Stern (2000) suggests that incentives and interventions interact, and the joint effect of combining them is often bigger than the sum of each intervention on its own.

4.3. Appliance standards and building codes

If consumers indeed make biased decisions in their efficiency investment, and they do not take operating cost into consideration, then appliance standards may be welfare enhancing. Mandatory appliance standards can define the minimum energy efficiency standard that will be required by law for a given appliance. Building codes would define certain minimum efficiency characteristics that buildings should have. In essence, consumers will not be able to choose inefficient appliances or homes, as they will not be on the market. Mandatory standards and codes will encourage manufacturers to provide better energy efficiency in the context where it is not the most salient feature for consumers (DEFRA 2010).

Koomey et al. (1999) found that each dollar of U.S. federal expenditure on implementing the appliance energy-efficiency standards contributed $165 of net present-valued savings to the U.S. economy over the 1990 to 2010 period. They estimated the average benefit/cost ratios for these efficiency standards to be about 3.5 for the USA as a whole. However households that are low appliance users may prefer less efficient appliances, and suffer welfare losses when standards are imposed (Morss 1989).

5. Public Goods and Pro-Environmental Behaviour

Supporting green energy and combating global warming is a public good. Behavioural economics can help understand why and under which circumstances individuals are willing to contribute to these public goods voluntarily. These contributions may be monetary (i.e. when individuals pay a premium for green energy) or non-monetary (i.e. when individuals act pro-environmentally but sacrifice their comfort).

5.1. Provision Point Mechanisms and Green Energy

Behavioural economics claims that many individuals are "conditional co-operators" and value fairness. Individuals would be willing to contribute to public goods if they know that others do not free ride and also contribute (this is what a tax system can achieve formally). In essence, the difference between a "behavioural" explanation and a "traditional" explanation is that under the former, individuals do not want to free ride, they are just concerned that others do and think that this is not fair; under the latter, individuals have an innate tendency to free ride, and that will be the case even if others contribute.

Moskovitz (1992, 1993a, 1993b) argued that customers would voluntarily sign up and pay higher electricity rates if the additional money collected were earmarked to support renewable energy projects and environmental activities. Since then, utilities in many jurisdictions have offered green energy tariffs. These green tariffs represent a contribution to public good. If individuals are indeed willing to make voluntary contributions, public policy may harness this tendency through devising mechanisms that make these contributions more likely.

Public economics has dealt with the problem of under-provision of public goods through such mechanisms as taxes, and provision point mechanisms (PPMs). Under PPMs, individuals make voluntary contributions to a project, with disclaimer that if the necessary benchmark amount is not collected, the contributions will be refunded. Rondeau et al. (2005) compared the voluntary contribution mechanism (VCM) with the PPM in the laboratory and in a small field experiment, and found that the PPM was able to achieve higher contributions. Traverse City Light and Power in Michigan, USA, successfully built a windmill using this mechanism (Holt 1996a); the city of Fort Collins in Colorado raised money for three separate wind turbines using it (Holt 1996b).

Rose et al. (2002) used laboratory and field experiments to test the use of a PPM to finance a renewable energy program run by Niagara Mohawk Power Corporation in the USA. In the laboratory experiment, the PPM increased the rate of participation in a green energy program substantially above that of a treatment group. When the PPM was tested in the field, sign-up rates observed were much higher than those from other green-pricing programs that solicit voluntary contributions.

One of the problems with selling green energy in some jurisdictions (such as the UK) is that of proving additionality. Fixed targets for given quantities of renewables set by the government mean that buying green electricity simply assigns renewable output that would have been forthcoming anyway to a given

group of customers. This is because all customers will be made to pay for the renewable energy anyway, regardless of whether any make voluntary or conditional contributions.

5.2. Crowding Out Intrinsic Motivation

Behavioural economics suggests that if individuals are motivated by the "warm-glow" effect, then giving monetary incentives would decrease their motivation for contributing to public goods. On the other hand, if individuals pay a fine for behaviour that diminishes public goods, their intrinsic motivation for avoiding this behaviour may be reduced. This "crowding out hypothesis" is intellectually appealing, but so far few studies have demonstrated this effect empirically in the context of energy.

Jacobsen et al. (2010) use billing data of participants and non-participants in a green electricity program in Memphis, Tennessee. They find that households participating at the minimum threshold level increase electricity consumption by 2.5% after enrolling in the plan. They explain this with the "buy-in" mentality of these households. Household's guilt of generating high emissions is reduced by buying into green electricity at the minimum threshold, and payment for green electricity crowds out their motivation to reduce energy consumption. However, the effect was not large enough to offset the environmental benefit of paying for green electricity. Therefore the net effect was a reduction in emissions.

5.3. Voluntary Contributions and Public Image

Individuals may be more likely to provide public goods if their contributions are "publicly" acknowledged. Thus token gifts (i.e. pins, mugs, and stickers) given in exchange for the contribution are one way to encourage provisions.

Yoeli (2010) conducted a large-scale experiment in collaboration with PG&E, a regulated investor-owned utility in Northern California. Consumers were sent letters inviting them to volunteer to install a device in their homes that would allow the utility to control their air conditioners when electricity supply was tight. Volunteers had to sign up for the program on a sheet that was displayed publicly near mailboxes. The treatment group of households was requested to write their names on the sign-up sheet, while the control group of households provided a unique, anonymous numerical identifier. Households that had to provide full identity information had a higher sign-up rate (however, the difference was not statistically significant).

5.4. Public Appeals to Conserve Energy

When increasing prices is considered socially or politically unacceptable, governments have occasionally resorted to public appeals through the mass media to induce energy conservation. In the absence of price signals, traditional economics would not expect public appeals to change behaviour, because individuals would have already optimized their consumption choices for the given price (and would free

ride on others' contributions to the public good of avoiding blackouts). However, behavioural economics suggests that public appeals may result in increased awareness, and may induce altruistically motivated individuals to conserve more energy. In addition, some behavioural economists postulate that public appeals affect social norms.

Reiss and White (2008) used household-level data on energy conservation in California during the energy crisis of 2000–2001. Data consisted of a five-year panel of San Diego Gas & Electric Company households' utility bills. The sample consisted of 70,000 accounts. The prices increased sharply as a response to the crisis—electricity prices more than doubled in a span of three months. As a result, the average household electricity use fell more than 13% in 60 days. Following the initial price increases, prices were rolled back and capped, and consumption rebounded to former levels. Subsequently, to avoid blackouts, the government used televised public appeals to urge households to reduce energy consumption. Public appeals were accompanied by energy-saving advice. Public appeals resulted in a 7% decline in energy use over six months. It should be noted that the households in California had heightened awareness of the consequences of energy shortages. Electricity prices had doubled in their recent memory. Therefore increasing prices was a credible threat for the consumers, and may have made them more receptive to social appeals.

IEA (2005) provides some international case studies where public appeals were successful in reducing energy consumption quickly. Some of the successful solicitations to reduce energy occurred in 2001 in New Zealand, Australia, and Brazil, as a result of shortfalls caused by drought. At the beginning of New Zealand's 2001 shortfall, the government calculated that blackouts could be avoided if everybody reduced their consumption 10% for 10 weeks. Thus "10 for 10" became the goal. The government distributed advice on how to obtain those savings but gave no incentives towards more efficient equipment or reduced bills. New Zealand employed public appeals through many extremely short reminders on television. The conservation goal was reached within 6 weeks.

IEA (2005) states that while a price increase is the first best scenario to deal with shortfalls, it may not be politically feasible in the short run. In designing successful public appeals to reduce electricity quickly, it is important to educate consumers, raising their awareness, and making conservation a matter of civil duty or prestige. This is particularly important in electricity markets where richer, less price-sensitive consumers, by not reducing their consumption in a time of crisis, impose a negative consumption externality on the poor. This is in contrast to most markets where consumption of the rich creates a positive consumption externality for the poor by allowing economies of scale to be exploited in production and facilitating increased competition.

5.5. Public Policy Instruments and Environmental Morals

When economic activity has a negative externality, traditional economics suggests that following instruments can be used to curb the extent of harmful behaviour: taxes, restrictions (i.e. quotas or bans) and tradable permits. Taxes will discourage the harmful behavior through increasing its price, while

quotas discourage the behavior through restricting the quantity of the "bad" allowed or available. Taxes levied on the activity that generates negative externalities are called Pigovian taxes, and have traditionally been applied to goods such as cigarettes and alcohol, or to activities such as pollution. With tradable permits, the overall allowable level of activity is established, and the permits for this activity are allocated to entities (usually firms). These allowances can be traded, so that the entities with the lowest marginal costs of reducing the activity towards the allowable level will be the ones that do so. Tradable allowances have been used to regulate fisheries and air pollution (Frey 2005; Tietenberg, 2003). Traditional economics assumes that the difference among these three policy instruments is purely in terms of economic and administrative efficiency.

Psychologists argue that another important distinction between these instruments is that they vary to the extent that they send the signals that crowd out intrinsic motivation. Frey (1999) calls intrinsic motivation for pro-environmental activity *environmental moral*. He argues that both tradable permits and taxes will have two opposing effects on consumers – an increase in price of activity will discourage behavior, but intrinsic environmental moral will also go down as a result (crowding-out). He argues that environmental moral will be reduced by tradable permits more than by taxes: tradable permits may be viewed as being similar to indulgences sold for sins in the Middle Ages (Goodin, 1994). These permits may convey impression that it is acceptable to sin as long as one pays the price for it. Frey also proposes that both low and high environmental taxes are more effective than medium level taxes. He argues that with low taxes, consumers may feel that protecting environment is something that has to be done from moral obligation. On the other hand, high environmental taxes make harmful behavior prohibitively costly and dominate the crowding-out effect. Meanwhile medium environmental taxes result in crowding out intrinsic motivation, but are insufficient to cause reduction in behavior due to extrinsic motivation.

With the climate policy the negative activity to be curtailed is carbon emissions. Taxes, restrictions and tradable permits are used as climate policy instruments, often simultaneously. European Union has the largest tradable emissions scheme in the world (EU ETS). So far, tradable permits have been assigned to the businesses, but not to final consumers. On the other hand, consumers in many jurisdictions are subject to carbon prices directly (effectively a tax on emissions) and quotas indirectly (through emissions standards). Unfortunately, the evidence of crowding out environmental moral due to the signaling effect of taxes and tradable permits has not been evaluated empirically, but studies have established the existence of the phenomenon in the laboratory and field experiments (Frey and Jegen 2001; Deci et al. 1999). However, its relevance to the actual behavior of consumers, as well as the magnitude of the effect remains yet to be determined. Meanwhile, *public perception* of the effect of these instruments is relevant for the political economy of public policy. To the extent that the public (particularly pro-environmental activists) perceive that taxes and tradable permits are morally inferior because they seem to sanction pollution and emissions, government may find politically harder to implement these mechanisms.

6. Concluding Remarks

Economics studies how agents interact and allocate limited resources. In essence, economics is about behaviour by definition. The traditional economics discipline is based on behavioural assumptions and axioms which allow models to explain the key phenomena of interest parsimoniously but with sufficient clarity and accuracy. What is referred to as *behavioural economics* is the modification of traditional assumptions by drawing insights from psychology. Normally, behavioural economists start from observations of how individuals actually behave and then show how this behaviour violates traditional assumptions. Researchers then proceed to offer models based on alternative assumptions that better match the observed phenomena. Behavioural economics is a growing and thriving field, but there are some theoretical and empirical gaps, many of which were mentioned in this survey. Below we discuss some of the future directions for behavioural economics in general, and its application to energy policy in particular. Technological innovations, such as smart meters and smart appliances (and, in the future, widespread use of electric vehicles) provide new ways to study how consumer behaviour responds to monetary and non-monetary interventions.

Theoretical and empirical work aimed at sorting out the interactions of various behavioural phenomena. Behavioural studies uncover anomalies in behaviour that are inconsistent with neoclassical economics. However, these anomalies are often studied on an ad hoc, case-by-case basis. Synthesizing behavioural anomalies within a consistent framework would be welcome. Some of the questions that need to be addressed are the following: How do we disentangle behavioural explanations from conventional information effects? What are the interactions between the alternative behavioural insights and between behavioural failures and market failures? For example, how do loss aversion and hyperbolic discount rates interact? Sorting out these interactions will be important in designing the optimal package of behaviour change-inducing measures to reduce or shift energy consumption.

Increased reliance on empirical research and impact evaluation. A lot of behavioural work has been based on experimental studies. However, ultimately economics is concerned about actual behaviour in markets, and some of the behavioural failures may no longer hold in a real market setting where behavioural anomalies cancel out. It is important to conduct empirical studies in order to uncover how relevant behavioural anomalies are to the way the markets work in non-ideal conditions. There seems to be good scope for linking experimental work with empirical trials to see the extent to which strong experimental results can be reproduced in fieldwork.

Study of large-scale interventions. A lot of behavioural research, both in experimental and field settings, has been carried out on small sample sizes. This raises two concerns: How scalable are the interventions, and even if behavioural anomalies do exist, do they represent fundamental departure from the way individuals make choices, or is it only about the tails of the "behavioural" distribution? If the observation is only regarding the tails of the distribution, how thick are the tails (Shogren et. al. 2008)? What is needed is much more attention to whole population interventions (i.e. the general rollout of smart meters) or natural experiments (such as the New Zealand's campaign for electricity demand reduction in

2001). Conducting randomized, controlled experiments involving large-scale interventions would help provide answers to these questions. Widespread use of smart meters will make this sort of research much easier to implement in the future.

Increased study of the relationship between short-run and long-run behavioural changes. While short-run behavioural changes may be extremely useful and important in energy, there are important issues to do with whether certain behavioural changes can be sustained over a prolonged period. With energy consumption this may be important in designing the school curriculum with a view to increasing awareness of energy conservation, or in keeping effective repeated interventions aimed at dealing with successive short-run energy shortages. Most studies of energy consumption behaviour do not resample behaviour over a prolonged period, but clearly there may be opportunities to design studies to monitor the effects of long-term interventions in the future.

Integrating behavioural economics within the framework of traditional economics. While behavioural economics provides insights about the way decisions are made, some of the departures from neoclassical economics are hard to reconcile within the traditional framework. For instance, how do we evaluate the impacts of policy if we can't make neoclassical assumptions about discounting? If individuals are really self-conflicted in their evaluation of costs and benefits over time then what is the rationale for the policy makers to cater to their farsighted-selves rather than their nearsighted-selves? While hyperbolic discounting is intellectually appealing, it makes equilibrium models intractable. Further theoretical work to reconcile these differences is needed. Institutional economics (following North 1990) includes the study of the impact of long-run behavioural differences between economic agents. It may be that behavioural economics is a way of understanding how short-run behaviour can be changed, while institutional economics studies how long behavioural differences can be sustained via the creation of appropriate institutions. Thus understanding the process of institutionalizing behavioural change may allow a reconciliation of more traditional economics with behavioural economics. This may be important in suggesting ways in which differences in energy consumption per capita currently attributed to vaguely defined "institutional" differences (such as between the UK and Denmark) can be narrowed.

Behavioural economics can provide valuable insights on how individuals make their decisions. These insights can be used to increase effectiveness of traditional interventions in energy policy. However, it is important that behavioural interventions do not crowd out more effective traditional interventions (Loewenstein and Ubel 2010). Behavioural economics should complement, not substitute for, more substantive economic interventions, such as those based on influencing energy pricing (e.g. via taxation) or energy investment (e.g. via subsidy schemes).

To come back to where we began, behavioural economics seems unlikely to provide the magic bullet to reduce energy consumption by the magnitude required by the IEA (2010) recommended 450 climate policy scenario. However it does offer exciting new suggestions as to where to start looking for potentially sustainable changes in energy consumption. It also may be that its most useful role within climate policy is in addressing issues of public perception of the affordability of climate policy and in

facilitating the creation of a more responsive energy demand, better capable of responding to weather-induced changes in renewable electricity supply.

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