Energy, the Environment and Behaviour Change: A survey of insights from behavioural economics

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Abstract

Evidence of climate change is largely undisputed but moderating the impacts not only of climate change but also of resource depletion is a complex, multi-faceted problem. Technical solutions will have a large role to play but engineering behaviour change within households and firms is essential to harnessing the potential for energy efficient consumption, production and investment. To inform debates about behavior change, this paper explores some insights from behavioural economics including analyses of bounded rationality, cognitive bias / heuristics, temporal discounting, social influences, well-being and emotions.

Keywords: energy economics, environmental economics, environmental behavioural economics

JEL codes: D03, Q5, Q58

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1 Introduction

Climate change and resource depletion are amongst the most crucial problems of our time. As outlined in the Stern Report on the science of climate change (Stern 2007, 2008), greenhouse gas (GHG) emissions are the biggest market failure the world has seen; they are not ordinary localised externalities and their impacts are large not only in global terms but also in terms of their impacts of future generations. Whilst there has been some scientific controversy about the specific evidence with some expressing scepticism about the extent of climate change, in Advancing the Science of Climate Change, the US National Research Council emphasizes that there is a strong, credible body of evidence, based on multiple lines of research, documenting that the climate is changing and that these changes are in large part caused by human activities. As shown in Figure 1, International Energy Agency estimates show large increases in global CO_2 emissions between 1973 and 2009.

World CO_2 emissions have risen from 15,624 in 1973 to 28,999 million tonnes of CO_2 in 2009, i.e. an annualized growth rate of 1.7%. Rises outside the OECD have been particularly large and pressure on the environment is increasing as less-developed countries grow and industrialise. So, without wide-scale policy and behaviour changes across all countries, anthropogenic climate change is likely to intensify.

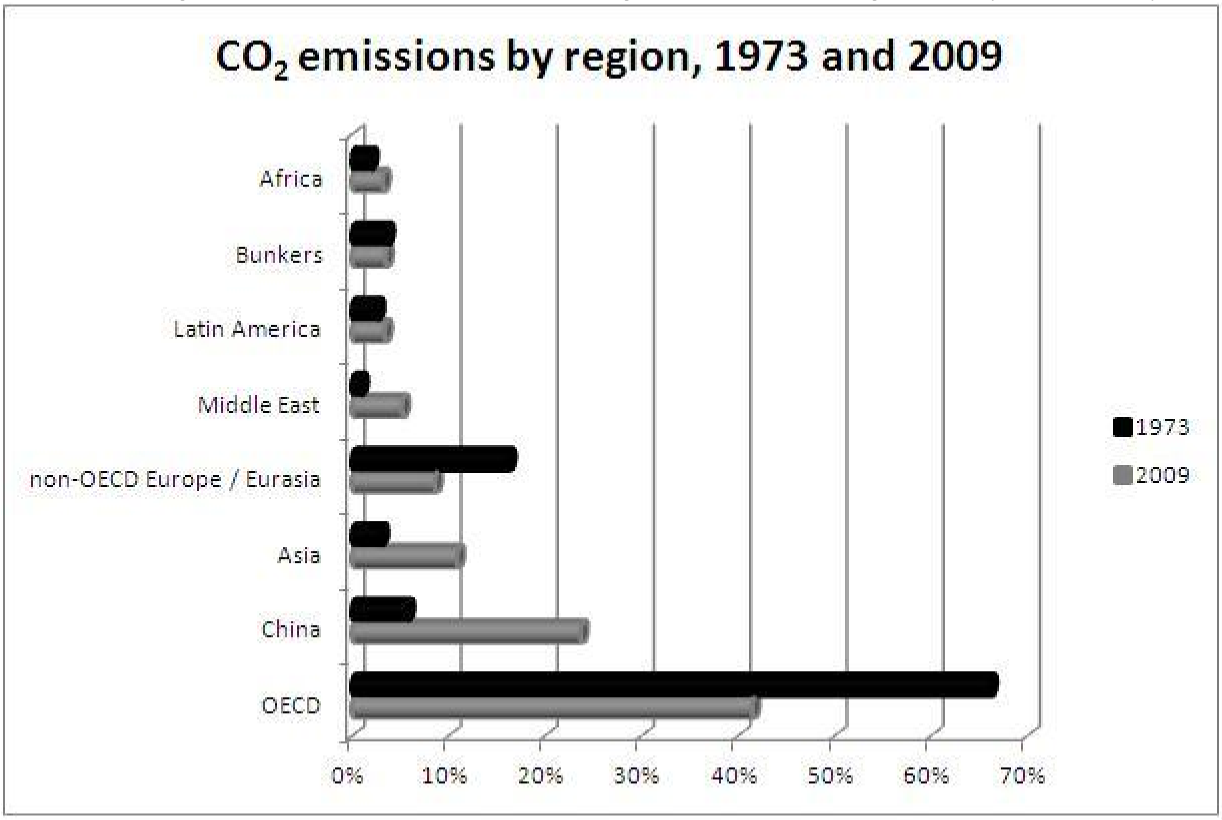

Fig. 1: CO_2 emissions by region, 1973 and 2009
Source: IEA (2011)

Whilst evidence of climate change is largely undisputed, moderating the impacts not only of climate change but also of resource depletion is a complex, multi-faceted problem. Whilst ingenious technical solutions undoubtedly have a large role to play, it is also important to analyse the behaviour of households and firms to enable a better understanding of how behavioural forces can be harnessed to promote energy efficient consumption, production and investment. Also, focussing on effective government policy, particularly in countries with underdeveloped energy infrastructure, is important because positive behavioural change requires government policy designed effectively to promote it. In terms of potential to save energy, a report by McKinsey and Company asserts that there is vast potential to reduce end-use energy consumption because there is a large untapped demand for energy efficiency; if this demand were stimulated comprehensively to encourage households and businesses to consume and invest in energy efficient appliances and buildings then the potential energy savings could amount to 9.1 quadrillion BTUs by 2020 representing an annual abatement of up to 1.1 gigatons of GHGs per annum, worth 23% of projected energy demand (Granade et al. 2009). US estimates from Electric Power Research Institute (EPRI), based on more modest assumptions about technological change and cost improvements in energy efficient devices, nonetheless also identify large energy efficiency gaps and forecast realistic achievable potential savings of 8% up to maximum achievable potential of 11% by 2030 (EPRI 2009), as shown in Figure 2.

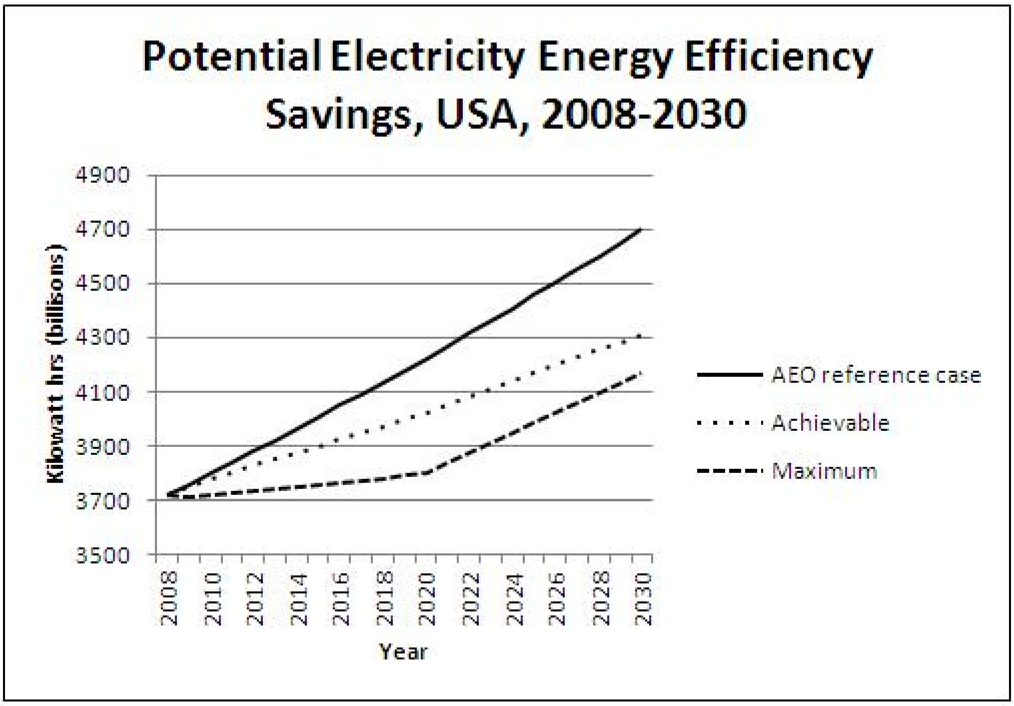

Fig. 2. Potential electricity savings, US 2008-2030
Sources: EPRI (2009); *Annual Energy Outlook 2011*, US Energy Information Administration

A major focus has been on changing the behavior of households: encouraging them to insulate their homes, buy more energy efficient appliances, switch off lights and equipment more frequently etc. What is the potential for reducing household energy usage? Evidence from the US shows that residential use of electricity is complex and spread across a number of household behaviours as shown in Figure 3.

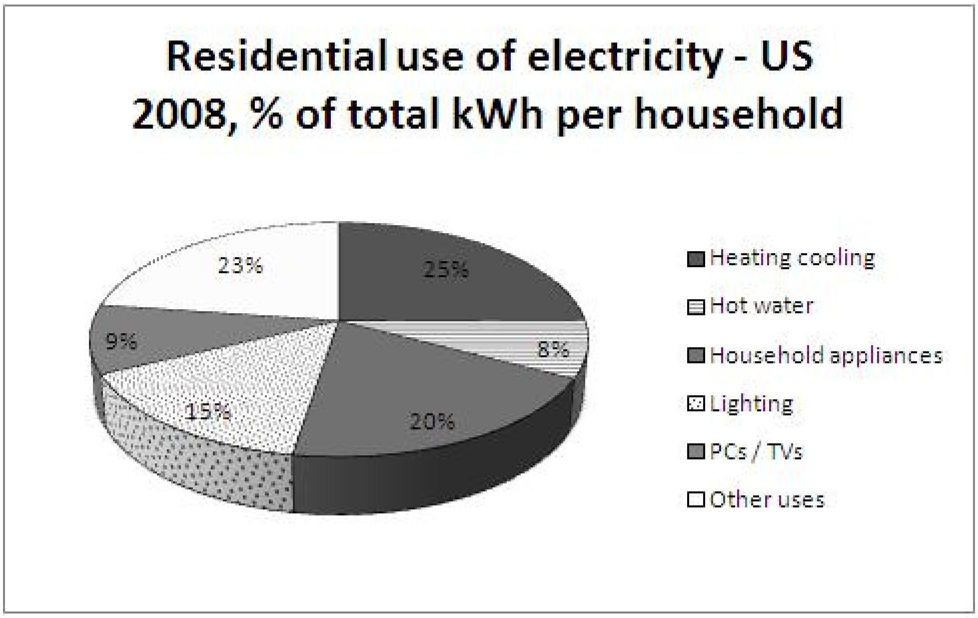

Fig. 3. Residential uses of electricity, US 2008
Source: EPRI (2009)

Major residential uses of energy include heating and cooling houses, using of household appliances, lighting and other uses, where the other uses include using a wide range of household items from coffee makers to hair dryers to pool pumps. There is no one major residential energy drain and each of these categories account for similarly large proportions of household energy consumption. So the policy challenge is enormous because promoting energy efficient household behaviour will require changes across a wide range of household activities.

The Energy Saving Trust (2011) identify potential energy savings from household behaviour changes and/or building and appliance improvements. For the UK per annum, this could save the average household up to £280 in energy bills and 1.1 tonnes of CO_2 emissions. Solid wall insulation can save £445 or more and up to 1.9 tonnes of CO_2 and if all UK households were to wash their clothes at 30 degrees centigrade or less, this could save 620,000 tonnes of CO_2 and £170million on energy bills. However, the disaggregated savings per change are generally not large; one household washing clothes in water at 30 degrees or less would save just £12 per year on their energy bill. The key policy question is therefore how to encourage households to tap into a number of potential sources of energy savings even when the private benefits in monetary terms are relatively low.

Households are not the only ones who can save energy; potential efficiency gains can be made within businesses too. Figure 4 shows US estimates of rises in energy consumption from 2008 to 2035 and shows that energy consumption in the industrial / commercial and transportation sectors overwhelms consumption in the household sector.

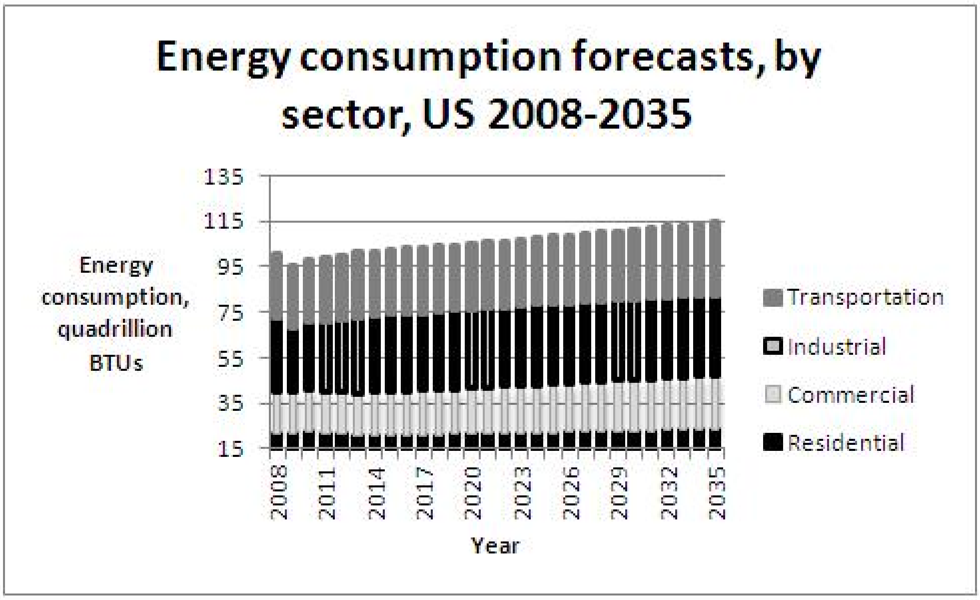

Fig. 4. Forecasts of US energy consumption, by sector 2008-2035
Source: *Annual Energy Outlook 2011*, US Energy Information Administration

Given this large consumption of energy by the non-residential sector, behavioural changes within business have the potential to generate significantly larger efficiency gains than can be harnessed just from the household sector. Overall, the evidence outlined above shows that closing the energy efficiency gap requires coordinated efforts across countries and also across different sectors within countries. It will not be enough to encourage more energy efficient behaviours from households; firms should be the focus too.

In standard economic analysis, environmental problems are often analysed as market failures i.e. as a problem with market institutions and not a problem with the way that individuals think and choose. Private actions by households and firms generate environmental externalities, usually negative externalities e.g. a firm polluting the atmosphere, a consumer littering / not recycling, because by definition - externalities do not have a market price. Collective action will not operate to eliminate these externalities because profit maximising firms and utility maximising households have incentives to free-ride on the constructive behaviour of others. This creates the tragedy of the commons, identified by Hardin (1968) as the environmental prisoners′ dilemma which emerges because no one household or firm has an incentive to invest, produce and consume in a socially beneficial way. If they did behave in the socially responsible way, they have no guarantee that others will do the same. Individuals immediately face concrete, tangible costs of environmentally responsible behaviour in the current period but the benefits are spread over time (perhaps over many generations) and across many individuals / globally so a socially responsible individual will gain no benefit whilst suffering the consequences of the anti-social behavioural of others. Overall, with rational, self-interested and independent economic agents, there will be no private incentive to contribute to the environment as a public good and the solution lies in filling the gap left by imperfect market institutions either by allocating tradeable property rights, e.g. emissions trading schemes; or via Pigouvian taxes and both these solutions have problems of their own.

Price factors have an impact on behaviour for example, Hassett and Metcalf (1995) analysing the impact of investment tax credit policies on residential environmental conservation investment found that tax incentives have a significant impacts on conservation though also found that controlling for unobserved heterogeneity in tastes for energy-saving activities is important. Budget constraints play a role: households and firms may know how to save energy but large upfront/sunk costs may constrain for households, particularly those facing fuel poverty. Brutscher (2011a) analyses liquidity constraints on households in Northern Ireland Continuous Household Survey (NICHS) and finds that, whilst there is a positive correlation between income and electricity use, a large number of low-income households use disproportionately large amounts of electricity, and this may be because liquidity constraints prevent them from making large upfront payments for oil. So they are forced to rely on electricity, which is more expensive. Using data from the NICHS Brutscher shows that increases in income via winter fuel payments significantly increases the probability that a household will use oil and significantly decreases the probability of using electricity.

Faruqui and Fox-Penner (2011) assume that energy consumption is price responsive but allow that managing price responses is complicated by fluctuations in demand for energy. They analyse some potential solutions to managing peak loads; the latest policies are founded not only on financial incentives and technological innovation but also on customer awareness and engagement. Social norms are important; energy utilities recognise that changing consumer behaviour is not only about lower energy bills but also about emphasising health benefits, the virtues of being green, impacts on children and doing better than your neighbours issues that are explored in the behavioural economics literature as outlined below. Overall though, Fox-Penner and Faruqui emphasise that there still plenty of potential to reduce peak demand by up to

20% by 2019 with 4-15% coming from residential consumers via demand-side management (DSM). Dynamic pricing is likely to play a significant role in shifting demand to quieter times to avoid capacity overload. With real time pricing (RTP) the consumer pays the market price prevailing at the time the energy is consumed; other DSM approaches have also evolved to focus on dynamic pricing with peak reductions by rate and technology. Fox-Penner and Faruqui conclude that CPP (critical peak pricing) can yield the largest gains, particularly when enhanced with technical innovation but significant gains are also possible with PTR (peak time rebates) and TOU (time of use) tariffs, especially if enhanced with technological innovations. Technology boosts price responsiveness, particularly important for the US where financial incentives pay a dominant role. Innovations such as in-home displays and smart meters can promote energy efficiency by reducing demand either via cash payments or price variation during critical times periods. (See also Faruqui and Sergici 2010, Faruqui, Sergici and Sharif 2010.)

On the production side, new technologies will also offer solutions that enable reductions in the costs of energy saving choices for example MBA Polymers has developed new plastic separation technology to facilitate plastic recycling. Even though plastic is potentially more valuable than metal, less than 10% of plastic trash is recycled because sorting and processing different types of plastic is so complicated; MBA Polymers new technology manufactures a mixed plastic composite out of shredder residues from metal recycling by sorting the plastics using optical sorting technology and then recombining the plastics to make plastic pellets. The energy and processing costs are significantly lower because recycled plastic manufacture is not a drain on natural resources especially oil and there will also be indirect energy benefits as people will substitute away from conventionally manufactured plastics towards cheaper recycled plastics. (Source: Biddle 2011.)

Another market problem that is the focus of standard economic analysis is asymmetric / missing information and related principal-agent (PA) problems: people do not have full information about the consequences of their actions, e.g. they do not know what happens if they dont recycle, for example. PA problems have received a lot of attention from policy-makers as exemplified in the IEA/OECDs Mind the Gap (IEA/OECD 2007). This report analysed a set of 8 case studies from 5 OECD countries (Japan, US, the Netherlands, Norway and Australia) across 3 sectors (residential, commercial and end-use) to increase understanding of the energy efficiency gap: potential energy savings are not being realised because of market failures including capital scarcity, information asymmetries and split-incentives. The report concluded that PA problems had a significant impact, for example 85% of annual energy use in Spain was affected by PA barriers.

Imperfect information can be addressed via carbon labelling and similar initiatives. However carbon labelling is relatively new and has yet to be widely adopted. A 2010 Which? survey showed that there is limited recognition of carbon footprint labels: 20% recognised carbon footprint labels relative to 82% for Fairtrade and 54% for organic labelling, though many countries including Japan, South Korea and France are extending the coverage of carbon labels. In France labelling is being extended to show water footprints and impacts on biodiversity as well as carbon footprints. Life cycle analysis can also be used as a way to inform consumers about reducing use-phase emissions e.g. 57% of Levi jeans lifecycle emissions were from consumers use especially from washing in hot water and drying in a machine; including eco-friendly washing instructions on labels can reduce use-phase emissions by up to 90%. (Source: The Economist 2011, p.14).

Standard economic principles can tell us a lot about how and why environmental problems emerge and some apparent inconsistences can be reconciled by recognising that market failures are endemic whilst retaining the assumptions of rational, self-interested and atomistic individual action. However, whilst some of the standard approaches summarised above offer important lessons about the importance of technology and monetary incentives/constraints, understanding how to engineer behavioural change by households, firms and industries, also requires an understanding of how people respond, sometimes imperfectly, to non-price factors. If it were just about prices then carbon taxes and emissions trading schemes might at least give a significant lead in moderating the problem but if behaviour is driven by non-price factors too then taxes and trading schemes may have limited impacts.

So what constrains the behaviour of households and firms? Modern research into climate change and resource depletion is starting to draw on lessons from behavioural economics in formulating a deeper understanding of the psychology behind energy decision-making illuminating questions of how and why households and firms fail to make energy-saving decisions. Psychologists suggest that policy-makers need to broaden their approaches to encouraging energy conservation. Stern (1992) for example argues that consumer responses to information and money are more complex than standard economic analysis suggest and other motivations drive people towards energy conservation. Similarly Black et al. (1985) analysed the behaviour of 478 residential customers in 1980 focussing on the interactions between contextual variables, including demographic, economic and structural factors and personal variables such as attitudes, norms and beliefs. They found that personal variables have more impact in driving decisions e.g. to turn boiler temperatures down, than major insulation decisions. This suggests energy conservation decisions reflect an interaction of economic and psychological factors and principles from behavioural economics can be used to explain why people dont always do the right thing. Behavioural economics can also provide insights into how policy can be designed to overcome these problems in a scalable and sustainable way.

Grubb et al. (2009) and McNamara and Grubb (2011) identify a wide range of behavioural barriers and drivers to efficiency technology up-take, including psychological barriers such as risk/uncertainty, constraints on learning, social norms, disempowerment and procrastination; and behavioural drivers including fashions and social pressure. They observe that uncertainty is at the crux of the energy efficiency gap and so providing more information - whether via smart metering technologies, labelling or certificates - will increase awareness and transparency of energy use. In particular, if the problem is that people are not well-informed then carbon footprint labels, e.g. the Carbon Trusts black footprint label, can be an effective way to give people more information about the emissions associated with the products they consume so that they can judge the environmental impact of their purchases.

Gowdy (2008) argues that apparently non-rational behaviour is central to human decision-making and so any approach based on an assumption that people are rational and self-regarding will be seriously flawed. Cognition reflects an interaction of rational and emotional decision-making processes and a greater focus on a unified theory of decision-making, e.g. as offered by neuroeconomics, can also illuminate environmental decision-making. This paper will explore some of these insights from behavioural economics in order to illuminate debates about energy, the environment and behaviour change. [1] The following sets of behavioural economics principles will be applied specifically to the analysis of energy and the environment: bounded rationality, cognitive bias and heuristics; behavioural models of temporal discounting; social influences, including social pressures on households to act in an environmentally responsible way and on firms to practise environmental corporate social responsibility in building their reputations; and behavioural analyses of emotions and wellbeing in the context of environmental decision-making. The paper will conclude with an analysis of potential policy solutions.

2 Uncertainty, bounded rationality and cognitive bias

2.1 Bounded rationality and uncertainty

Simon (1972) identifies some limitations on strictly rational decision-making and argues that a lot of behaviour takes place under conditions of bounded rationality: strict rationality is prevented by information and cognitive constraints. This insight has been applied in a number of analyses of environmental behaviour occurring when there are constraints on information, knowledge and learning. Shogren and Taylor (2008) draw on Mullainathan and Thaler (2000) in identifying three aspects to limits on rational behaviour as seen in environmental behavioural economics: bounded rationality, bounded willpower and bounded self-interest. Just increasing the availability of information is not necessarily the simple solution it seems; Leiserowitz et al. (2010b) note that often, the behaviours that would be most effective (e.g. driving cars less often) are neglected in favour of the less arduous behaviours such as switching off lights; knowledge and belief are not enough and just because people have knowledge about the benefits of environmental actions does not mean that they will engage in those actions.

One fundamental constraint on rationality is lack of knowledge though Stern (2000) argues that whilst knowledge is a necessary component in engineering environmental behaviour change, it is not sufficient in itself. Pongiglioine (2011) emphasises the role of knowledge in a behavioural analyses of climate change and individual decision-making. In risky situations, deep psychological mechanisms propel people towards inaction and apathy and this constrains pro-environmental behaviour and so behaviour change requires a combination of understanding and procedural knowledge - i.e. practical common-sense knowledge about energy efficiency and the environment. To an extent this is consistent with the self-interest assumption and can be explained in terms of standard economic models incorporating transaction costs. Problems emerge because selfinterest interacts with subjective perceptions and limited knowledge/ imperfect information. Procedural knowledge is particularly important as it enables people to turn

[1] See also Baddeley (2012).

subjective beliefs into concrete actions to reduce environmental impact (Kaiser and Fuhrer 2003). Similarly, Reynolds et al. (2010) focus on knowledge deficits to explain environmental inaction and empathy gaps. Pongiglione argues however that it is not all about knowledge deficits; the main obstacles to behaviour change reflect an interplay of factors: perception, self interest and limits to knowledge where knowledge includes awareness, understanding and procedural knowledge.

Uncertainty about the future, as well as knowledge about the present, has a dampening impact on decisions about energy and the environment. Decisions between risky alternatives will affect both firms and households: firms in their investment decisions and households in their energy consumption decisions as well as in purchases of lumpy consumption goods such as refrigerators and boilers.

For consumption, carbon labelling can reduce consumers uncertainty about the impact of their purchases and provide some guidance to environmentally conscious consumers but the question of how emissions should be measured and reported remains. Best practice would involve calculating emissions over the life-cycle of a product in its manufacture as well as its end-use, but for many products life-cycle emissions are uncertain, e.g. how do you calculate the end-use emissions from shampoo given the variability in its use: end-use emissions will depend how long someone spends in the shower and how hot the water is etc. (The Economist 2011).

Uncertainty also affects investments and, as noted above, technology has the potential to offer numerous innovative possibilities in terms of ameliorating climate change and conserving energy across all sectors: investments in more energy efficient / environmentally sustainable production methods by all firms; investments in the specialist production of energy efficient capital equipment and white goods for firms and households; innovative investments in renewable energy production by the energy sector itself and also investments by households in microgeneration equipment e.g. solar panels which, with feed-in tariffs, enable householders to become prosumers producing their own energy, consuming some of it and feeding the remainder into the grid.

For any of these innovative investments, uncertainty is a profound problem. Large sunk costs are involved; the investments may be irreversible, especially if the equipment is specialist and not easily used in other production. In standard economic analysis, real options theories of investment capture the impacts of uncertainty and irreversibility on the timing of investment; with uncertainty target rates of return are higher so fewer projects are viable and investment activity slows down (Dixit and Pindyck 1994).[2] High target rates of return deter energy efficient investment because of uncertainty, inertia and because natural diffusion rates for new technologies are slow (Hassett and Metcalf 1996, Jaffe and Stavins 1994, McNamara and Grubb 2011). The standard real options approach to capturing uncertainty is problematic because it is based on an assumption of investors as rational maximisers; behavioural economics offers some alternative insights in relaxing this assumption and providing an alternative analysis of responses to uncertainty founded on an assumption of bounded rationality.

[2] See also Baddeley (2003), chapter 9 for a survey of real options theories.

2.2 Heuristics and biases

Kahneman and Tverskys prospect theory offer an alternative model of decision making under uncertainty, identifying a number of factors inconsistent with rational maximisation including loss aversion, framing effects, reference points, heuristics and cognitive bias (Kahneman and Tversky 1979; Tversky and Kahneman 1974, 1986). People are affected by bounded rationality and cognitive limitations when assessing quantitative information about energy and the environment. Research has shown that, in encouraging drivers to be aware of their fuel use, gallons-per-mile is more effective than miles-per gallon but miles-per-gallon is more often reported (Loewenstein and Ubel 2010). Status quo biases will lead people to stick with old habits and avoid change, and to an extent - partly this may be an economically rational way of avoiding the transaction costs associated with change (Pongiglione 2011, McNamara and Grubb 2011). However there is evidence that it is not just about transaction costs; for example, in the UK switching energy supplier is a quick and easy process; if a customer decides to switch, the new supplier contacts the old supplier; cost comparison websites are easily accessible so overall the risks and transaction costs associated with a switch are small. Yet, even in the face of rising energy prices from the UKs Big Six energy suppliers, households do not necessarily apply competitive pressure by switching supplier: a 2011 YouGov poll commissioned by Anglian Home Improvements showed that 51% of respondents are likely to delay switching energy supplier and would prefer to ration energy, e.g. by wearing warmer clothing (YouGov 2011). This reluctance to switch may partly reflect a status quo bias / familiarity bias.

Environmental reference points will be affected by context. For example, environmental valuation based on stated preference surveys may be affected by a number of disparities including divergences between willingness to pay (WTP) and willingness to accept (WTA) (Carlsson 2009). Also Knetsch observes that, in valuing losses of duck habitat, WTP is only appropriate if the duck habitat is absent; stated WTP will undervalue environmental resources and WTA should be used instead (Knetsch 2010, Brown and Hagen 2010). Uncertainty and bounded rationality also lead to greater reliance on heuristics i.e. everyday reasoning using heuristics, quick decision-making rules of thumb. Heuristics will be used in a world of bounded rationality when people want or need to make decisions quickly and simply (Gigerenzer 2007, Gigerenzer and Goldstein 1996, Gigerenzer and Todd 1999). Sunstein (2006) analyses the role played by the availability heuristic in peoples intuitive cost-benefit analysis of climate change; he argues that if people have recently experienced serious tangible harms from climate change then climate change will be perceived as a more salient problem.

Kempton and Montgomery (1982) analyse the use of heuristics in ordinary energy consumption decisions and observe that miscalculations can lead to underinvestment in energy efficiency, especially because information about energy efficiency is often presented in a way that is intelligible to experts but esoteric to ordinary consumers. Adapting old methods to new situations when old methods will not provide the optimal solution is a heuristic device. For example, consumers will use folk quantification to simplify their measurement of residential energy decisions. The use of these folk methods is reasonable in the sense that it saves time and effort in computation but it does also lead to mistakes. Kempton and Montgomery (1982) analyse folk quantification via interviews of 30 Michigan families, 10 of whom were using energy saving devices. These families used folk units e.g. familiar absolute measures such as gallons, dollars, months to gauge their energy use: e.g. one householder conceptualised his energy consumption in terms of how many times per month he had to fill his oil tank, i.e. he did not conceptualise his energy decisions in terms of kilowatt-hours. People also focussed on peak consumption - e.g. a woman described the impacts of insulation on reduced gas bills by saying to her husband that they were no longer getting large $100 gas bills as they had before. Kempton and Montgomery also identified a tendency to over-emphasise certain forms of consumption, e.g. people overemphasised lighting as a drain on energy and were more likely to turn the lights off than they were to use less hot water - even though the latter had a larger impact. This overemphasis on lighting could reflect historical factors (lighting always used to be the biggest energy user) and/or problems of perception and categorisation: lighting output is more salient; we notice it more; it is also a prototype representing the broad general category of electricity use. People also focussed on first-hand experiences and experiences of friends rather than impersonal, but objective, data summaries from organisations.

Kempton and Montgomery also identified biases when people did not recognise that behaviour changes had had an impact on their bills. They found that some householders focussed on the dollar amount of their energy bills, neglecting the fact that consumption measured in dollars reflects prices as well as volumes, so folk methods for calculating savings from reducing energy consumption neglected the impact of rising prices and led to underestimations of the savings. Similar problems affected energy investments, i.e. by using simple payback methods without adjusting for price increases, folk methods led householders to over-estimate how long it would take them to pay-off their energy efficient investments. Overall, whilst heuristics are cognitively efficient in the sense that they are easy to learn and use within a households general budgetary decision-making, they lead to systematic errors in quantification, ineffective energy conservation and underestimation of benefits of investments in energy efficiency.

3 Time, Planning and Habits

Climate change and resource depletion are problems that will intensify over time; similarly decisions about energy efficient consumption/investment involve costs now for benefits in the future. Given the importance of time to decisions affecting energy and the environment, the behavioural literature on inter-temporal decision-making offers a number of relevant insights. McNamara and Grubb (2011) observe that energy is an abstract commodity invisible and intangible and so learning about substitution towards more energy efficient consumption is delayed by perceptions of risk and procrastination; in resolving these problems habits and planning will play a crucial role.

3.1 Goals, planning and feedback

Intentions do not always translate into action and often there are conflicts between declared intentions and actual action, e.g. a Fondazione Eni Enrico Mattei (FEEM) survey indicated that whilst 70% of Italians surveyed are willing to increase energy savings only 2% are currently reducing their use (Pongiglione 2011). People may want to reduce emissions but will not approve of it if it has tangible consequences for themselves; e.g. American survey evidence shows that 78% of Americans oppose gasoline tax and 60% oppose business energy taxes (Leiserowitz 2006) but even though people may express concerns about climate change, there is limited real commitment to environmental action by Americans: 52% of Americans claimed to support Kyoto Treaty in principle but if they had to pay an extra $50 per month then they would oppose it (Sunstein 2006).

Intentions can be reinforced when people make a concrete commitment to conserving energy, and the commitment may endure even when the initial incentive to commit is temporary. Cialdini (2007) describes the enduring impact of lowball tactics in promoting changes in habits a lowball being a tempter offer which is later withdrawn. Pallak et al. analysed the gas consumption behaviour of a sample of Iowan households. A control group of households were given some energy saving tips but the advice had no significant impact on their energy use. Then a matching sample of households were told that they would receive positive publicity for their efforts; they would be identified as energy saving citizens in local newspaper articles. The publicity treatment had a significant, positive effect with each homeowner saving on average 422 cubic feet of natural gas, equivalent to first month savings of 12.2% in gas consumption. But the most interesting result occurred when the households were sent a letter telling them that they would not receive any positive publicity after all - yet, on average, these households increased their fuel savings to 15.5% in the second month. Pallack et al. found similar results in an analysis of air-conditioning use. These apparently anomalous results have been attributed to the fact that the initial promise of publicity encouraged householders to make a commitment to energy reduction and this commitment did not disappear when the promise of positive publicity was withdrawn (Cialdini 2007, Pallack et al.1980).

Goals modify behaviour; ambitious goals lead to greater and more prolonged effort (Locke and Latham 2006). Planning is also important because effective behaviour is not just about intention; behavioural control including self-confidence guides action (Ajzen 1991). Whilst standard economics emphasises the role of monetary incentives, Bamberg (2002) analyses two environmental behaviours using and new bus route and shopping in a bio-shop. He finds that forming intentions not just about the goal itself but also about implementing the new behaviours increases the likelihood of the new behaviours. Implementation intentions substitute for monetary incentives: monetary incentives alone also increase the likelihood of the new behaviour but monetary incentives and implementation incentives together do not have an additional impact. Becker (1978) emphasises the importance of feedback alongside ambitious goal-setting. He analysed the behaviour of US families in identical 3 bedroom houses: 80 families were asked to set goals for reducing energy consumption during the summer: half were set an easy goal; the other half were set a difficult goal. Half of each group were given regular feedback 3 times per week. An additional 20 families were used as a control group. The group with the difficult goal and regular feedback was the only group to consume significantly less electricity; they reduced their electricity consumption by at least 13%.

Thaler and Sunstein (2008) emphasise the importance of salient and frequent feedback in changing habits. Hargreaves, Nye and Burgess (2010) found that information feedback on electricity consumption leads to decreased use. Darby (2006) also emphasises the importance of direct feedback with information presented clearly, using computerised tools; indirect feedback is more effective in addressing larger impacts, e.g. seasonal impacts on energy consumption. Direct feedback via self-meter reading, direct displays, consumption displays and interactive feedback lead to savings of up to 15%; indirect feedback, e.g. frequent bills and information leaflets lead to savings of up to 10% (Darby S 2006, Brophy Haney et al. 2009b). Performance feedback is also important because it enables more effective learning.

3.2 Behavioural discount functions

As noted above, environmental decisions are often taken with a view to the future and in judging future consequences, people will be affected by present bias. This links to dual-self models, e.g. Thaler and Sunstein (2006) argue intrapersonal conflicts between a Doer self and a Planner self makes people unwilling to take action if the costs are immediate and the payoffs more distant because the Doer prefers to spend less in the present. This can lead to an excessive focus on current costs / benefits relative to future costs/ benefits and encourages procrastination and over-indulgence. In an environmental context, this may also lead people to underestimate the benefits of environmental actions. For example, even when long-term incentives and payoffs are substantial, only 19% of Europeans opt for home insulation and only 6% opt for eco-friendly cars (Pongiglione 2011 citing Special Eurobarometer Survey 75.1). Also, Hepburn, Duncan and Papachristodoulou (2010) apply hyperbolic discounting to a fishery model: fisheries collapses because at minimum viable population the marginal rate of return is lower than relatively high early-on discount rate. This may explain the demise of Canadian cod and Peruvian anchoveta fisheries. Allcott and Mullainathan (2010) also argue that environmental decision-making is affected by procrastination: attention wanders, peripheral factors subconsciously influence decisions and perceptions, though commitment devices and default options can influence constructive choices and enable effective planning.

Brutscher (2011b) assesses temporal inconsistencies in energy decision-making using data from Northern Ireland Continuous Household Survey analysing pre-payment in household electricity consumption. He finds that upfront payments are associated with higher electricity consumption than ex post payment even when transactions costs are higher and feedback is given about electricity use. Using data from 10,124 households, he explores links between top-up behaviour of households using pre-payment meters. Households will balance the costs and benefits of top-ups topping-up is costly because of foregone interest but this is balanced by the benefit of convenience topping-up a pre-payment meter means that the household does not have to make a payment every time they use electricity. [3]

Brutscher identifies two behavioural anomalies in these households electricity consumption: he finds that people top-up more often with smaller amounts than optimal; and increases in tariff do not lead to equal changes in number and amounts of top-up; instead increases in tariff lead to increases just in the number of top-ups. These anomalies cannot be explained by learning because there is little adjustment in months following change in tariff so learning is slow or non-existent. ODonoghue and Rabin

[3] See also Gourville and Soman (1998) on temporally separating payments from consumption.

(1999) might argue that top-ups are used by sophisticated agents as a pre-commitment device to save electricity to resolve the conflict between an impatient present self and a patient future self but this does not explain the asymmetric adjustment of number versus amount of top-ups; if the behaviour reflects pre-commitment then there should still be a unique optimal top-up amount but the data suggest that people are adjusting by choosing different top-up amounts depending on the timing.

A more convincing explanation draws on Thalers mental accounting model (Thaler 1985, 1999). People perceive costs differently depending on the context and whilst each £10 payment seems trivial, one larger £100 payment does not. To test the mental accounting model Brutscher uses data from a natural experiment to analyse the impact of an exogenous increase in minimum top-up amount. An increase in minimum top-up amount from £2 to £15 was implemented in May 2009 and this did lead to decreases in electricity use: electricity consumption decreased by around 15 KWh as a result of the change in minimum top-up. This is consistent with mental accounting models in which people treat small amounts as trivial even when paid more frequently (Brutscher 2011b).

4 Social influences

Social influences will take three major forms: informational influence/ social learning; social preferences and values; and normative influence/peer pressure.

4.1 Social learning

In terms of informational influence, social learning about energy efficiency can take place effectively within group settings. Nye and Hargreaves (2010) outlined evidence from two UK experiments conducted by Global Action Plan in which environmental information was communicated in a social setting. One (the Environmental Champions Program) was office-based and focussed on 280 people with a team of energy champions drawn from different departments. These champions engaged in a 3 month communication campaign, providing practical information about environmentally friendly behaviour leading to a 38% reduction in waste production and a 12% reduction in energy consumption. The second programme the Eco-Teams Program, focused on household habits and involved neighbourhood meetings to inform communities about energy use. There were a number of positive impacts: 16% adopted green energy tariffs, 37% installed energy efficient light bulbs and 17% reduced domestic heating. Participants observed that the EcoTeams Program worked because, whilst they were environmentally aware before participating, practical knowledge was beingcommunicated to participants.

Social information can be useful in setting reference points. For example, without a reference point, information about embedded emissions is of little use to the consumer because they do not know what it means, reference points can be set around social comparisons; for example, the French supermarket chain E. Leclerc is introducing carbon labelling which includes information not only about carbon emissions per kg for specific products but also total carbon footprints for each trolley of food alongside a social comparison with the average trolley footprint (The Economist 2011, p 14).

4.2 Social preferences fairness and inequity aversion

Gowdy (2008) applies insights from behavioural economics and experimental psychology to the issue of climate change and specifically to the question of reducing CO_2 emissions. He argues that resolving the current crisis of sustainability needs more emphasis on broader facets of human behaviour e.g. greed, egoism, cooperation and altruism. Models of extreme rationality will be of limited value in encouraging people to consider more carefully their energy and environment decisions; financial incentives may in fact crowd out intrinsic motivations and feelings of collective responsibility and so environmental policy should draw on cooperative, non-materialistic aspects of human nature. Frey (1997) argues that monetary incentives can crowd out civic motives but money can also crowd in civic motivations when it is used to acknowledge social worth of individual contributions (Frey and Oberholtzer-Gee 1997).

Individual preferences and attitudes will be affected by differences in age, gender, education, socio-economic status, and political views. Costa and Kahn (2010) that political opinions play a role, identifying rising polarization in environmental attitudes between political groups: liberals and environmentalists are more responsive to environmental nudges than average and Costa and Kahns econometric estimates show 3%/6% reductions in energy consumption in Democratic households for low/high users but a 1% increase in consumption in Republican households. Republicans increase electricity consumption in response to nudges either because they are defiers or because of boomerang effects (which occur when people are over-achieving relative to others and so adjust their performance downwards, see also below). Fairness can be incorporated into individual utility functions, e.g. see Fehr and Schmidt (1999) on inequity aversion, but subjectivity is still problematic as the question remains of how to assign weights to inequity aversion. Gowdy (2008) notes that distributive preferences include accountability, efficiency, need and equality equality raises moral questions and accountability implies that polluters should pay proportionally to emissions. Concerns about fairness will also affect the global management of environmental decision-making, especially with respect to the developing world.[4] Dealing with climate change will need cooperation, trust and reciprocity; and even when cooperative frameworks are imperfect, participation can establish credibility and good will (Gowdy 2008). Given that the North got rich by burning fossil fuels is it fair to tell the developing world to stop using them? Stiglitz (2006) argues that a fair solution could be to implement a common global carbon tax and allow each country to keep the tax revenues so that if less developed countries are polluting more then they will also have more taxation revenue to spend on reducing capital and labour taxes.

4.3 Social pressures and social norms

There is a large literature from behavioural economics on the impact of social pressure and social norms on environmental decision-making. Social norms will drive public-

[4] See also Rosser and Rosser (2006) on evolution of global environmental institutions with growth.

spirited behaviour and conditional contributions to public goods and these norms and pressures will be affected by the values and attitudes outlined above.

Schultz (1999) notes that descriptive norms can be communicated in written information; conformity does not require the direct observation of others. He investigated participants awareness of causal relationships between descriptive social norms and behaviour and found that normative information about average recycling by neighbourhood families increased the amount and frequency of recycling. Similarly, Goldstein et al. (2008) analysed hotel towel re-use and tested the impact of different types of information; hotel guests were asked to re-use towels either to help the hotel or, for the normative appeal, to do what their fellow guests were doing. In the third control condition, the card did not include any specific reasons for towel re-use. Goldstein et al. found that the card appealing to the norm led to significant increases in towel recycling. Schultz et al. (2007) analyse the impact of norms, including descriptive norms (which provide points of comparison e.g. to others consumption) and injunctive norms (which incorporate instructions). They study these norms by analysing the energy consumption behaviour of 290 households in San Marcos California. All households had visible energy meters; half were given just descriptive information about consumption in other households; the other half given were given the descriptive information plus an injunctive message about whether the changes in their energy consumption were acceptable or not. The observed impact of the norms reflected the nature of the norm: descriptive norms were found to be constructive and encouraged people who were consuming too much relative to others to consume less in the future; but descriptive norms were destructive because generated boomerang effects (mentioned above), i.e. people who were consuming less than others adjusted their consumption towards the average by consuming more. Injunctive norms were reconstructive: for example, a pictogram of a smiley face versus a frowny face reinforced the descriptive normative signals.

Nolan et al. (2008) extend these finding using two studies aimed at assessing the weight that people ascribe to social norms as factors affecting their energy conservation decisions. The first study surveyed 810 Californians to explore stated reasons for engaging in energy conservation and testing actual factors influencing conservation behaviour; respondents were asked a series of questions about their energy conservation beliefs, motivations and actual behaviour. Self-reported beliefs were assessed according to answers to questions about how much they thought saving energy would benefit society / the environment; how much money they thought they could save; how often their neighbours try to conserve energy. Behaviour / intentions were judged by the answer to question How often do you try to conserve energy? Motivations were assessed by questions about reasons for trying to save energy e.g. using less energy saves money / protects the environment / benefits society, other people are doing it. Responses were rated on a 4 point scale from not at all important to extremely important. The findings revealed an inconsistency between the stated motivations and actual behaviour: because others are doing it was judged to be the least important reason at the self-reported motivation stage; but the highest correlation with actual conservation behaviour was a persons beliefs about whether or not their neighbours were doing it.

Nolan et al.s second study was a field experiment involving 981 Californian households in San Marcos assessing participants awareness of the extent to which their behaviour was affected by different messages. Normative information was circulated in the forms of messages on door hangers; each message was illustrated with a graphic icon. The messages urged the householders to conserve energy via specific conservation behaviours (e.g. taking shorter showers, turning off lights / air-conditioning). There were four appeal treatments, each appealing to different motivations: 3 appeals used non-normative messages: protecting environment (environmental responsibility), benefiting society (social responsibility) and saving money (self interest). The fourth appeal was based on a descriptive norm with factual information about the energy conservation behaviour of recipients neighbours. There was also an information-only control treatment people were just told that they could save energy by taking the various actions without appealing to any specific motivation. Actual energy use in home was the dependent variable and electricity meter readings were taken before and after the intervention. This reliance on objective information from meter readings prevented inaccuracies from self-reporting and/or imperfect memory bias. The data showed that normative social influence had a direct impact on conservation behaviour and the social norm condition led to biggest reduction in energy consumption; people conserved more energy under the social norm condition than either under the control condition or any of the other informational conditions; however, the householders did not detect the influence of these messages; they did not appear to realise that they were affected by the descriptive norm.

Nolan et al. conclude that these findings suggest that nave psychology based beliefs about energy conservation are inaccurate. Trying to encourage people to be socially responsible / protect the environment rarely succeeds in increasing pro-environmetnal behaviours perhaps because people have already adjusted their behaviour to these factors. In changing the behaviour of recalcitrant consumers, new motivations and messages are needed so that normative messages can reach new populations who might not otherwise want to conserve energy.

Allcott (2011), drawing on research from Goldstein et al. (2008), Schultz et al. (2007) and Nolan et al. (2008), focuses on role played by social norms in guiding energy conservation strategies and identifies three pathways via which social norms play a role: a tournament pathway via which people gain utility from out-performing their neighbours frugality; a conditional cooperation pathway via which people contribute to a public good if others do too; and a social learning pathway. Allcott notes that boomerang effects can be explained most easily in terms of the second and third pathways though he does also emphasise the role of feedback

Allcott analysed data from a randomised natural field experiment using Home Energy Reports (HERs) in collaboration with OPOWER an electricity utility in Minnesota. The electricity consumption of 80,000 treatment and control households was analysed. Each household was sent a HER with two features: an Action Steps Module giving energy saving tips; and a Social Comparison Module comparing households energy consumption with that of its 100 geographically closest neighbours. The monthly programme led to decreases in energy consumption of 1.9-2.0% but with decay effects; impacts decreased in the period between receiving one monthly report and the next, but then increased again once the next report was received. Allcott infers that this reflects an interaction of social norms and bounded rationality / heuristics, in particular the availability heuristic (discussed above). There is an attention channel: people do know about energy conservation strategies but they need to be reminded because attention is malleable and non-durable. Receiving a HER reminded people about the strategies that they should be using. Given bounded attention to social norms, social norms will only affect behaviour when norms are at the top of the mind.

Attitudes will also be moulded by family upbringing. Developmental psychology focuses on the role of education in embedding habits from a young age and these habits can be transferred within the family structure. Families will be influenced (either via learning or via social pressure) by the recycling habits of other family members.Gronhoj and Thogersen (2012) analyse the impact of parental attitudes and behaviour on adolescents recycling behaviour. They focus on the role of parental influences and the fact that parents can play a key role in teaching pro-environmental practices and the. Family norms take two forms: descriptive norms normative information is conveyed via parents actions; and injunctive norms parental instructions to their children about pro-environmental behaviours. Nonetheless there may be differences across families, reflecting generation gaps and differences in parenting style. Also, issues of identity will be important the extent to which the child identifies with the parents will affect the transmission of environmental values across generations.

Gronhoj and Thogersen analyse evidence from a stratified sample of 601 Danish households representative of the Danish population in terms of socio-economic characteristics. Families were interviewed via internet-based surveys with questions to capture the influence of individual pro-environmental attitudes versus the social influence of family norms on adolescents pro-environmental behaviour. Families were asked about attitudes and actions with respect to specific pro-environmental practices including buying eco-friendly products; reducing electricity use; and separation of waste for recycling. Adolescents were also asked about the parents attitudes and actions. The impacts of generation gaps, i.e. the difference in age between parents and child, were also analysed alongside the relative weight of personal attitudes versus social influences. Gronhoj and Thogersen test three hypotheses: adolescents behaviour depends on family norms and is more influenced by descriptive norms than injunctive norms; the larger the generation gap the weaker the influence of norms. They find that adolescents pro-environmental behaviour is heavily influenced by their own attitudes but also by the existence and strength of parental pro-environmental attitudes and actions. Parents actions, i.e. the descriptive norms, dominate the injunctive norms and the impact of the descriptive norms is also dependent on the childs perception of their parents behaviour i.e. the extent to which their parents actions are visible and unambiguous. Gronhoj and Thogersen conclude that parents are important role models and can play a key role in moulding the pro-environmental behaviour of adolescents

4.4 Social influences on firms: reputation-building and corporate social responsibility (CSR)

Social influences will affect firms as well as households and many companies are incorporating environmental responsibility into their corporate social responsibility (CSR) strategies, reflecting a desire to accumulate social capital via reputation building (Brophy et al. 2009a). Data from the Carbon Discloure Project suggests that pressures from competitors and investors as well as customers will affect firms decisions to disclose their carbon emissions, though this will reflect signalling solutions to asymmetric information problems as well as reputational concerns (Brophy Haney 2011). Corporate attitudes towards fairness are important and firms are not invariably engaged in an unquestioning pursuit of profit and firms will act according to environmental principles e.g. a US Chamber of Commerce decision to oppose policies to address climate change led to resignations by Apple, Nike, Pacific Gas and Electric, Exelon and PNM Resources (Johansson-Stenman and Konow (2010), Brown and Hagen 2010). To some extent this is a response to consumer pressure and firms do worry about consumers perceptions of what is fair e.g. in terms of pricing (Kahneman, Knetsch and Thaler 1986).

Firms are driving the adoption of carbon labelling even though it is expensive and there are no international standards and this may partly be because of reputational considerations and/or informing consumers. Profit motivations will also play a role and there may be direct value in determining the carbon footprints of products, e.g. Walkers crisps by calculating carbon footprint were able to save energy and cut costs: they were buying potatoes by gross weight which mean that farmers were keeping potatoes in humidified sheds and adding extra water that later had to be fried off. The process of assessing the carbon footprint of the crisps revealed these additional costs and so Walkers changed its purchase strategy to buying by dry weight; energy was saved both from the humidification and also from the reduced frying time (The Economist 2011, p.14). Firms concerns about reputation can also encourage them into more environmentally sustainable production methods. There may also be reputational competition amongst firms and this will be encouraged via information disclosure - e.g. social nudges in the form of environmental black lists such as the Toxic Release Inventory can generate social nudges because bad publicity affects relationships with investors and competitors as well as customers (Thaler and Sunstein). Thaler and Sunstein suggest that a Greenhouse Gas Inventory requiring most significant emitters to disclose theiar emissions could have similar beneficial effects as the Toxic Release Inventory, particularly given the current salience of climate change problems in the public consciousness.

Firms will also be affected by the actions of regulators, and this may generate strategic conflicts. When firms social motivations will interact with strategic considerations it introduces additional complexities, for example Shogren et al. (2010) assert that a regulators subsidy can interact negatively with social motives of a firm concerned about reputation. Selfish firms will make an optimal effort and socially oriented firms will be subsidised less than is optimal.

5 Emotions, wellbeing and happiness

5.1 Well-being

Gowdy (2008) rejects the standard rational actor view that there is a trade-off between material consumption and environmental protection. Increasing per capita income does not increase wellbeing beyond a certain point and drastic reductions in fossil fuel use will mean a reduction in production of consumer goods; but if welfare policy goals can shift from income to well-being more broadly defined then this will be a positive development, i.e. there is no necessary trade-off between the environmental protection and wellbeing. Similarly in developing countries reorienting policies towards living a full life rather than income creation, then this would alleviate pressure on the environment.

Environmental problems will have an impact on peoples wellbeing, particularly if they create anxieties for individuals. The European Commission (2002) conducted 7,500 interviews for 15 member states of the EU and found that 89% of respondents were concerned about environmental pollution; 86% about natural resources and waste generation and 82% about trends relating to nature and wildlife; 72% are concerned about climate change; 73% believe that the environment influences the quality of life very much or quite a lot relative to 64% for economic and social factors. These attitudes are relatively robust over recent time with not much change since the global financial crisis and recession. The 2011 Eurobarometer Surveys on the environment and climate change found that 95% of EU citizens feel that protecting the environment is personally important to them and 76% believe that environmental problems have a direct impact on their lives though only 69% believe that they should be personally responsible for using natural resources more effectively. For climate change, 68% of people think that climate change is a very serious problem; 89% think it very serious or fairly serious; 78% think that fighting climate change and improving energy efficiency will have positive impact on jobs and economy; 68% support environmental taxes but just 53% had taken some sort of action to combat climate change; 66% reduced and recycled waste. This survey evidence reveals some inconsistencies between opinions about the significance of climate change and concrete actions taken to combat climate change. In addition, some respondents seem not to realise that recycling is an activity that can help to combat climate change. (Source: European Commission 2011a, 2011b).

Desires to maintain current quality of life will also lead to inertia especially as conspicuous consumption can signal social status. The sacrifices that people are prepared to make will reflect their socio-economic conditions, e.g. a Pennyslvania survey analysed the role of wealth and environmental attitudes in environmental action and found no significant association between personal economic conditions and environmental concerns though people on lower incomes less willing to incur monetary costs and richer people were less willing to sacrifice living standards and comforts (Pongiglione 2011). Other factors affecting positive environmental action include knowledge, an internal locus of control (i.e. taking personal responsibility) and perceived threats to personal health (Fransson and Grling 1999).

To assess the impact of socio-economic status and environmental attitudes, Baddeley (2011) analyses survey responses from 2764 respondents to Northern Irelands Continuous Household Survey 2009/10, using ordered probit techniques. The data suggests that apathy (low levels of reported concern about environmental issues) is associated with reduced environmental action. Environmental awareness (familiarity with common phrases about environmental conservation etc.) correlates positively and significantly with the number of environmentally sustainable actions taken, though this survey may be susceptible to self-reporting biases given the positive normative connotations of positive environmental action. Larger household size also has a positive significant impact, perhaps because social pressure increases when observed and/or encouraged by others in a family unit. Owner-occupiers are also more likely to engage in environmental action, perhaps because home ownership promotes lower discount rates and more forward-looking behaviour. Socio-economic status (as measured by whether or not a household depends on benefits), number of children, the age of housing and whether or not the householders were public rental tenants were insignificant suggesting that poverty does not constrain environmental actions and the presence of children does not either.

5.2 Emotions and Salience

Weber (2011) notes the importance of voluntary reductions in energy consumption but most in Western household fail to install energy saving technologies even if they would save money in long-run if they did. They also seem reluctant to make personal sacrifices in terms of lifestyle and some argue that this is because they have not experienced the consequences of climate change. However, empirical evidence does not suggest that lack of experience reduces motivations to act. Actions to reduce energy use are not related to uncertainty about climate change existing, and have more to do with whether or not people think that their behaviour will be effective.

Leiserowitz (2006) notes that people claim to be very concerned about climate change, ranking it highly on lists of global threats; but when it comes closer to home and people are asked to judge more proximate threats, climate change is low on lists of priorities. Leiserowitz argues that people do not perceive climate change as a direct threat and this links to the impact of vividness and emotions on behaviour; people do not have vivid, concrete, personally salient affective images of climate change and so environmental behaviour change is a low priority.

The evidence about the impact of first-hand (and devasting) experiences of environmental calamities is mixed. Spence et al. (2011) analyse UK survey data from 1822 individuals and find that flood victims were more concerned about climate change and were more confident that their actions would have an effect. Other studies suggest that direct experience of the impacts of climate change may restrain action if it leads to cognitive suppression of frightening realities (Pongiglione 2011). Lorenzoni et al. (2007) observe that motivation depends on people believing that their actions will be effective but a 2004 BBC poll shows that only about a half of people think that behavioural changes will impact on climate change. This may link feelings of powerlessness. Experience of detrimental consequences of climate change does not necessarily link to mitigation efforts and responses to questions about willingness to change behaviour to protect the environment. Whitmarsh (2008) reports survey evidence showing that the salience of risk does not predict behaviour: those who had experienced floods were no more likely to think that the problem could be solved. UK flood victims felt unable to control their situation during the floods and so did not expect to be able to take effective action against climatic events in the future. There were no significant differences in the responses of UK flood victims and non-victims in attitudes towards combating climate change (Pongiglione 2011, Spence et al. 2011, Whitmarsh 2008). Direct experience may in fact restrain action if cognitive dissonance / cognitive suppression take hold; fear and helplessness may be paralysing (Pongiglione 2011, McNamara and Grubb 2011).

Strauss (2008) analysed responses from a Swiss rural community: 95 residents were interviewed and most acknowledged that climate change was taking place but felt helpless and prefereed to focus actions on things they can control. Norgaard (2006) interviewed people in a Norwegian rural community and found that people recognised climatic changes and had high level of knowledge about the climate but made no mitigation efforts, instead associating climate change with fear and helplessness. These feelings of helplessness may be exacerbated by a social organisation of denial because motivation is harder if people feel that they are acting alone and that there is no impetus to collective action, an emotive version of the free-rider problem.

Yates and Aronson (1983) emphasise salience and vividness and argue that there is too much emphasis on initial costs; more vividness is needed in energy saving advice. Similarly, Bazerman (2006) assert that one of the problems is that environmental damage is not a vivid threat: it does not engage emotional, visceral responses and this encourages apathy. This could also link to salience and the availability heuristic: people form their perceptions and decisions on the basis of recent experience but if people have not experienced the consequences of environmental damage then they are less likely to worry about it (see also Sunstein 2006, discussed above).

6 Policy implications

As outlined above, a wide range of behavioural factors affect environmental decision-making and this creates some policy dilemmas, particularly in terms of whether or not the best policies should rely on price and/or non-price factors. For policy-makers, engineering behaviour change in the face of climate change and dwindling energy reserves is a significant policy challenge, more so because long-term behaviour changes are not necessarily resolvable via technical quick fixes.

6.1 Impacts of monetary incentives

Reiss and White (2008) assess policy makers focus on public appeals in encouraging voluntary reductions in consumption to mediate demand. They analyse the impacts of price shocks versus public appeals on the energy consumption of 70,000 randomly selected households in San Diego, California using 5 years of utility billing data. During 2000 this area had large unanticipated increases in electricity prices caused by a range of factors including increased production costs, design flaws in the electricity wholesale market and actions of suppliers. Reiss and White found that household energy use fell by more than 13% in 60 days or so after the price increase, reflecting investments in new appliances and behavioural changes. The legislature then introduced a price cap and consumption rebounded. California also had a media campaign at the time - aimed at encouraging voluntary conservation alongside the price cap and Reiss and White estimate that this lead to a 7% decrease in energy use. They conclude that behaviour is affected by both prices and public appeals but public appeals suffer the same pitfalls as conditional cooperation to a public god: given the private costs of contribution, tangible benefits will only emerge if aggregate participation is high; overall this suggests that a range of policy tools is required and effective policies should address price factors alongside public appeals.

Other financial incentives are important too, particularly when residential energy-saving investments incur large upfront costs. A utility grant programme that paid for 90% of home retrofits achieved penetration of up to 19.3% (Stern et al. 2006; Dietz et al. 2009). Fuel poverty is another particularly pressing policy issue and Brutscher (2011a) argues that social tariffs designed to help the fuel poor, e.g. a two-part tariff with a subsidized price for low levels of consumption, is likely to exacerbate fuel poverty because the problem is liquidity constraints; because fuel poverty is often associated with anomalously high electricity usage, policies could focus on helping poorer households to overcome liquidity constraints, enabling a shift from electricity by facilitating heating oil purchases.

Policies to alleviate financing constraints have been piloted in the UK. The UKs Green Deal was implemented to address the old and energy inefficient characteristics of Britains housing stock domestic homes generate 27% of UKs GHGs. A study of Pay As You Save (PAYS) pilot undertaken by BQ, London Borough of Sutton and BioRegional in 2010/11 explains that Green Deal energy retrofits were offered to owner-occupiers with costs spread out and paid through energy bills. Under the Sutton pilot scheme, 67 homes were retrofitted with insulation, draught-proofing, new boilers and/or microgeneration technologies e.g. solar photovoltaics (PV). The costs were financed via a 40% grant and a 60% interest free loan - repaid over 10 to 25 years with repayments on loans guaranteed to be less than fuel bill savings for the 25 year loads. The aim was to understand what motivates people to install energy saving measures. Initially the scheme was over-subscribed but after the first step of an energy audit, a large number of householders decided not to proceed e.g. because the loan would not stay with the house and so if they moved their investments in the energy efficient technologies would be worth less. For those who did proceed, the involvement of London Borough of Sutton made the scheme trustworthy; the future savings were another important factor in the decision to proceed, as were improvements in comfort. Average spend per household was 13,000 with CO_2 emission savings expected to range between 6% and 52%. There was some evidence of cognitive bias with 28% of households opting for 10 year repayment which would incur loan repayments in excess of the energy savings; of those who did select the 25 year payback scheme, 72% achieved energy savings in excess of their loan repayments. Overall, the main lesson from the PAYS pilot was that financial aspects are not only aspects that make a subsidised deal attractive (Bioregional et al. 2011).

6.2 Regulatory strategy

Energy policy regulators have taken an interest in behavioural themes, for example Ofgem has analysed consumer biases and their impacts on energy consumers, emphasising that problems of limited cognitive capacity, status quo bias, loss aversion and time inconsistency. In policy terms, this can be understood within a framework of consumer decision-making emphasising the Office of Fair Tradings mantra: access, assess, act. Consumers access information e.g. about tariffs; they evaluate it and then they act. Ofgem argues that policies must take this decision-making process, and the behavioural biases that constrain it, into accunt (Ofgem 2011).

Asheim (2010) analyses strategic behaviour between firms / consumers and environmental agencies postulating that environmental agencies will use information selectively to promote intrinsic motivations to act responsibly. Voluntary contributions to environmental protection partly reflect the fact that shirking environmental responsibilities generates disutility. Moral motivations and intrinsic motivation lead to larger contributions but not enough to ensure optimal provision of public goods. Taking these factors into account, environmental agencies may not release all information. They do not have to release signals if releasing them would have a negative impact on behaviour change, e.g. a regulator will have an incentive to withhold a signal if it would communicate a low level of threat to the environment; in this way they can ensure that high levels of contribution are sustained. Asheim notes that this raises issues of credibility: it is best to keep environmental agencies independent to ensure credibility. Asheim concludes that, overall, using Pigouvian taxes may be less complicated; with taxes the environmental agency has an incentive to use all the information available to them. Attempts to promote intrinsic moral motivation are a poor substitute for optimal economic instruments.

6.3 Smart meters

Another emphasis in modern energy policy is on smart metering technology to overcome the informational constraints on effective planning of energy consumption. Bounded rationality constrains effective planning it is a complex task to manage demand even if time-varying tariffs are available. Smart metering technologies could enable people to adapt either to real-time pricing or to other tariffs which match supply and demand conditions more effectively. They could also be adapted to incorporate normative information, to harness the social influences identified by Schultz et al, Nolan et al., Allcott and others, as outlined above.

McNamara and Grubb (2011) observe that smart meters can play an important role e.g. in conveying helpful, immediate feedback to energy users enabling them to develop new energy-efficient habits; however the rapid pace of smart meter rollouts in Europe, by 2020 at least 80% of electricity customers should have smart meter - may also hamper further innovations.

6.4 Behavioural nudging

There has been a strong emphasis in recent policy initiatives on Thaler and Sunsteins (2008) libertarian paternalism an approach in which policy-makers allow people freedom to choose for themselves but encourage them in the right directions using behavioural nudges (see also Dolan et al. 2010). Thaler and Sunstein argue that effective nudging can be used to overcome various cognitive biases which emerge because of poorly designed choice architecture, e.g. the status quo biases which emerge because of choice overload / complexity. This insight can be applied to various aspects of policy on energy and the environment e.g. perhaps people do not switch energy supplier because they are confused by the complexity of alternative options available.

In terms of heuristics and biases, including present bias and status quo bias, default options on household appliances can be manipulated so that people expend less energy on heating water etc. More sophisticated measures could incorporate remote control of household equipment to promote energy efficiency. Thaler and Sunstein also emphasise the importance of frequent, simple feedback and this could be achieved via smart metering technology. They also argue that emotions and visceral responses can be tapped into using technological innovations e.g. the Ambient Orb is used by Southern California Edison to engage visceral responses; it glows green when energy consumption is relatively low but then glows red when the consumer is using a lot of energy; analysis of its impact showed consumers reducing their consumption in peak periods by 40% (Thaler and Sunstein 2008)

Allcott and Mullainathan (2010) argue that nudges can affect behaviour as much as price changes and psychological cues can also be more cost effective. Households are often reluctant to take easy energy consumption reduction measures even though the benefits would be large. Non-price based behavioural interventions can provide trigger points for behaviour change though evidence so far is not necessarily representative. Studies of impacts of social norms as discussed above (e.g. Schultz et al. 2007) indicate that a combination of descriptive norms and energy conservation tips has the potential to reduce electricity consumption by over 2%. These are cheap programmes and could generate 12.7 million tonnes of CO_2 (MtC) of annual carbon abatement, comparing favourably with generation of energy via renewables e.g. wind power, carbon capture.

Allcott and Mullainathan (2010) emphasise the importance of behavioural interventions which are scalable and so have large impacts, e.g. using market incentives to encourage firms to adopt innovations that nudge consumers towards better choices, recognising that - whilst price is important - firms interact with consumers in many other ways too; and also rethinking the way that information about energy efficiency is conveyed Some tailoring of policies would also be important: Home Energy Reports could profile specific sub-sets of households, targeting those most likely to take concrete steps towards energy conservation, e.g. the high energy users.

Support for behavioural nudges is not undivided however. Behavioural nudging is perceived by some as a simplistic set of cognitive tricks (e.g. simple changes to the way in which information is framed) and facile behavioural nudges (smiley faces to generate normative influence). Some argue that standard approaches will have a greater impact, e.g. Stern et al. (2010) assert that utility grant programmes have the potential to reduce carbon emissions by 123 million tons per annum, a lot greater than the 12.7MtC savings estimated by Allcott and Mullainathan (2010). Stern et al. (2010) argue that there will be significant opportunities to reduce energy consumption only if insights from behavioural economics are combined with other policy tools. Social and behavioural science research shows that norms, social networks and social influence and attention to convenience and design will work alongside financial incentives and better information.

A major policy hurdle is that people tend to support policies that have only a minor impact on their lives (Bord et al. 1998) and so small nudges might not be sufficient to make a real difference. Loewenstein and Ubel (2010) argue that more and better information is not enough and too much is claimed for behavioural economics. Behavioural economics alone is not enough to tackle the policy challenges; e.g. using social comparisons will have a relatively small impact in comparison with a carbon tax and so behavioural nudges should complement not substitute for other economic interventions. In the end, prices need to increase to reflect costs. Stern et al. (2010) in response to analyses of the impact of social influence, also observe that policy designs drawing on the power of social influences and ease-of-use will deliver limited benefits on their own: policy-makers need to use these features alongside standard financial incentives and better information.

Rowson (2011) concludes that nudges are simple, cost effective technical solutions; they can play a crucial role and a greater awareness of effective choice architecture should not be discounted. It is important however not to underestimate the adaptive challenge engineering long-term changes in behaviour is hard and complex. Policies must be designed to ensure long-term, permanent changes in peoples behaviour and habits, changes that can endure long after the novelty of a new technical gimmick has worn off. In confronting this challenge, collecting more empirical evidence about how, why and for how long various policies will work, is the crucial challenge.

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