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Making Energy Efficiency Pro-Poor

Insights from Behavioural Economics for Policy Design

Babette Never

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Insights from behavioural economics
for policy design

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Abstract

This paper reviews the current state of behavioural economics and its applications to energy efficiency in developing countries. Taking energy efficient lighting in Ghana, Uganda and Rwanda as empirical examples, this paper develops hypotheses on how behavioural factors can improve energy efficiency policies directed towards poor populations. The key argument is that different types of affordability exist that are influenced by behavioural factors to varying degrees. Using a qualitative approach, this paper finds that social preferences, framing and innovative financing solutions that acknowledge people's mental accounts can provide useful starting points. Behavioural levers are only likely to work in a policy package that addresses wider technical, market and institutional barriers to energy efficiency. More research, carefully designed pre-tests and stakeholder debates are required before introducing policies based on behavioural insights. This is imperative to avoid the dangers of nudging.

Keywords: energy efficiency, behaviour, lighting, Ghana, Uganda, Rwanda

JEL codes: D03, D10, Q40, Q48, Q56

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Abbreviations

CFL	Compact fluorescent light
LED	Light emitting diode
RWF	Rwandan franc
WTA	Willingness to accept
WTP	Willingness to pay

1 Introduction

Energy efficiency is central to energy security, the mitigation of greenhouse gas emissions and technological catching-up of developing countries. In addition, it can contribute to poverty reduction by helping poor households to save money. Despite decades of efforts to increase the energy efficiency of economies and to diffuse energy efficient technologies worldwide, results are still poor – especially in developing countries. While much has been written about the possible over- or underestimation of the size of this so called energy efficiency gap and the factors responsible for its existence (Gillingham / Palmer 2013; Allcott / Greenstone 2012; Anderson / Newell 2004; Jaffe / Stavins 1994), there is still no satisfactory answer to the question of how to close it. Market failures, a lack of information and awareness, and badly targeted incentives and tariffs are among the most common barriers to energy efficiency (IEA 2010; Gillingham et al. 2009).

Recent research on energy consumption in industrialized countries has shown that behavioural factors – such as people’s tendency to hold on to technologies they already own even though they are costly, to procrastinate or to react to losses more strongly than to gains – may provide explanations for the failure of respective policy and market incentives (Gillingham / Palmer 2013; RAND 2012; Pollitt / Shaorshadze 2011). It is still unclear, however, to what extent these factors apply to developing countries. What does behavioural economics have to offer developing countries with regard to energy efficiency diffusion? To what extent can policies that take behavioural insights into account better balance the political goals of affordability, energy access and clean energy? In discussing these questions, this paper reviews the behavioural economics literature from the perspective of energy efficiency in developing countries and establishes some analytical tools and hypotheses for future research that take into account insights from development research. Finally, it aims to show how energy efficiency policy can be made more pro-poor by using the empirical examples of energy efficient lighting in Ghana, Uganda and Rwanda. My key argument is that different types of affordability exist among the poor and are influenced by behavioural factors to varying degrees. The connection of behavioural economics, energy efficiency and poverty reduction contributes to closing this research gap. This paper therefore advances theoretical debates in development research, behavioural science and environmental policy; develops an innovative research agenda; and provides the practical debate with a new direction.

Behavioural economics has become such a vast field that it is impossible to provide a comprehensive overview of all its developments. I thus only review those core concepts of behavioural economics that are relevant to energy efficiency, particularly in developing countries (section 2). Studies on microinsurance and health behaviour provide valuable insights here. After briefly presenting the main barriers to energy efficiency diffusion in developing countries, section 3 assesses the potential and pitfalls of these principles for energy policy design by discussing which behavioural factors may be helpful and which harmful to the poor. An empirical analysis of energy efficient lighting in Ghana, Uganda and Rwanda will be conducted in section 4, thereby refining the assumptions of the previous sections and developing concrete hypotheses for future testing. Methodologically, this paper approximates an abductive qualitative approach that draws on available literature, reports and newspaper articles. The three countries selected have all run large-scale lighting programmes in recent years with different approaches and varying degrees of success, while being under significant pressure to increase energy access, secure energy supply and keep

energy policy pro-poor. This makes them particularly suitable for comparison. Finally, this paper provides an outlook for both research and practice in section 5.

2 Behavioural factors in decision-making

2.1 Utility maximizing decisions and their alternatives

Have you kept your old, rattling fridge for years even though you know there are more efficient ones? Have you ever put off an investment decision because there was simply too much to choose from? Behavioural economics offers some answers to why people hang on to things they already own, procrastinate, change their minds, help others and do not always behave rationally.

Neoclassical economists assume that individuals take rational, utility maximizing decisions after accessing and considering all relevant information, which often includes a cost-benefit analysis. In this traditional scenario, preferences and tastes are fixed and altruistic motives or fairness does not exist. Preferences and discounting rates remain the same over time unless the pay-off changes. An individual thus prefers to consume a good or resource now rather than at a later point in time, irrespective of the way the information about the good is framed.

A wide range of studies from behavioural economics as well as psychology (e.g. Goldstein et al. 2008; Yates 1983), sociology (e.g. Dahrendorf 1959; Stern / Dietz 1994) and political science (e.g. Lau / Redlawsk 2001) have shown that extra-logical factors impact on individual and public decision-making, thus challenging the traditional economic view on various grounds. Since Simon's early work on bounded rationality (1956) and Allais' (1953) and Ellsberg's (1961) critiques of the standard probability model, behavioural economics has developed four major strands of economic research: (1) prospect theory and loss aversion; (2) inconsistent time preferences and hyperbolic discounting; (3) information, mental accounting and framing; and (4) social preferences and social aspects. The concepts and results of these strands often overlap.

The first strand of research on prospect theory was developed as an alternative to expected utility theory. Prospect theory argues that people take decisions based on different valuations of losses and gains, relating them to a reference point (Tversky / Kahnemann 1992; Kahnemann / Tversky 1979). The status quo or the aspiration level most often serves as such a reference point. In contrast, expected utility theory sees an individual as being indifferent to reference points because only absolute wealth matters, not relative assets compared to a specific point in time. Prospect theory further assumes that in a situation of risk and uncertainty,¹ an individual is more risk-averse if the decision involves a potential gain (concave value function) and behaves in a risk-seeking way if a loss is likely (convex value function). This loss aversion implies that losses loom larger in people's minds than gains (Tversky / Kahnemann 1992). For political actors who take this into account, the framing of information crucial to the decision-making process becomes relevant (see

1 Risk in economics means that probabilities about a future event occur with a measurable probability; under uncertainty, either probabilities cannot be calculated or it is unclear whether a future event will occur at all.

below). In contrast to the expected utility model, probability is non-linear in prospect theory: individuals assign too much weight to small probabilities and underestimate medium and high probabilities. This tendency is related to hyperbolic discounting (see below).

Loss aversion may to some extent explain the endowment effect (Thaler 1980), the status quo bias (Samuelson / Zeckhauser 1988) and the difference between the amount that an individual is willing to pay (WTP) for a good or service and willing to accept (WTA) to abandon a good or tolerate something negative (e.g. pollution) (Knetsch / Sinden 1984). According to the classic Coase theorem, the gap between WTA and WTP should be very small, but many empirical tests have falsified this claim. Standard economic theory can explain these deviations to some extent as well (Mansfield 1999), but people's tendency to overvalue things they already own (endowment effect) or unwillingness to change the current situation (status quo bias) are more psychologically grounded explanations. Since these two behavioural factors may in turn be influenced by loss aversion and multiple reference points (Ericson / Fuster 2013), maintaining analytical clarity in empirical field experiments is challenging. At this point there is insufficient empirical evidence to clarify the mutual influence of these factors on real-life political and economic decisions and to show which factor matters most for different kinds of decisions.

The second strand of research looks at time inconsistencies and hyperbolic discounting. In a nutshell, time inconsistent decision-making means that a person takes a different decision in the same situation at a later point in time. Hyperbolic discounting presents one possible way of explaining and modelling these inconsistencies. While standard decision-making theory assumes that discount rates and preferences are independent of the decision date, a change of preferences over time is possible in hyperbolic discounting models. A substantial body of research has found that subjects tend to choose earlier, smaller rewards over later, larger rewards when the earlier reward offers immediate consumption; this preference is reversed when both rewards are delayed (Pesendorfer 2006). For instance, if offered the choice between a free meal voucher valid for today and two free meal vouchers valid for tomorrow, people will most likely choose the one for today. But if given the choice between a voucher for a meal in 100 days and a voucher for two meals in 101 days, people will most likely choose the second option. Laibson (1997) call this the 'immediacy effect'. It is connected to an individual's tendency to not care enough about his or her own future self and results in procrastination or difficulties in committing to long-term investments, such as retirement schemes or climate change management (Gowdy 2008). Self-control mechanisms that target temptation such as automatic reminder messages may counter this effect (Tsvetanov / Segerson 2013). A topic of hot debate among environmental economists is the extent to which hyperbolic discounting functions provide sufficient deviations from standard discounted utility models to understand the 'black box' of environmental decision-making (Gowdy et al. 2013; Rubinstein 2003). Thus, the current challenge for research on long-term environmental problems and energy system change no longer lies in the fine-tuning of econometric modelling, but rather in analysing actual messy decision-making situations – both in the public and private realms.

In a third strand of research, the analysis of how people deal with different kinds and amounts of information has attracted many behavioural economists. The framing and priming of information in certain ways represent key concepts in this literature (Li / Chapman 2013; Gallagher / Updegraff 2012; Bertrand et al. 2010). Framing can be used by policymakers, donors or companies to shape and implement their programmes as well as by stakeholders to

influence policy. The framing of contents in this regard overlaps with discourse analysts' interest in the production and dominance of certain storylines and narratives. On the one hand, too much information may prevent an individual from taking a decision (choice overload), as Iyengar and Lepper (2000) found. On the other hand, feedback on the way peers have decided or behave can spur the decision-making process (Allcott 2011a).

Three tools that people use to handle information are of particular interest: (1) mental accounts for different types of investment, which prestructure spending behaviour (Thaler 1999); (2) heuristic shortcuts to process information which may sometimes be more effective and at other times lead to mistakes; and (3) a tendency to react more to salient, clear and up-to-date information and to focus on the short-term costs and effects of one's actions (Wilson / Dowlatabadi 2007). By way of example, this could be a prominently placed, clear and recently awarded certificate regarding the non-toxic contents on the birthday present for your child – for example, the German Stiftung Warentest label. These different heuristics have generated a lot of controversy in psychology (Gigerenzer / Gaissmaier 2011) and also present a challenge to empirical work on energy efficiency behaviour (see section 2.2).

A fourth strand of behavioural economics that is also relevant to energy efficiency targets social preferences. In rational choice thinking, interpersonal considerations such as fairness, altruistic motives and trust do not impact decision-making. In the past decade behavioural economists have conducted a series of canonical experiments (e.g. the ultimatum game, dictator game, trust game and public goods game) that have identified instances in which individuals do care about these factors (e.g. Fehr / Gächter 2000; Chater / Vlaev 2008; for an overview, see Wilson 2011 and Cardenas / Carpenter 2008). The so-called warm glow effect, for example, describes the positive feelings people experience when contributing to the public good or helping others (Andreoni 1989). These results overlap with some of political science's and sociology's work on norms (e.g. Wiener 2009) and social psychology's insights into the influence and perception of others, norms and attitudes (e.g. Stern 1999; Stern / Dietz 1994).

In all four strands of behavioural economics, expanding the methodological toolbox is required. The vast majority of behavioural economics research uses game-theoretic set-ups and lab and field experiments. However, not all those behavioural economics variables tested are useful for real economic situations or can be empirically measured outside of experimental settings, as Pesendorfer (2006) correctly argues.

2.2 Key concepts of behavioural economics in energy efficiency

Many of the above-discussed behavioural factors may be relevant for energy efficiency, but only a few have been empirically tested in this particular field. Furthermore, applications of behavioural economics to energy efficiency have thus far only focused on industrialized countries. Empirical work has been conducted on feedback and framing, hyperbolic discounting and decision-making shortcuts, self-control problems and temptation. Loss aversion, the endowment effect, inconsistent time preferences and salience are also likely to be relevant to investments in energy efficient technologies or appliances as well as to policymakers' decisions (Pollitt / Shaorshadze 2011; Wilson / Dowlatabadi 2007). These factors have not yet been systematically analysed in empirical settings.

Feedback mechanisms have been well explored in many case studies on energy consumption behaviour, for example in the United States (Allcott 2011a; Costa / Kahn 2010; Ayres et al. 2009), the United Kingdom (Dolan / Metcalfe 2010) and the Netherlands (Abrahamse et al. 2007). Feedback on electricity use can reduce household consumption, albeit by a rather small percentage (0.3–6.3 per cent) of the electricity bill (Allcott 2011a). A scaling-up of these effects is required to make a meaningful difference, possibly in combination with other instruments. In the Netherlands the combination of feedback with tailored information – avoiding choice and information overload – and goal setting has proven useful as households react differently to different incentives (Abrahamse et al. 2007).

Feedback is possible before and during energy consumption (e.g. through in-house meters) or after consumption (e.g. through electricity bills or extra information comparing individual households to neighbourhood consumption). Based on a comparison of 26 energy projects in 10 different industrialized countries, Fischer (2008) argues that appliance-specific feedback provided over a long time span and presented clearly is most effective, particularly if interactive and computerized tools are used. Here, framing and feedback go hand in hand. It is, however, an open question as to whether this can be transferred to developing countries where households typically use a prepaid token system for electricity, where most households do not own a computer and where it would prove difficult to instal monitoring systems. In Northern Ireland low-income households using prepayment meters were found to consume more electricity than bill paying consumers, recharging smaller amounts more often (Brutscher 2011); whether this applies to other countries as well is unclear. Brutscher (2011) claims that people's different mental accounts for larger and smaller purchases are responsible, though he only indirectly tests this by looking at electricity expenditure and electricity consumption panel data.

Concerning hyperbolic discounting and decision-making shortcuts, some studies have shown that car buyers incorrectly estimate fuel usage over time (Allcott 2011b; Turrentine / Kurani 2007). But empirical evidence for these factors is still not sufficient at this point. It is difficult to empirically determine whether individuals' beliefs are systematically biased because multiple behavioural and non-behavioural factors may influence a decision-making process at the same time. Moreover, lab conditions and real-life decision-making may also differ – this is a general challenge for lab-based experimental economics.

Tsvetanov and Segerson (2013) find that self-control problems and temptation are responsible for households' choices of refrigerators – both with and without energy efficiency labels. They use an alternative model to hyperbolic discounting based on Gulf and Pesendorfer's (2001) framework to explain the energy efficiency gap. Here, a difference between richer and poorer households becomes relevant, as Tsvetanov and Segerson already indicate themselves. For poorer households or individuals, initial up-front costs of an energy efficient appliance or technology appear larger and may objectively exist in liquidity constraints. In such a context, not buying an energy efficient light bulb actually becomes rational. However, further research is required to distinguish and test mechanisms of temptation and discounting for different energy efficient technologies.

The argument that loss aversion and the endowment effect can explain the energy efficiency gap has been made by several researchers (Gillingham / Palmer 2013; Pollitt / Shaorshadze 2011; Greene 2011). However, clear empirical evidence is still lacking. Keeping inefficient

technologies or household appliances simply because they still work can come together with faulty calculations of future amortization of new investments. Here again, the perceived and actual liquidity constraints of enterprises and households may come into play.

Generally, these behavioural insights could be used by governments and administrations to formulate policies and regulations, by donors and NGOs to shape their programmes and by companies to sell their products and services. In the area of political steering and policy design, several possibilities and challenges result from these initial findings. Based on libertarian paternalism, Thaler and Sunstein (2009) propose a purposeful framing of consumer choices by influencing the choice-setting process. The target groups of policies are nudged towards beneficial decisions that counter previous market, policy and behavioural failures. An example of a nudge towards energy efficiency is making an energy efficiency investment the default option (e.g. a utility company's default installation of smart meters for new customers). Allcott, Mullainathan and Taubinsky (2013) argue that shaping behavioural interventions this way may help to close the energy efficiency gap. They integrate nudge-inducing mechanisms in their modelling of the externalities and internalities of energy taxes. The optimal policy formulas show that tax or subsidy levels and welfare gains are determined by the average *marginal* internality of the instrument, instead of just the average internality. For instance, environmentally conscious consumers buy more efficient products and are thus more likely to react more strongly to subsidized efficient light bulbs. They may, however, be a marginal group among all consumers; thus it matters who is saving energy, not only how much is being saved, when designing taxes and subsidies adequately (Allcott et al. 2013, 34). This calls for a thorough analysis of consumers and their behaviour before political actors start developing policy. Here, the representation of interests of different voter and interest groups among policymakers also has to be considered. Competing political actors often shape technocratic or expert recommendations to their political goals before implementation.

Target groups' different reactions can be a challenge for nudging programmes, as Costa and Kahn (2010) found. In the United States liberals are more apt to react to feedback information on their electricity bill than conservatives (Costa / Kahn 2010). Political affiliation is not the only characteristic that may impact on the uptake of energy efficiency: general attitudes to energy and the environment, income group, education level, gender, age and socio-economic background also matter. Though relevant research is still in its early stages. Sustaining behavioural change presents an additional challenge for policies and instruments that aim to nudge. Those research projects that conducted a follow-up study showed that behavioural changes were often not sustained and non-monetary incentives proved rather ineffective over time if they were not tied to the pricing of electricity or energy (Pollitt / Shaorshadze 2011).

Generally, it is important to distinguish between the energy conservation behaviour or habits of individual consumers and investment decisions in energy efficient technology as different behavioural factors and different context conditions may apply in both areas. The extent to which the poor behave differently and whether a change in energy efficiency behaviour through nudging is possible under income and energy access constraints will be discussed in the next section.

2.3 Do the poor behave differently?

From the perspective of the poor, liquidity constraints and having to satisfy the most pressing short-term needs may seem like the most decisive factor in whether to invest in energy efficient appliances (e.g. an energy efficient light bulb). Many economists assume that the poor are more risk-averse, more impatient in their decision-making and less likely to plan for the future. Bertrand, Mullainathan and Shafir, however, argue that the poor experience the same weaknesses and biases as all other people, but that these may be more sharply pronounced and have potentially more detrimental consequences (Bertrand et al. 2004: 419). The feeling of scarcity, or rather poverty itself, acts like a constraint in poor people's minds, automatically capturing most of an individual's cognitive capacity (Mullainathan / Shafir 2013). The resulting focus on immediate needs causes the neglect of other issues (Mullainathan / Shafir 2013), which possibly explains why energy efficiency occupies a rather small place in people's mental accounts. Mullainathan and Shafir's scarcity argument still needs to be empirically validated though.

Empirical studies that test the interplay between behavioural economics principles and other possible influences on energy efficiency diffusion in developing countries are scarce. Apart from behavioural factors, it is useful to differentiate between financial, informational and organizational barriers to energy efficiency investments in developing countries (Kostka et al. 2013). For Chinese small and medium enterprises, informational barriers, family ownership and internal decision-making structures, governmental regulations and support, and a lack of skilled labour have been identified as major barriers to more energy efficiency (Kostka et al. 2013). In St. Lucia knowledge and attitudinal factors seem to be at least as strong as demographic factors (including income) regarding the purchase of energy efficient light bulbs (Reynolds et al. 2012). Decisions taken are thus multifaceted, implying that it might be useful to combine behavioural levers with measures targeting other barriers specific to the respective country context in a policy package.

Regarding research strand 1 on prospect theory (see section 2.1), several findings exist. Poor consumers' willingness to pay for green products could be lower due to financial constraints – though evidence for this is mixed. Green consumerism is indeed influenced by multiple factors (e.g. environmental knowledge, behavioural intention, perception of consequence) in developing countries and emerging economies (Wang et al. 2013). The portion of participants in field experiments in Guatemala (van Kempen et al. 2009), Malaysia (Mohamed / Ibrahim 2007) and India (Goswami 2008) willing to pay for sustainable firewood and eco-labelled clothing varies, but is not negligible (up to 30 per cent of consumers, depending on price). Although the issue of preferences in experimental settings differing to actual preferences applies to developing countries – as it does to industrialized countries – the assumption that the poor will not buy green products is a hasty one.

Moreover, it cannot be assumed that all poor households and individuals behave the same in terms of risk and loss aversion. There is first evidence that regional differences exist. For example, people with low incomes in western China are more risk- and ambiguity-averse than people in eastern China, while being a migrant worker or a resident worker does not make any difference (Li et al. 2013). Thus, differences in income levels and associated levels of risk aversion cannot always explain poor people's behaviour.

Using a combined model of expected utility, risk aversion and loss aversion, Clist et al. (2013) offer a complementary explanation for underinvestment and underinsurance. In a risky choice lottery in a Ugandan field lab, consumption utility, risk aversion and loss aversion all explain first-round choices to different degrees (id.). Second-round choices were then most strongly influenced by social factors such as information on how others chose – which confirmed existing research. Generally, risks that result through market or regulatory imperfections and limited access to credit are likely to be complemented by perceived risks (e.g. unfamiliarity with a more efficient new technology). This requires additional research.

Empirical work on time inconsistencies in developing countries (research strand 2) is sparse. Ito and Kono (2010) found some evidence of loss aversion and hyperbolic discounting in the uptake of a health insurance scheme in India, albeit using a very small sample. In Uganda people's willingness to pay for energy efficient cookstoves increased with the introduction of payment by instalments, which helped overcome liquidity constraints and the immediacy effect (Beltramo et al. 2013). Addressing time inconsistencies was more relevant in this case than the framing of messages, for which no consistent effect was found. There is still a lack of systematic data and empirical testing on the relationship between development and hyperbolic discounting (Cardenas / Carpenter 2008). Generally, there seems to be little difference in risk and time preferences between developed and developing countries. Cardenas and Carpenter note that many people in developing countries are ignorant about the basic laws of probability (Cardenas / Carpenter 2008: 329). But Kahnemann and Tversky (1979, 1992) reported similar findings for some people in industrialized countries. Here again, more work is required to find out exactly when, how and why the poor behave differently in complex decision-making situations.

Concerning self-control problems, small monetary or monetary-equivalent incentives may help to solve procrastination in the uptake of health services and changing health-related behaviour (Banerjee et al. 2010; Thornton 2008). There is also some evidence that the salience effect exists in different developing countries as well (research strand 3). Text messages with salient information and reminders helped to overcome procrastination in a series of randomized field experiments on savings behaviour in Bolivia, Peru and the Philippines (Karlan et al. 2010). However, a study on fertilizer purchase in Kenya could not establish a clear causal link between investment decisions and current information or marketing – other factors such as availability of funds at a certain time may be just as important and mutually reinforcing (Duflo et al. 2009). Again, it becomes clear that decision-making outside experimental settings is likely to be under multiple influences that sometimes coincide with behavioural economics and sometimes do not.

Research strand 4 on social preferences and social issues has been most widely assessed in developing countries, though not with an energy efficiency focus. A number of studies have tested social preferences – including trust, fairness (ultimatum game), altruism (dictator game) and cooperation – in field labs in different developing countries (for an overview see Cardenas / Carpenter 2008). The majority of studies indicate that variations in trust and reciprocity – associated with social capital – are correlated with the GDP growth rate, the percentage of the population in poverty, the unemployment rate and inequality within the country (Cardenas / Carpenter 2008). There is virtually no evidence

to suggest that the poor are more risk-averse than the rich, while findings on whether the poor are more impatient is mixed (id.). In real, complex situations of uncertainty it is quite likely that risk-averse behaviour coincides with loss aversion, ambiguity aversion or the willingness to cooperate with others. It is not clear whether poorer people are more loss-averse. In a comparative field experiment in six Latin American cities, ambiguity-averse and loss-averse participants had significantly lower levels of well-being (Cardenas / Carpenter 2013). However, the authors themselves point out that alternative interpretations and difficulties in terms of direction of causality between the level of well-being and preferences remain due to the set-up of their study.

The uptake of microinsurance schemes by poor households, for example, depends to some extent on income levels but also on trust, familiarity with the product and the supplier, social networks and peer effects (Giesbert / Steiner 2011; Thornton et al. 2010; Giné et al. 2008; Anderson / Stamoulis 2006). A lack of trust in the provider or vendor of a product – such as microinsurance or energy-related services – hampers its diffusion. Trust-building is essential for the proliferation of energy service companies that develop and implement energy saving measures for their customers (Kostka / Shin 2011).

In common-pool resource experiments in Namibia and South Africa, historical developments and cultural norms and habits were found to influence cooperation behaviour (Prediger et al. 2011). Context- and country-specific approaches and testing are therefore useful. Distributional norms are likely to be local phenomena that also vary with local economic conditions (Cardenas / Carpenter 2008). Analyses of attitudes to energy and governmental service provision in this regard are important to understanding the respective background.

While many research gaps still exist, the different studies discussed indicate that the behaviour of poor individuals and households in developing countries does not differ *per se* from that of people in industrialized countries. There are several challenges to research and practice in the field, and they concern the matter of (a) methods, (b) policy design and (c) the rebound effect in energy efficiency.

With regard to methods, experimental economics faces three challenges in developing countries. First, both lab and field experiments still often rely on student participants, skewing the representativeness of results. Second, as in industrialized countries, possible disparities between stated and actual preferences exist. The perceived social appropriateness of answers is difficult to overcome. Third, in some societies (e.g. Vietnam) people may have difficulties with imagining hypothetical situations (Anderson / Stamoulis 2006), which results in experimental settings producing hardly any valid findings. Apart from these methodological issues, it is also possible that there are differences between perceived risks and real or perceived liquidity constraints that impact on both energy efficient investments and energy-related habits (see section 4).

In terms of policy design, Datta and Mullainathan (2012) suggest that a diagnosis of the behavioural bottlenecks should be the start of a policy or intervention design process. Based on this analysis, the selection of one or more behavioural design principles for an intervention can occur – for example, by providing microincentives, reminders and tailored messages or reducing the need to self-control by paying out smaller amounts of

money more often. Although the authors then suggest a pilot phase and redesign of the intervention, they say very little about the actual implementation in specific local socio-economic and political settings. In fact, the possible pitfalls of nudging and designing policies this way are not discussed at all. In their experiment, de Haan and Linde (2011) found that people who had been nudged towards not changing a good default option may actually perform worse in repeated choices with changed circumstances. Nudging could therefore affect the choice process itself. Moreover, determining the choice architecture for individuals is problematic from a democratic freedom point of view. After all, who determines what makes a ‘good choice’? Depending on the political decision, the actual process leading to the shaping of policies is often characterized by a number of players, interests, coalitions and networks that may mediate or reinforce these possible disadvantages.

Within energy efficiency studies, a careful conceptualization of the rebound effect² may be necessary for developing countries – particularly in areas with low levels of energy access. On the one hand, the rebound effect may be detrimental to energy efficiency if new and old technological appliances are run at the same time, thus actually increasing consumption. On the other hand, being able to increase consumption with more efficient devices could be positive for development – for instance, if more tokens for prepaid electricity were available to households. Research on the rebound effect in developing countries and its links with other aspects of development remains scarce (IRGC 2013; Roy 2000). The positive and negative implications of the rebound effect mentioned here show that carefully differentiating between target groups and the balance of political goals is useful when evaluating energy efficiency policy outcomes.

In sum, the state of behavioural economics and the debate on its application to energy efficiency and developing countries have made clear that a variety of factors (e.g. social preferences, salience and loss aversion) are likely to be relevant to the poor’s energy-related decision-making. Behavioural factors may thus provide additional explanations of why the diffusion of energy efficiency in developing countries remains slow. There is no evidence that poor people behave differently to other demographics per se, but their decisions can have harsher consequences. The lack of financial slack means that giving in to temptation (e.g. buying sweets instead of saving for the expensive fridge required) or making poor decisions when faced with uncertainty (e.g. farmers buying and using excessive amounts of fertilizer, which turns out to be harmful to the field) are more detrimental to poor households than richer households (Mullainathan / Shafir 2013; Banerjee / Duflo 2011). However, many of the behavioural factors proven to be barriers in developed economies – and which may be relevant for energy efficiency in developing countries – remain untested at this point. It is also unclear what happens if nudging meets diverse local socio-economic and political contexts. This requires a differentiation between the groups targeted by energy efficiency measures that carefully examines both the positive and negative consequences of the rebound effect.

2 The rebound effect describes the amount of energy saving that is taken back by a more frequent or longer use of the new technology or service. Direct, indirect and economy wide rebound effects are possible. The debate about how to measure and deal with these effects is ongoing (IRGC 2013).

3 Implications: Pro-poor energy efficiency policy

3.1 Barriers to energy efficiency in developing countries

The debate about how to best measure pro-poor growth while taking multidimensional poverty into account is ongoing (e.g. Grosse et al. 2008; Ravallion / Chen 2003; Kakwani / Pernia 2000). The same applies to sustainability, which adds an environmental perspective. For pro-poor energy efficiency, both aspects are necessary. For the purposes of this paper, pro-poor policies imply absolute poverty reduction that benefits the poor more strongly than the rich – similar to pro-poor growth (Klasen 2008). I define pro-poor energy efficiency policies as those whose effects support poverty reduction without directly, indirectly or unintentionally harming the environment – neither in the short term nor the long term.

Clean, efficient and affordable energy is generally said to have positive effects on income availability (e.g. less money spent on energy), health (e.g. less harm from smoke), education (e.g. more light for studying) and possibly new job creation (e.g. microbusinesses built on the sale of renewable energy products and services). Before focusing on energy efficiency and the poor in more detail, this section briefly outlines the barriers to energy efficiency in developing countries. These barriers make up a large part of the decision-making environment of the poor on energy issues.

In this paper I focus on the moderately poor and the urban poor. I exclude the ultra poor because their preference is likely to be access to energy by any means given that they typically lack access to and thus consume very little energy. In their case, developmental concerns take precedence over energy efficiency or savings concerns – that is, they are focused on increasing energy consumption rather than limiting it.

The diffusion and scaling-up of energy efficiency in developing countries is hampered by a variety of market, financial, technical, regulatory, institutional and informational barriers (IEA 2010; Sarkar / Singh 2010). Table 1 summarizes the most common obstacles, adding those behavioural categories that are most relevant for pro-poor energy efficiency attitudes and purchases. Examples of what these barriers imply for the poor are also provided.

Without discussing each of these barriers in more depth, three important points should be noted. First, the particular combination of barriers in a given country may strongly impact on the behaviour of the poor and, in turn, the possibilities to change something using insights from behavioural economics. If minimum energy performance standards for efficient light bulbs are missing, the presence in the market of low-quality bulbs that break more easily and leak mercury will increase the poor's possibly already existing distrust in the product and/or vendor. Second, behavioural insights may support energy efficiency policy both for the target group (here, the poor) and on the policymaking side. Utilizing behavioural insights could help to overcome institutional blockages in the policymaking process and/or a lack of information among policymakers. By way of example, this could be clear and simple messages about why energy efficiency is useful for a particular country, an electorate or the poor. The simultaneous presentation of possible solutions in a simplified way could diminish some of the fear associated with the different technicalities of the problem (framing/choice overload). Discussing solutions with short-term as well as long-term benefits could help to dissolve political resistance or a lack of interest (salience, technical and regulatory barriers). Third, not all of the above-listed behavioural factors

Table 1: Barriers to energy efficiency		
Barrier	Example	Relevance for the poor
Market	<ul style="list-style-type: none"> – Market organization and price distortions – Principal–agent problem whereby investor does not reap rewards of improved efficiency – Transaction costs (project development costs vs. energy savings) – Limited demand for EE goods and services 	High prices for electricity and EE equipment; restricted access to different energy alternatives
Financial	<ul style="list-style-type: none"> – Lack of understanding of EE investments – (Perceived) risk aversion – Limited financing/equity 	High upfront costs; energy costs represent a large proportion of overall income; perceived risk in investing in unfamiliar technologies
Information/awareness	<ul style="list-style-type: none"> – Lack of sufficient information and consumer understanding (relates to behavioural barriers) – Lack of interest and deeper understanding by policymakers and administration 	Lack of understanding of the multiple benefits of efficient light bulbs, cookstoves and appliances (e.g. savings, health, demand side management effects), lack of knowledge how to save energy in daily life
Regulatory/institutional	<ul style="list-style-type: none"> – Energy tariffs that discourage EE investment (e.g. declining block prices) – Import duties on EE equipment – Lack of appliance standards, labelling, building codes and testing as well as poor enforcement – Incentive structures that encourage energy providers to sell energy rather than invest in cost-effective energy efficiency – Institutional bias towards supply-side investments 	<p>Confusing, highly priced products or products of low quality that discourage investment</p> <p>Possibly higher costs for grid-connected electricity because usually only access fees are subsidized</p>
Technical	<ul style="list-style-type: none"> – Lack of affordable EE technologies that suit local conditions – Insufficient local capacities for identifying, developing, implementing and maintaining EE investments 	<p>Lack of affordable EE technologies that meet the specific needs of the poor and support informal job creation (e.g. solar-powered mobile charging station)</p> <p>Lack of capacity to deal with EE equipment once it is broken</p>
Behavioural	<ul style="list-style-type: none"> – Prospect theory, loss aversion and endowment effect – Inconsistent time preferences and hyperbolic discounting – Information (e.g. feedback, salience), framing and mental accounting (all related to choice architecture) – Social preferences and social aspects (e.g. social norms, trust, status, free riding) 	<p>Irregular income that limits mental accounts to short time spans; lack of trust in utility providers/vendors of EE products</p> <p>To be further determined in the next sections</p>
Source: IEA 2010; Sarkar / Singh 2010; Author's own additions: EE = Energy efficiency		

will automatically support the demand for and use of energy efficient products among the poor, while also actually being pro-poor. Following a multidimensional understanding of poverty, energy is just one of several aspects that make up poverty status. Excessively high expenditures on energy efficient equipment with long payback periods could be harmful to other poverty dimensions. Influencing the choice architecture in this way may fuel distrust in political leadership and, in extreme cases, could be seen as a threat to participation and democracy by the poor.

The sheer number and interrelatedness of barriers to energy efficiency may at first seem discouraging for achieving more pro-poor energy efficiency. The following sections will therefore discuss in more detail which behavioural insights can support the uptake of energy efficient technologies among the poor, how changing energy saving behaviour among the poor can be incentivized, and where such a change in behaviour does and does not make sense for poverty reduction reasons.

3.2 Efficient technologies, investment decisions and energy saving behaviour of the poor

The poor primarily consume energy through cooking, lighting, heating and economic purposes (e.g. running a microbusiness); radio, television and mobile phone usage may also play a role. The range of energy efficient technologies that they could use in carrying out these activities depends, first of all, on the energy sources used and whether access to the electricity grid is given or not. This section clarifies in which areas more energy efficiency is possible for the poor and which behavioural factors play a role. First hypotheses and suggestions for interventions will be developed.

Generally, the poor in many countries use a mix of energy sources even if they have grid access (Shrestha et al. 2008; Masera et al. 2000). Higher electricity prices and fuel preferences for specific tasks (e.g. cooking) are often cited reasons (id.). According to the energy ladder hypothesis, a household's choice of energy source or fuel depends mostly on income. With rising income, households move from traditional fuels (e.g. wood, biomass) to transitional fuels (e.g. kerosene, liquefied petroleum gas) to modern and cleaner fuels such as electricity from the grid or renewable energies (Leach 1992). A range of studies supports these basic findings (e.g. Lay et al. 2013; Heltberg 2004), but some also contradict them, showing that the availability of fuels and strategic decisions on current fuel prices also matter (Hiemstra-van der Horst / Hovorka 2008; Masera et al. 2000). Unstable energy supply can make backup technologies necessary – for example, diesel generators in countries where electricity outages are frequent or biomass-fuelled ovens where the availability of liquefied petroleum gas cannot be guaranteed.

The affordability of energy is certainly a key issue for the poor. Many studies set the threshold for affordable energy at 10 per cent of a household's income (e.g. Fankhauser / Tepic 2007). To some extent, this is a normatively set number because energy and electricity prices vary greatly and affordability is a politicized concept (Winkler et al. 2011); nevertheless, it is a useful guideline. Banerjee and Duflo (2011) show that the poor do not always consciously aim at reducing their poverty by, say, investing in more food when more money is available to them. Instead, they tend to make choices that interrupt boredom and increase social status, such as purchasing televisions and using mobile phones. From an efficiency perspective,

investments that do not reduce poverty are acceptable as long as the equipment bought uses electricity efficiently (e.g. highest energy label category) and is not left running when not in use. Educating consumers to completely switch off equipment that is not being used is a very easy step that is independent of income or poverty status. Thus, income is not always the sole reason behind energy source and technology choices.

For those poor households *without access to the electricity grid*, there are four ways in which energy saving behaviour can be practised: (1) lighting, (2) switching to more efficient fuels and efficient cookstoves, (3) insulating or effectively ventilating homes and (4) using efficient appliances.

First, more energy efficient lighting is possible in combination with an off-grid energy source (renewable energy plant or diesel generator). A compact fluorescent light (CFL) or light emitting diode (LED) can be used in solar lanterns or connected to solar home systems. LEDs are more efficient, especially with fluctuating voltages in developing countries, and contain no toxic mercury; they are, however, also more expensive. High quality CFLs can absorb up to 10 per cent fluctuation in voltages before their lifespan shortens. The mercury content of CFLs (0.5 mg in high quality ones, about 25 mg in low quality ones) presents a health challenge to many developing countries where adequate waste management and recycling facilities are non-existent. If poorer consumers knew about the health risks, the resulting mistrust, risk aversion and uncertainty about the technology and the utility/donor selling them may add to the barrier of higher upfront costs – especially if payment by instalment is not possible.

The uptake of solar home systems and solar lanterns is influenced by several behavioural factors that do not correspond with standard economic theory. In spite of higher costs, East Timor communities prefer solar home systems to solar lanterns due to better light quality, less risk of damage to the photovoltaic module and longer duration of nightly operation (Bond et al. 2010). In India, in contrast, the uptake of solar lanterns has been slow because programmes focused solely on communicating subsidies rather than benefits and thus impeded early adopters and, in turn, their ‘spreading the word’ (Velayudhan 2003). Changing modes of payment – for instance, by renting lamps – has been suggested as an additional solution (Chaurey / Kandpal 2009). Possible behavioural constraints that impact on the choices of the poor here are trust, uncertainty and risk aversion (i.e. not understanding the costs and benefits of the technology); framing; and mental accounting barriers (see section 4 in more detail).

Second, switching to more efficient, cleaner fuels not only is beneficial for energy efficiency and climate change reasons but also significantly reduces indoor air pollution, particularly from cooking. The debate about fuel-switching and the uptake of modern cookstoves in developing countries has been going on for over 30 years now. It cannot be dealt with in more detail here. Fuel availability, fuel price and social/cultural factors all have an impact. A recent study found that cookstove trial periods, explanations of the cookstoves as part of a group event (social aspects) and payment by instalment (mental accounting) increased the willingness among Ugandan rural households to purchase cookstoves (Beltramo et al. 2013) – though only to a certain extent. A deeper analysis of the remaining challenges in this debate goes beyond the scope of this paper.

Third, insulating the poor's homes against the cold to allow for better space heating counts as a 'no regret', low-cost option to improve energy efficiency (Spalding-Fecher et al. 2002). In South Africa a successful governmental programme saw new ceilings installed in poor homes, leading to a decline in energy costs by 50 per cent during the four-month winter period (id). However, investing in energy efficient buildings only makes sense for those segments of the poor that plan to remain in their homes for the longer term. Since retrofitting a building is a one-off investment that may be a low priority for the poor, it seems rather unlikely that behavioural factors – apart from framing advertising to give feedback or using loss aversion for governmental or donor-run programmes – will have a continuous, long-term impact on the buildings sector. The likelihood that the poor will care about new building codes may also be rather small.

Fourth, using efficient appliances in combination with renewable energy sources or diesel (e.g. to run a mobile phone charging stall) is also possible in an off-grid context. Energy efficient televisions and mobile phones are the appliances most likely to be used by the poor, followed by rice cookers and fans in Asian countries (Shrestha et al. 2008). These efficient appliances have to be available and clearly labelled as efficient before marketing campaigns that make use of clear and simple framing and feedback can be applied effectively. To build customer trust and reduce risk aversion, product quality has to be assured and affordable, and low-quality imitations must be prevented from entering the market. Payment schemes are also likely to be an issue, not only in connection with mental accounting but also with times when income is available. Banerjee and Duflo (2011) found that poor people with irregular income do not apply for credit from microfinance institutions, because this usually entails strict weekly repayments. Some poor people therefore choose informal lending schemes with high interest rates but more flexible repayment schedules. The regularity of income may therefore be an issue for poor households in terms of purchasing energy efficient appliances that require a loan or credit.

Farmers using irrigation systems that run on diesel or grid electricity could invest in more efficient pump systems. This only makes sense if the farmer does not pay a sufficiently subsidized electricity flat rate (as is the case in northern India) or if power cuts occur regularly during peak load times. In these cases, careful calculations of payback periods and price effects (less frequent power outages due to lower peak load) are required. To actually contribute to poverty reduction, however, investment in energy efficient pumps at all costs should not be the goal. Here, when new and old equipment are used in parallel, the endowment effect may be a hindering factor. This could be overcome by taking old pumps in part exchange for new ones, with the vendor being reimbursed by the recycling industry or the government.

Poor households *with access to the grid* have all of the above options. In addition, a wider range of energy efficient appliances (e.g. refrigerators) that require higher amounts of electricity may be used. Here, clear labelling that avoids an overload of information is important. In this respect, labelled-product advertisements incorporating feedback and social status could be useful. Many poor households may not be aware of their energy consumption. Feedback on electricity bills (either on the paper document itself or provided by the fee collector) and information on energy consumption levels of different kinds of household appliances could be a first step in addressing this. Feedback that employs neighbourhood consumption comparisons to nudge needs to be carefully

debated in the respective country beforehand. A survey of the poor may be appropriate to establish whether they are likely react negatively to feedback telling them to cut their energy use when they only have intermittent access to electricity in the first place. Increased energy consumption and rebounds can often have a positively effect on poverty reduction (e.g. through longer shop opening hours and increased studying time for children). Generally, feedback on bills only makes sense in areas where power cuts are not a regular occurrence.

Token-based prepayment systems offer a way to better fit poor demographics' energy use to their unstable income situations and mental accounts. Prepayment can increase energy consumption (which is favourable in the case of the poor) and at the same time give customers more control (Tewari / Shaah 2003). Prepayment meters are being introduced to an increasing number of countries not only as a pro-poor initiative but also as a measure to counter electricity theft. Relays simply cut off the electricity once the token has been used up. This means that distribution losses for utility providers decrease, which reduces costs and should – at least in theory – lead to lower electricity prices for consumers. However, utilities may not pass on their savings but reinvest in new generation capacities or grid extension. Generally, prepaid electricity as a type of pay-as-you-go system seems to work well. Information on meters and smart cards that are used in combination with tokens could utilize framing to influence consumption. This may pay off in combination with an offer of more efficient, reasonably priced products, such as CFLs.

Token systems may have the disadvantage of restricting the access of the ultra poor, for whom illegal electricity connections are the only possibility. Many households may not be legally connected, but occupants may have instead illicitly connected to a main line or hired middlemen to do so. Dealing with electricity theft is a complex issue that needs economic, technical, social and institutional solutions (Katiyar 2005). Debating the role of behavioural factors would require an extensive amount of empirical data analysis for specific cases, which is not possible in this paper.

To avoid undermining trust in energy efficient products in general, it would be advisable not to make use of default settings in developing countries for now. Nudging too hard, inadvertently nudging in the wrong direction (unintentionally non-pro-poor) or restricting choice too much may backfire in third wave democracies (like Ghana) and hybrid regimes (like Uganda and Rwanda), where the participation of the poor is a very sensitive topic. Saving energy makes sense for the moderately and urban poor only to the extent that devices are switched off when not in use and that grid-connected lights are not left on unnecessarily during power outages (lights are often left on to show when the power has come back on).

This general discussion of on- and off-grid technologies and energy saving possibilities of the poor has made clear that behavioural factors already do play a role and could play a more relevant role in a variety of settings. Table 2 summarizes the possibilities for energy efficiency of the poor, potential relevant behavioural factors and possible interventions (to be tested in future research). The interplay between the existing technological, financial and institutional barriers and possibilities – both among the poor and among the policy and market environment – needs to be taken into account to understand the actual decision-making context and how to change it.

Table 2: Starting points for pro-poor behavioural energy efficiency interventions		
	Behavioural constraints*	Possible interventions*
Lighting	Risk aversion/uncertainty about product	Provide salient, clear information; labelling/certification (with controls)
	Trust in vendor/product	Build/use local sales networks, let people try out the product; organize local Q&A events; efficiency labels (with controls)
	Mental accounts (high upfront costs)	Subsidies and pay-as-you go funding schemes; renting instead of buying
	Framing	Salient, clear information on payback periods; possibly make use of loss aversion
Fuel switch	Social preferences/norms	Increase WTP by explaining cookstoves and solar systems at social events with neighbours; let people try out products (cultural/social norm change as long-term goal)
	Mental accounts	Subsidies and pay-as-you-go funding schemes; renting instead of buying
Appliances	Framing	Salient, clear information on payback periods; possibly make use of loss aversion
	Endowment effect	Take old products in part exchange for new products; maybe use loss aversion in advertising; send reminder text messages
	Hyperbolic discounting	Salient, clear information on payback periods; let people with positive experiences explain to others; encourage group savings (combination with social pull)
	Trust in vendor/product/label	Build/use local sales networks; let people try out the product; organize local Q&A events; efficiency labels (with controls)
Technical equipment (e.g. pumps)	Hyperbolic discounting	Salient, clear information on payback periods; let people with positive experiences explain to others; encourage group savings (combination with social pull)
	Endowment effect	Take old products in part exchange for new products or make turning in old compulsory for purchases on credit; maybe use loss aversion in advertising; send reminder text messages
* More research required that tests causal links and impacts and adapts interventions to local context.		
Source: own compilation		

From the preceding discussion, I have generated a first set of three hypotheses:

H1: If poor households have a relatively regular income, paying for energy efficient equipment (e.g. CFLs, efficient cookstoves) becomes more likely with payment by instalment or pay-as-you-go systems because this better fits their mental accounts.

H2: Attractive, simple to use combinations of energy efficient equipment increase the likelihood that poor people will accept, buy and use it.

An example could be subsidized solar home systems that offer mobile charging which could be used by households or microbusinesses.

H3: If the trust in the utility provider, donor or vendor of electricity/energy efficient equipment is low and uncertainty about the product is high among the poor, introducing a social element will increase the likelihood of purchase.

This could be achieved by having groups learn about the pros and cons of a product and then challenging them to explain it to their relatives the next day. If innovative financing solutions for energy efficient appliances are available, then combinations of trust-building, social factors and smart use of the endowment effect can overcome behavioural barriers on a larger scale.

These general assumptions need further refinement according to specific elements of energy efficiency and the context of the cases under study to turn them into viable hypotheses. The following empirical section takes a first step towards this goal by developing more targeted hypotheses in the field of energy efficient lighting.

4 Comparing energy efficient lighting in Ghana, Uganda and Rwanda

4.1 Socio-economic and regulatory context

Among the sub-Saharan countries, Ghana is one of the leaders in energy efficiency. Although Ghana has a higher general level of development and per capita income than Uganda and Rwanda, significant portions of all three of these countries' populations belong to the urban and moderately poor. Moreover, all three ran large-scale CFL deployment programmes between 2007 and 2012. Uganda's and Rwanda's programmes were financed by the World Bank, whereas Ghana's government financed its programme on its own. I will briefly outline to what extent these programmes were accompanied by legislation, regulations and pro-poor initiatives, before assessing the role of behavioural factors and the assumptions developed above.

Rwanda plans to massively extend its grid and connect 70 per cent of its population by 2017 (Government of Rwanda 2014). It also plans to invest USD 4.7 billion mainly in extending power from hydro, methane gas, geothermal and peat sources (Government of Rwanda 2014). This clear step towards more grid-based electricity could spur the market for CFLs and, prospectively, LEDs once these become cheaper through international market maturity or subsidies. It is easier to plug CFLs or LEDs into a working socket than to buy an additional device that produces electricity first. Currently, no specific legislation, labelling or regulations on minimum energy performance standards for efficient lighting exist. The Ministry of Infrastructure is working on legislation that will help to prevent low-quality CFLs entering the market (UNEP 2012: 26). Also, the National University of Rwanda is conducting an environmental impact assessment of CFL disposal. No recycling or waste management system is in place yet. In Rwanda, import taxes on energy efficient lighting products have been lowered and some products are exempt altogether. In terms of foreign direct investment, the Indian company Sahasra Electronics is building an LED manufacturing plant in Kigali, which is due to be completed in March 2014. The Rwandan Energy and Water Sanitation Authority is conducting feasibility studies to determine whether to subsidize LEDs to make them

affordable (Gasore 2013). The government supports the switch to LEDs given their higher efficiency levels and smaller mercury content.

In Uganda there are no regulatory mechanisms, minimum energy performance standards or certification standards for efficient lighting products. There is no domestic production plant for CFLs or LEDs, but the government was required to waive import duties (previously 25 per cent) and VAT (previously 18 per cent) on efficient lighting products due to its participation in the World Bank CFL programme. The import of solar lanterns and combinations of solar home systems with CFL or LED is also tax-free. No recycling or waste management system has been established. The National Bureau of Standards has an electrical testing laboratory where the quality of light bulbs and other electrical appliances are assessed per Ugandan and international standards (UNEP 2012).

Ghana has a comprehensive set of regulations and policies targeting efficient lighting. The government removed import duties and VAT on CFLs back in 2003. Moreover, minimum energy performance standards for self-ballasted fluorescent lamps have been in existence since 2005. To verify compliance, a facility at the Ghana Standards Authority was set up to run the necessary tests – entry to which is controlled by customs. Failure to comply with standards may incur in a fine of 250 penalty units or 12 months' imprisonment (Ghana Energy Foundation 2005). Following a severe energy crisis in 2006, energy efficiency became a priority issue. In 2007 the Ghana Energy Commission distributed 6 million CFLs free to consumers in exchange for inefficient incandescent lamps. This cost the government USD 15.5 million. The programme resulted in peak savings of 124 MW and CO₂ savings of 112,320 tons per year. In 2009 CFL penetration had increased from 3 per cent to 79 per cent and the number of incandescent lamps in the market had decreased from 58 per cent to 3 per cent (UNEP 2012, 58).

The production, import and sale of incandescent lamps have been prohibited since 2008. Energy efficiency standards and labels have been in use for different household appliances, including light bulbs, since 2008/9. No strategy for recycling or management of CFL disposal exists, even though a study found that 64 per cent of those surveyed experienced at least one incident of broken CFLs, while 75 per cent of end users claimed to have no knowledge of mercury content in CFLs (UNEP 2012, 48).

The price of electricity and therefore its affordability for the poor with grid access is similar in all three countries. In Rwanda the electricity tariff is presently set at a flat rate of RwF 134/kWh (USD 0.22/kWh) for residential and commercial consumers. The government's objective is to cut the average electricity tariff to half of this (USD 0.10/kWh). In Uganda domestic consumers also pay a fixed rate of UGX 524/kWh (USD 0.21/kWh), while commercial consumers and medium and large industries have different tariffs according to peak and off-peak times. The Ugandan Electricity Regulatory Authority has steadily increased tariffs in the last decade to cope with increasing demand. In 2013 the Public Utilities Regulatory Commission (PURC) in Ghana induced a tariff reform. The initially proposed increase of 65 per cent for the poor using up to 50 kWh and 78 per cent for all other customer classes was rescinded in November 2013 after labour groups threatened to go on strike. The new tariff now only increases prices by about USD 0.05/kWh (a 25 per cent increase) for the poorest using up to 50 kWh and USD 20/kWh for all other residential consumers. Ghana is therefore the only one of the three countries that offers a special tariff for the ultra poor.

4.2 Relevant behavioural factors

In Rwanda the World Bank's CFL deployment distribution project ran from 2007 to 2010. About 400,000 CFLs were given to existing customers of the utility company Electrogaz in exchange for incandescent bulbs. The first 50,000 were handed out for free in a pilot phase, and the rest were then sold for the price of an incandescent bulb (USD 0.37/lamp). A further 400,000 bulbs were given for free to new Electrogaz customers as part of a welcome package, thus accompanying the government's grid electrification programme. Incandescent bulbs were collected and destroyed and the destruction controlled by a third party. Additionally, the World Bank supported an intensive awareness-raising campaign. In Rwanda the CFL was advertised in multiple languages in a simple comic-style message (see example Annex). The message emphasized that the lamp uses five times less energy than standard bulbs, lasts eight times longer and helps the consumer to save a lot of money. While empirical data about the success of this particular message is not available, framing built on loss aversion could have been even more effective (e.g. 'You could be wasting Rwf 10 every week by using the wrong light bulb'). The same applies to framing that is more salient, gives feedback on neighbours and is tailored to mental accounts (e.g. 'This lamp saves you the money for 1 kg of cassava a month', 'While your neighbours will still be using the same new lamp they bought today during the next rainy season, you will have had to buy three of the old type by then').

The Rwandan solar lighting market is relatively small and largely supported by donors. About three-quarters (80 per cent) of the purchases made are solar lanterns (Disch / Bronckaers 2012). A GIZ renewable energy programme that started in 2013 aims to sell an additional 350,000 lanterns. Solar home systems that can charge several light bulbs, charge phones and provide electricity for a radio or television (depending on the size of the system) make up 11 per cent of the market, whereas micro-solar kits that can only charge a couple of light bulbs and a mobile phone have a market share of 8 per cent (Disch / Bronckaers 2012). From the perspective of the companies involved in these markets, the affordability and price of the products, the management of distribution (including its financing) and import/transport were cited as the most relevant barriers in a survey conducted by the NGO Tubura (id.). Door-to-door sales through local networks and agents were found to be far more effective than vending in regional shops, but are also expensive to implement. Advertising and awareness-raising campaigns that used local radio question and answer sessions to immediately react to customer concerns were more successful than ordinary block advertising (id.) even though the print ads contained fairly clear messages (see Annex).

From a behavioural point of view, several tentative conclusions are possible here. Trust in locally known vendors combined with a countermeasure to the status quo bias (e.g. going to people's homes instead of having them come to the shop) increases the chances that poor households will purchase the product. Companies could switch to small-scale franchise-type product distribution, thus also supporting job creation for the poor. Social aspects through direct communication that can eliminate uncertainties and risk aversion are also relevant. In line with the general hypothesis developed in the previous section, products that combine multiple purposes for the poor meet their preferences more closely and have a higher chance of being bought. It would be interesting to test whether vendors supplied any explanation about actual payback periods in terms of energy savings compared to the usual energy

sources – thus countering potential hyperbolic discounting – and whether this made any difference.

Bottom-up lighting initiatives are very small-scale but bring about direct poverty reduction effects and sometimes already implicitly make use of behavioural insights. An example of this is the Solar Sisters initiative (active in Uganda, Rwanda and the Democratic Republic Congo), which (a) trains local women in the use and sale of simple solar lights that replace kerosene lamps, (b) provides them with a number of lights and (c) lets them sell these lights in their local communities, which thus establishes a network. These saleswomen collect a commission on each sale.³ Since 2010 about 500 female entrepreneurs have sold over 80,000 solar lights. This may seem like a moderate achievement, but given the difficulties of the solar market to emerge at all in these countries, it represents quite a success. Here, the knowledge of the local social norms, trust and a simple business model pays off for the saleswoman and the consumer. Moreover, in Uganda there are an increasing number of microbusinesses offering mobile phone charging with a small solar panel – a service that is quite profitable for the entrepreneur (Collings 2011). Some microentrepreneurs also use their charging stalls to sell or rent solar lanterns and sell mobile credit – explicitly choosing frequented social settings. The effects on poverty reduction, pro-poor job creation and energy efficiency of these local bottom-up initiatives and informal microbusinesses are of course small in the overall picture of pro-poor growth. Nevertheless, they could pave the way for more successful large-scale programmes and market development – increasing social acceptance and awareness as well as explaining technologies and savings rates – while contributing to long-term market creation by preparing consumers.

The Ugandan CFL bulk procurement scheme saw 800,000 CFLs distributed, of which 600,000 were distributed for free by the utility company UMEME Yellow Pages. Another 50,000 bulbs were retained as free-of-charge replacements during the warranty period, and the remaining bulbs were sold at a low bulk price after the warranty period elapsed in order to support the development of a market with high quality CFLs. Before the World Bank programme, about 150,000 CFLs and 1.5 million incandescent bulbs were sold annually in Uganda. A survey among Kampala electricity customers was conducted beforehand, which showed that households were using three light bulbs on average – usually bought in supermarkets or at lamp dealer stalls. Awareness levels of energy savings through CFLs was very low among low-income residential users (i.e. the urban poor). The prime reason given for not buying CFLs was price. There are no current figures available that reveal whether customers who were given free CFLs also bought them again after the end of the bulb's lifespan and thus further supported the market. Of the 10 per cent of customers who reported a broken bulb after one month, 52 per cent replaced it with an incandescent bulb. Moreover, 17 per cent of eligible customers did not want a CFL bulb at all (World Bank 2009). This indicates that some underlying problems exist. In its programme evaluation, the World Bank admitted that its awareness-raising programme was limited to wealthier populations in Kampala through English-language materials and radio messages. Further problems encountered include the development of a CFL black market where free government bulbs were sold and the discrepancy between the number of CFLs distributed and the number of incandescent bulbs collected. Some customers were also distrusting of the yellow uniforms

3 <http://www.solarsister.org/> and https://unfccc.int/secretariat/momentum_for_change/items/7072.php (accessed January 7, 2014).

of the UMEME staff: they mistook them for members of the NRM party and suspected they were part of a political campaign (World Bank 2009). Behavioural factors that are very likely to have played a role in this programme are trust (in the product and vendor/provider), framing and the status quo bias, which is positively overcome by going to people's homes instead of the poor having to make the extra effort.

The Ugandan solar energy market has been slow to take off, even though it could provide off-grid lighting alternatives for the poor. Taking neighbouring Kenya and their sizeable solar home systems market as a role model has not worked out for Uganda thus far. According to the owner of Barefoot Power, one of the major solar lighting companies in Uganda, only 5 per cent of the population have access to solar energy. While a variety of donor and public-private initiatives at grassroots level exists, large-scale diffusion has not happened yet. Opinions about the reasons behind this differ: affordability and excessively high upfront costs, expectations of grid access in the near future, theft of systems resulting in reluctance to buy and unfamiliarity with the new technology (Kulabako 2013; World Bank 2009). In some cases, this lack of familiarity has been aggravated by the relabelling of products so that they show higher capacities than they can actually produce. Obvious product 'failure' then is likely to increase potential distrust and risk aversion on the part of buyers among the poor.

Ghana already has a history of demand side management and a combination of awareness-raising and energy-saving campaigns. In the early 1990s Ghana had already started a demand side management programme, which was largely rejected for political reasons. The public perceived the initiative as an attempt to shift the blame for supply problems to the consumer because the Ministry of Energy was the sole body charged with all energy questions. Additionally, the main electricity provider sells electricity through middlemen who have no interest in decreasing demand, as their own revenues would decrease. This situation gave rise to the politically neutral Energy Foundation in 1995. A survey conducted in 2000 revealed that 80 per cent of respondents who had heard the Energy Foundation's energy efficiency messages and jingles began to switch appliances off when not in use. The combination of this campaign with an increase in electricity tariffs and the introduction of more efficient appliances and light bulbs led to a 5 per cent reduction of energy consumption at utility level. Since then Ghana has continued on this path of using the wide variety of measures and incentives described above. Easy-to-remember, catchy radio jingles with clear messages (e.g. reminding people to switch off appliances when leaving the house) that are played repeatedly are behavioural levers (salience and framing).

Today off-grid lighting systems in Ghana are mainly aimed at poor rural communities – for instance on islands or at lakeside locations where grid connection remains unlikely for the foreseeable future. In the run-up to its current programme on rural energy development, the World Bank commissioned both a quantitative (1,000 households) and qualitative market study (55 interviews) on solar-powered lighting products for rural Ghanaian households. The studies found that, on average, consumers deem a price of USD 9.80 for a solar lantern and USD 6.50 for a solar task light (e.g. desk lamp) as neither too cheap nor too expensive. Average household income was USD 115, with four people living in a household. Fifty-one per cent of people in the sample fell in the poorest category and 30 per cent were in the next group up. Respondent households most often used paraffin lamps with a glass cover for lighting. It cost USD 3.20 to run the lamp monthly and USD 0.58 to initially buy the lamp. The majority also used candles (USD 1.44 per month, with each candle costing USD 0.19)

or battery-operated torches (USD 2.30 for batteries per month) as backup. For 32 per cent of consumers, a solar-powered lantern would be their preferred source of off-grid lighting, followed by a paraffin lamp with a glass cover (26 per cent). However, in the qualitative study – which let households try out two different types of solar-powered lights for three nights – people were willing to pay a maximum of USD 24–27 (equals to the purchase and running of their usual devices for four to five months) for the most popular type of lamp. On average, the households surveyed were prepared to spend USD 10–20 on the second most popular light, which would mainly serve as a reading light for school children (World Bank / IFC 2008; 2009).

The users liked the products because they were attractive and modern and thus increased their social status in the neighbourhood. Other positives were that they were durable, solar powered (having only an initial cost was actually rated as an advantage) and provided light coverage of a large area in the sort of bright light preferred. Many of the interviewed parents said they reserved one of their light sources exclusively for their children's study. Here, the desk-type solar lamp was particularly useful. Some households said that a solar lamp that provided an electricity socket for charging a mobile or running a television would be extremely helpful. Barriers to actual purchase are the lack of a light stand, high costs and uncertainty about the safety and protection of the panel from water, accidents and other elements during recharging. Some households indicated a willingness to purchase if some sort of financing scheme were provided to them, while a few indicated a will to buy even without a subsidy or loan (World Bank / IFC 2008; 2009).

This Ghanaian example indicates that taken together, status and local social norms can be a powerful factor that affects the perception of affordability and, in turn, the willingness to pay. Unfortunately, the study does not make clear whether lights were actually on sale after the end of the initiative. The social and attractive character of the study worked well in combination with the possibility to try out the equipment at home. The latter might have induced a positive endowment effect (i.e. it was hard for some of the households to let go of the solar lamps). Lighting Africa proposes several financing mechanisms to overcome initial end-user costs: microcredits by microfinance institutions if lending is connected to other larger loans (otherwise the transaction costs of lending are too high for the microfinance institutions); engagement of the informal financing sector; mobile phone-based lending and pay-as-you-go systems; and payroll loans⁴ for those employed at larger firms able to take over the initial purchase of the product (Lighting Africa 2012). Pay-as-you-go or fee-for-service systems have been shown to be viable in Senegal (Diouf / Pote 2013) and India (Chaurey / Kandpal 2009), but none of these proposals have been sufficiently empirically tested yet. Finally, clear explanations of payback periods and possible additional repair costs after 3–5 years in comparison to the costs of current conventional lighting may help to inform consumer decisions.

In sum, the analysis of lighting programmes in the three countries indicates that social aspects such as trust, status and social norms; framing; the status quo bias; risk aversion; and

4 “Once an employee makes a purchasing decision, he or she first receives a non-cash loan from the financial institution. The financial institution then directly pays the PLS vendor, who delivers the PLS to the employee. Finally, the employee authorizes the FI to deduct loan re-payments directly from his or her payroll” (Lighting Africa 2012, 65).

uncertainty are likely to play a role in the diffusion of energy efficient lighting products among the poor. More efficient use of mental accounting and loss aversion in framing awareness campaigns and advertising could be helpful as could utilizing the endowment effect in a positive way (e.g. by letting people try out equipment for a set period of time). However, careful research analysing the existence, mutual effects and potential outcomes in specific local settings is required before political actors or donors can make use of these insights.

4.3 Hypotheses

From the theoretical debates in sections 2 and 3 and the initial comparison of energy efficient lighting in Ghana, Uganda and Rwanda, different hypotheses can be deduced. I argue that it is useful to distinguish between types of affordability that correlate differently with behavioural factors.

First, there is a ‘do-no-harm’ line (a kind of raw affordability) that should not be crossed when designing interventions and that is also ideally not crossed by the poor themselves. This line does not mean that the poor are unable to buy these products – they can, after all, use credit. But their purchase would actually be harmful to poverty reduction if, for instance, the debt could not be paid. This differs locally and could be higher or lower than the often proposed threshold of 10 per cent of income. For example, a household that buys an energy efficient CFL may thus be unable to afford new seeds the following week, but will be able to do so three or four weeks later. The CFL is affordable but not easily affordable. The ‘do-no-harm line’ is crossed if the household cannot afford to buy any seeds at all in the near future and misses planting time because of purchasing a CFL.

Second, there are two types of perceived affordability that can be more strongly influenced by behavioural insights and that are also more strongly influenced by the preferences and the behaviour of the poor themselves. I argue that *perceived financial affordability* and *perceived social affordability* exist – neither of which harm poverty reduction. Perceived financial affordability is tied to hyperbolic discounting, mental accounts and to some extent the endowment effect as a form of economic perception. High upfront costs are often cited reasons for not investing in energy efficient products. With adequately subsidized prices or financing models (e.g. saving/credit, payment by instalment or pay-as-you-go/leasing systems), the poor will not fall further into poverty, but rather will benefit from poverty reduction through energy savings over time – savings that could be used to buy seeds, for example. Perceived social affordability relates to social preferences and aspects such as trust, status and local norms. The Ghanaian households surveyed preferred the solar lights for reasons of status and light quality but still claimed they were not really affordable. But if one or more of their neighbours were to actually own a solar light, this perception might change. Both types of affordability may be influenced by framing and salience.

Based on these arguments, the following general hypothesis (H4) is proposed:

Energy efficiency, behavioural levers and nudges (trust, status, social events, salience, feedback, framing, endowment effect through trying equipment) are more likely to be effective if perceived affordability is high among the poor target group. The likelihood of

success further increases if the regulatory environment that assures quality and availability of efficient products (standards, labels) is developed and enforced in parallel.

Concerning perceived financial affordability and its relation to behavioural insights, I put forward the following hypothesis (H5), which relates perceived financial affordability to the likelihood of actual investment:

The perceived financial affordability of energy efficient products depends on a poor individual's mental accounts, hyperbolic discounting and/or uncertainty about investment payback periods. The closer payment schemes are to a person's mental accounts and the more clearly explained payback periods are, the higher a poor household's perception of financial affordability becomes. This, in turn, increases the likelihood of actual purchase.

Finally, the relationship between cost and benefit, trust and uncertainty about new products – which is captured by perceived social affordability – leads to the following hypothesis (H6):

The higher the social acceptance of an efficient product or service in the community, the higher its perceived social affordability in a poor household becomes. In turn, this increases the likelihood of purchase/behaviour change. Poor households are more likely to purchase efficient products and engage in energy saving if (a) neighbours or friends already use the product and/or the vendor is known to them, (b) if status increase and payback periods are explained clearly by the vendor, and (c) if people are allowed to try the equipment at home and their suggestions on improvements are taken into account by the donors/vendors.

For energy efficient lighting, this implies that lighting companies are likely to be more successful in increasing their market share and creating demand if they run a trust-building programme with local sales personnel (who are also trained as repair personnel for solar and pico-hydro products).

These hypotheses need to be empirically tested and further adapted to local contexts in subsequent studies.

The discussion of energy efficient lighting in Ghana, Rwanda and Uganda has shown that regulatory mechanisms, political enforcement and domestic market development could be improved by incorporating demand side management, which draws on behavioural insights. In the long run, the creation of donor-independent domestic markets for clean, energy efficient lighting products is required. Pro-poor energy efficiency policy in this regard means taking the raw and perceived affordability of energy efficient technologies and services into account, while using opportunities to support the domestic labour market whenever possible.

5 Outlook

This paper reviewed the current state of behavioural economics and its applications to the field of energy efficiency in developing countries. It discussed the implications of this literature for pro-poor energy efficiency policy, taking energy efficient lighting in Ghana, Uganda and Rwanda as empirical examples.

Social aspects such as trust in the utility provider or vendor of a product, status and local norms, as well as clearly framed and salient messages, are likely to have an impact on the diffusion of energy efficiency – though more research is needed here. Innovative financing solutions (e.g. pay-as-you-go systems and prepaid electricity metering) that more closely correspond to poor people's mental accounts may also matter.

Using qualitative methods, this paper develops hypotheses on different types of affordability. A 'do-no-harm' threshold of poverty reduction exists, below which poor people can afford and actually may purchase goods; it is, however, harmful to other dimensions of their poverty status. Above this line, a perceived affordability exists that is easier to influence in a pro-poor manner with behavioural levers. Perceived affordability is strongly influenced by the preferences of the poor themselves and less so by external socio-economic barriers. Perceived affordability differentiates into perceived financial affordability and perceived social affordability. This paper hypothesized that the integration of behavioural factors in energy efficiency policy will be more effective if the share of perceived affordability grows among the poor. Offering payment schemes and providing information that approximate the mental accounts of the poor, while countering potential hyperbolic discounting, increases the chances that energy efficient products will be bought. The social acceptance of an energy efficient product or service in a community increases the perceived social affordability. Thus targeting existing local social preferences increases the likelihood that poor households will take energy efficient investment decisions or orient their behaviour towards being more energy efficient. However, future research needs to further refine and empirically test these hypotheses. Additionally, empirical work needs to be carried out on a wider variety of behavioural insights and pro-poor energy efficiency, including the positive and negative consequences of the rebound effect. This paper provides a first step in the direction of behavioural energy efficiency measures in developing countries and has thus set a new agenda for both research and practice.

For political actors, using behavioural insights to scale up energy programmes is useful if it is part of a policy package that targets existing market, technical, financial and institutional barriers. Behavioural economics does not represent the silver bullet for low-carbon energy efficient development; it is merely one piece of the puzzle. For energy efficient lighting, for instance, the introduction of minimum energy performance standards and labels for light bulbs, quality controls, tax exemptions and adequate price subsidies could be complemented by behavioural insights. The combination of measures and particularly the role of behavioural factors need to be pre-tested, surveyed and adapted to the respective local context in a country. This is imperative to avoid two dangers of nudging. The first danger is that pushing consumers or target groups too hard towards the 'good choice' or inadvertently pushing in the wrong direction can result in subsequent undesired choices. Some people who have been subjected to nudging actually perform worse in repeated choices. The second danger is that influencing the choice architecture of the poor to some extent impacts democratic freedom of choice. To avoid backfiring, open debates with political actors and stakeholders in the respective country are required before any set of measures based on behavioural insights can be introduced.

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Annex

Annex 1: Advertisement for a CFL bulb in Rwanda




Source: Ashok Sarkar, World Bank, September 2013, Presentation, http://wbi.worldbank.org/wbi/Data/wbi/wbicms/files/drupal-acquia/wbi/Session%201_5%20-%20Sustainable%20transition%20to%20EE%20Lighting.pdf (accessed 13 December 2013).

Annex 2: Poster advertising the Uganda CFL programme


HOW TO GET YOUR ENERGY SAVER

- 1**



YELLOW PAGES PERSONNEL


An Agent, a representative of Yellow Pages Limited who has been authorized by the Ministry of Energy and Mineral Development will come to your house and introduce him/herself.
- 2**




SURRENDER

RECEIVE

You will surrender 3 to 4 ordinary bulbs in working conditions and obtain energy savers in exchange.
- 3**




You will sign a form provided by the agent to confirm receipt of the energy savers.
- 4**



The agent will crush the ordinary bulbs and put them in the packaging of the energy savers he came with.
- 5**

In case the bulb blows within three months, you will return it to the UEDCL stores in Lugogo for replacement.
- 6**

This is just the start; you are encouraged to acquire more energy savers from reliable distributors and supermarkets.



ENERGY SAVER

100W 20W

Reduce Your Electricity Bill, Use Energy Savers

For more information contact:
The Commissioner, Energy Resources Department,
Ministry of Energy and Mineral Development, P. Box 7270 Kampala
Telephone: 0-414-257863

Source: UNEP 2012

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