# REDUCING DOMESTIC ENERGY CONSUMPTION: A USER-CENTRED DESIGN APPROACH

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**Abstract**

Energy use within the UK domestic sector is on the increase, causing significant environmental and social stresses. This increase in energy consumption is not only due to the rising proliferation of technological devices within the home, but also to their context of use, and the behaviours and habits attributed to and enacted through their operation. To reduce energy consumption we need to engage with householders in meaningful and effective ways to prompt more efficient behaviour. This paper examines the role of design in influencing a change in energy using behaviours within the context of social housing. Drawing upon the findings of an interdisciplinary literature review the authors outline the impact of domestic comfort practices on energy use. The emerging field of Design for Sustainable Behaviour is mapped out with relevant behaviour models and theories, and factors which could inform the development of design interventions to promote energy reducing comfort practices in social housing are discussed. The paper concludes with an evaluation of the types of interventions which could prove effective in reducing energy consumption in social housing whilst still delivering comfort.

**Keywords**

*behaviour, comfort, energy, sustainable design*

## 1. Introduction

The Climate Change Act 2008 (Great Britain, 2008) sets out the target of achieving a reduction of greenhouse gas emissions by 2050 to at least 80% of those recorded in 1990, with an intermediate target of 34% for the budgetary period up to and including 2020 (Great Britain, 2009). By 2008, the total UK greenhouse gas emissions by end-user had dropped

by 19.1% (DECC, 2008), signalling that much work is still required in order to reach the 2020 target. With the residential sector accounting for 24.3% of total emissions in 2008 (DECC, 2008), domestic energy use presents itself as a salient target for greenhouse gas reduction. Energy expenditure in two identical homes having been shown to produce a factor of two difference (Darby, 2006); illustrating that the behaviour of the inhabitant can play more of a role in domestic energy consumption than the technological devices that populate them. With silver bullet solutions such as new housing stock, or more efficient heating systems no longer viable due to the recent economic downturn (Mintel, 2009), the ways in which consumers interact with their domestic energy systems, such as in the occupants attainment of comfort, need to be explored.

The Carbon, Control, and Comfort (CCC): User-centred control systems for comfort, carbon saving and energy management project, to which this research is aligned, is an interdisciplinary UK project aiming to reduce domestic energy use by 20% (EPSRC, 2010). With access to social housing tenants and working alongside housing and energy providers across the UK, the aim of the CCC project is to not only understand the comfort and energy consuming behaviours enacted within social housing, but to also design and implement feedback prototypes in order to affect a behavioural change to reduce domestic energy consumption, whilst maintaining the tenants expected level of comfort. This paper reports on the findings of a doctoral research literature review focusing on the role of feedback as a behaviour change mechanism, Design for Sustainable Behaviour as a method of implementing feedback mechanism's, as well as the ethical implications of changing behaviour through design.

## 2. Factors Influencing Household Energy Use

When discussing influences upon domestic energy consumption, there are three factor to consider; the occupants knowledge and perceptions of energy and energy conservation; the role of norms and behaviour in influencing motivation to use or conserve energy; as well as the occupants perceived ability to engage in energy conservation practices (Steg, 2008).

Energy is perceived differently to other forms of consumer goods as it is invisible and abstract in its nature (Burgess and Nye, 2008, Fischer, 2008). The cognitive framework developed relies on its associated activities, its indirect consumption (Fischer, 2008). This can lead to incorrect cognitive links between energy and product use and operation, such as the underestimation of the amounts of energy involved in domestic practices (Steg, 2008). Furthermore, energy is generally regarded as a "low interest" product due to its relatively low share of a household's expenditure, its constant and featureless supply, as well as the consumer's lack of fear over "diminishing stock". It is also not a product of status, nor is it

attributable to a lifestyle choice in the same way as, for example, organic produce (Fischer, 2008). Energy use in general is not connected to a considered frame of consciousness (Burgess and Nye, 2008).

The underlying psychological consumptive and behavioural decisions that consumers make also influence domestic energy use. The consumer decision model can be granulated to include the personal domain, the contextual domain, and the behavioural domain (Steg and Vlek, 2009).

The personal domain pertains to the personal and social beliefs and pressures that form and shape the value basis of an individual. Motivational factors within this domain include the weighting of costs and benefits such as in Ajzen's Theory of Planned Behaviour which suggests that choices are made based on a rational decision by framing the highest benefit, against the lowest cost; as well as the consumers moral, normative, and symbolic values by which to frame social approval or disapproval and to influence conduct (Steg and Vlek, 2009, Stern, 1999).

Motivational factors alone, however, do not determine an individual's course of action; the contextual domain that surrounds them constrains or affords behavioural opportunities, concerning itself with the context or physical infrastructure that influences an individual's decision processes or behaviour. Contextual factors may affect action through the constraining or facilitating of options; a change in context may lead to a more positive attitude to a service, which in turn may foster behavioural action; may moderate between motivational and behavioural factors through accessible and valid alternatives; and finally, the activation of normative goals affects frequency based on availability to perform the action (Steg and Vlek, 2009).

Habitual behaviour is governed by automaticity of cognitive process, whereas the two other domains suggest a level of cognitive reasoning (Steg and Vlek, 2009). In defining the characteristics of a habit, firstly a goal must be present and achievable; secondly if the achieved goal is satisfactory, the same action is repeatable; and thirdly, a habitual response is governed by the cognitive process that develops through frequency and association of the context and motivational factors (Steg and Vlek, 2009). Verplanken (2003) expands upon this definition, stating that the strength of a habit is not determined just by the frequency of past behaviour (the more frequent we perform an act, the more likely it is to become habitual; a learning process), but is also constructed of four further parts; lack of awareness (a lack of conscious decision making, delegating of control of the act to environmental cues); efficiency (the freeing of mental capacity to do other things at the same time through the application of expectation filters); difficulty of controlling behaviour (a habit in principle is controllable, but it

is difficult to implement deliberate thinking and planning to overrule); and identity (the reflection of one's own identity and personal style) (Verplanken and Orbell, 2003, Verplanken and Wood, 2006).

**3. Feedback**

Several strategies exist that build upon these psychological factors in order to promote a change in behaviour, including: psychological strategies and antecedent interventions which influence the cognitive determinates of an action prior to its enactment through a prompt in motivational factors, such as in the use of commitment, goal setting and informational strategies (Abrahamse et al., 2005, Darby, 2006, Ofgem, 2010, Stern, 1999, Steg and Vlek, 2009); structural strategies which aim to change the context by which decisions are made through either a change in products or services, or a change in policy, legislation, and pricing (Crosbie and Baker, 2010, Steg, 2008, Steg and Vlek, 2009); or through consequence interventions which are similar to structural strategies, however, the perceptual focus shifts towards the positive and negative consequences of behaviour and action, rather than just the physical inhibiting or enabling of a context, and includes the use of rewards and feedback (Abrahamse et al., 2005, Burgess and Nye, 2008, Ofgem, 2010, Steg and Vlek, 2009, Stern, 1999).

Feedback instruments can be employed in two ways. As a tool to illustrate the actual cost (such as time or money) of consumption and generate normative reflection, feedback can be used to tangibly present and frame 'problems' caused through behavioural action. A suitably framed 'problem', presented through the feedbacks form and delivery content may therefore influence the normative or motivational consideration process (Fischer, 2008). Information is taken in, is acted upon it, and an interpretation is made (Darby, 2006). Alternatively, appliance specific feedback can be used to link a specific interaction with a product or system to energy consumption, thereby increasing an individual's product/system understanding and increasing the consciousness of the individuals own behaviour (Fischer, 2008). By allowing individuals the ability to explore their own energy use and its effects, the concern/action gap can be bridged, promoting efficiency as opposed to trying to generate an intangible sense of social obligation (Darby, 2008).

Darby (2006) proposes five categories of feedback (shown energy savings are presented in Table 1.): direct feedback presented immediately to the individual without processing, from either the meter (e.g. gas meter) or from an associated device; indirect feedback presented to the individual after being externally processed (e.g. bills processed by a utility company); inadvertent feedback (education though association); utility-controlled feedback which concerns the control and provision of data of an individual's energy consumption data back

to both the individual and the utility provider (commonly referred to as 'Smart' meters or technology (DECC, 2009)); and energy audits (education through an understanding of the energy capital of a building).

Table 1: Categories of Feedback (Darby, 2006, OPOWER, 2010)

| **Categories of Feedback** | **Shown Energy Savings (%)** |
|---|---|
| **Direct Feedback** | **3-20** |
| Basic Metering without Separate Direct Display Monitors | 10-20 |
| Key Meters and Keypad Meters | 3-20 |
| Direct Display on Monitors Separate from the Meter | 10 |
| Use of TV's and PC's for Display | 8.5-18 |
| Ambient Devices | 16 |
| **Indirect Feedback** | **0-10** |
| Informative Billing | 8 |
| **Utility Controlled Feedback** | **1.5-3.5** |

## 4. Feedback Considerations

There are several ways by which feedback can influence the energy consuming behaviour of an individual through the provision of information, but as Wood et al (2007) points out, informational content alone is not enough to promote action, rather it is the way by which this information motivates the individual to act. Presentation of information is the key to securing an individual's engagement.

- Frequency and Duration. The latest update of information should be present when the individual conducts an energy consuming act and may be open to a change in behaviour, and secondly when the individual chooses to acknowledge the feedback. On a display local to an action, information should remain short to maintain immediate interest; a centralised display would show a larger time base (Abrahamse et al., 2005, Darby, 2006, Fischer, 2008, Hargreaves, 2010, Wood and Newborough, 2007).
- Accuracy. To form a cognitive bridge between action and effect, information must not only be frequent, but also be accurate. Estimated feedback disassociates the individual with the consequences of their behaviour, and furthermore, removes any time of use prompts to frame or challenge their action (Fischer, 2008, Hargreaves, 2010).

- Contents and Metrics. Energy consumption feedback can be presented to the individual through; energy units (e.g. Kilowatt-hour (kWh)), cost (e.g. pence), environmental impact (e.g. CO2), and/or behavioural units (e.g. number of times an appliance has been used). Each of these unitary types uses a different language to frame the context of energy consumption, thereby activating different norms and motives within the individual (Burgess and Nye, 2008, Fischer, 2008, Fitzpatrick and Smith, 2009, Hargreaves, 2010, Ofgem, 2010, Wood and Newborough, 2007).
- Breakdown. Information may be granular by; appliance, energy type, rooms or zones, or temporally. By disaggregating consumption information, the conscious link between action and effect can be greater established through educational awareness (Darby, 2006, Fischer, 2008, Fitzpatrick and Smith, 2009, Hargreaves, 2010).
- Presentation Medium. The medium presented has an effect on its ability to engage with the individual, and should therefore be framed by the motivations, norms, and capabilities of the target individual (Fischer, 2008).
- Presentation Mode. The choice of presentation mode is split into; text, through the use of numeric, alphabetic, or combined alphanumeric information; and graphical, through the employment of visual statistical charts, and should not involve using any additional materials to aide understanding or calculation. The frequency and location of the information presented may affect the selected visual presentation (Abrahamse et al., 2005, Darby, 2006, Fischer, 2008, Wood and Newborough, 2007).
- Ambience. Ambience alone to convey energy consumption is ambiguous and ineffective unless the ambience feature has characteristics that can be easily cognitively mapped (Fitzpatrick and Smith, 2009).
- Location. If an action requires instantaneous feedback in order to improve cognitive connections between action/effect, the device must be placed in such a position as to afford this information. By fitting in aesthetically with the individuals chosen location, the device is more likely to be accepted and incorporated into a routine. Device's may also be transient (Fitzpatrick and Smith, 2009, Hargreaves, 2010).
- Technical Expectations. If there is a failure during technical installation of a feedback device, or with the provision of accurate information, interest in the feedback or the perception of it may be reduced or damaged (Crosbie and Baker, 2010, Hargreaves, 2010).
- Historic and Normative Comparisons. By providing a comparison to the individuals own, immediate and localised consumption, a context is provided by which to assess, evaluate and compete. There are in effect, two types of comparison; historic (current

against previous consumption), and normative (comparison against factors that may instil normative motivations, such as other households or activities) (Abrahamse et al., 2005, Fischer, 2008, Fitzpatrick and Smith, 2009, Hargreaves, 2010, Wood and Newborough, 2007).

- Additional Information, Comparisons, and Instruments. Feedback itself is a means of displaying consumption, and not the format by which to understand how to modify consumption behaviour or as a means to necessarily provide the motivation level required to do so. In order to enhance the potential of feedback to promote motivation and awareness of how to manage energy consumption, additional information and further instruments are required, such as supplementary information, and the use of goal setting, commitment or financial incentives and rewards (Darby, 2006, Fischer, 2008, McCalley, 2006, Wood and Newborough, 2007).
- The Rebound Effect and Other Challenges. The provision of feedback and other forms of information do not always lead to a reduction in energy use. Fischer (2008) and Abrahamse et al (2005) both point to research that shows if an individual is made aware of how cheap energy is (e.g. by comparison to a larger household budget), or that they use a lower amount by comparison to others, that they may actually increase their consumption. Further challenges may include: certain appliances (e.g. a computer or additional heating for medical conditions) may be deemed as necessities and therefore use cannot be reduced or removed; energy use may become framed as a negative activity thus increasing guilt and stress, especially to those on a low income; different domestic temporal rhythms and 'natural' consumption patterns need to be considered; conflicting domestic relationships and practices may be gendered or generational (Hargreaves, 2010); consumption behaviours may become distorted (e.g. using a gas kettle because only electricity use is measured); and perhaps most important of all, personal and social norms are unique to each individual (Fitzpatrick and Smith, 2009). Context will also influence the selection of technologies (e.g. installing a clip on meter in a flat may be problematic) (Ofgem, 2010).

**5. Design for Sustainable Behaviour**

Design for Sustainable Behaviour (DfSB) is a branch of sustainable design theory concerned with the application of design strategies that attempt to influence consumer behaviour during the use phase of a product towards more sustainable practice (Lilley, 2009). DfSB when applied to the interface between a user and their goal – the product, can be used by the designer to shape user perception, learning, and interaction (Tang and Bhamra, 2009b). This affords the opportunity to the designer to challenge and affect habit formation, which as

discussed previously, could influence their consumption of household energy through product use.

Research shows that there is no single approach or methodology for changing the behaviour of a user towards more sustainable action (Bhamra et al., 2008); which as a consequence, has lead to the development of several DfSB strategies.

### 5.1 Design with Intent

Design with Intent (DwI) is a branch of DfSB that attempts to encapsulate the application of persuasive technologies and behaviour change theory across a wide range of disciplines (Lockton et al., 2008). Presenting a 'suggestion tool' for designers, the aim of the DwI Method (Lockton et al., 2009b), is to facilitate quick access to a broad range of behaviour change solutions that already exist, in order to draw parallels between the designers own brief and the solutions offered, or to use the tool as a means of approaching a brief from outside of their own discipline.


Figure 1: Design with Intent Toolkit v0.9 (Lockton et al., 2009a)

The six lenses presented by the DwI Method, shown in Figure 1. summarize segmented design perspectives on behaviour change theory: the Errorproofing Lens is concerned with

the prevention of user errors by either making the error impossible to perform, or by applying extra steps or physical functions that guide or limit the user's actions; the Persuasive Lens promotes a change in behaviour through the use of contextual feedback, allowing the user to consciously determine the most suitable solution based on the norms and motivations activated by a scenario; the Visual Lens is concerned with the psychological meaning of design semiotics and affordances, using visual information to either overtly or covertly guide user interactions; the Cognitive Lens uses an understanding of the psychology of decision formulation and hierarchy to shape and to persuade a user into a specific action; the Security Lens acts as an inhibitor, preventing errors or restricting behaviour through the use of overt negative agents; and the Architectural Lens allows the designer to channel and control user interaction through an understanding of the architecture of a built environment, system or product (Lockton et al., 2009b).

This tool affords the designer the opportunity for comparative assessment and 'outside-of-the-box' thinking, relying on the designers innate abilities and experience to make judgements with regards to the solutions offered by the Method, and the solutions required by their brief (Lockton et al., 2009b). The Dwl Method, however, does not provide any means by which to understand why consumers act, only methods by which to affect what they do. There is no support to trying to understand the underlying normative and motivational causes of the behaviour that the designer is attempting to change, which as Jelsma et al (2002) state, "makes little chance to enrol users in new ways".

### 5.2 The Theoretical Minimum

Elias et al (2007) propose a strategy by which to quantitatively evaluate behaviour. Introducing the concept of a theoretical minimum, a baseline can be established as to the minimum amount of energy that a product requires to operate, its peak efficiency. Deviation from this theoretical minimum comes in the form of intrinsic energy losses and user-related energy losses (Elias et al., 2009).

Intrinsic loss is determined by the build of the product; through the technology employed in its fundamental operation, the materials by which it is constructed, as well as the ability of the designer and the design process by which the product has been designed (Elias et al., 2009). User-related loss, is defined by the way in which a product is operated by the user, described by Elias et al (2009) as "a range of good and bad behaviours with good behaviour being more energy-efficient than bad". By quantifying the energy losses attributed to a product, a designer can direct efforts to mitigate these losses; through a better technological understanding and design practice, or through a behavioural design approach. Figure 2

illustrates the process by which the intrinsic and user-related losses of a product are identified, ranked, and consequently redesigned.

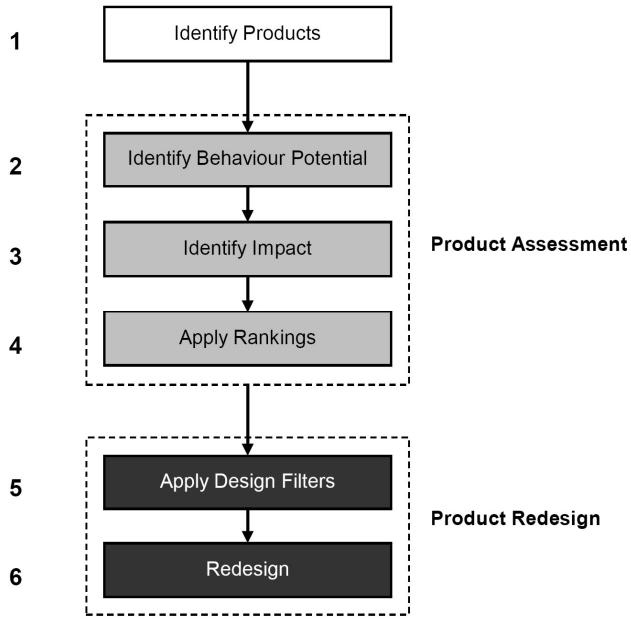


Figure 2: Six step method for a products assessment and redesign (Elias et al., 2008b)

Assigning behaviour labels based on efficiency assumes there to be an optimum state of operation by which to benchmark 'good' or 'bad' behaviours, which is decided at the discretion of the designer (Elias et al., 2009). However, products are not always used in the same way by different people, or as the designer may have intended (Pettersen and Boks, 2008a). A 'bad' behaviour perceived as user misuse or inefficiency, in reality may be an indication of a requirement not considered by the designer. The literature suggests that qualitative research should be used as a means to identify those behaviours that use the most energy (Elias et al., 2008a), however, the strategy doesn't attempt to understand why the user perpetrated the action or underlying motivations.

### 5.3 Delft Model

In order to generate sustainable user interaction with a product, a dual branched typology is proposed by the literature (shown in Figure 3.), as part of a design tool to help designers dealing with the psychological, behaviour changing aspects of design, and to address the traditional focus of product design as a technologically focussed discipline (Wever et al., 2008). The first branch is called functionality matching, whereby the delivered functions of a product, match up with a desired functionality. This has the aim of removing redundant

functions which may deliver a negative consumption impact, and also aims to add functionality to remove any negative behaviour triggers (Wever et al., 2008). The second aspect of the typology is concerned with influencing behaviour through design. This 'behaviour adaption' branch is split into three sections; eco-feedback, scripting and forced-functionality (Wever et al., 2008).

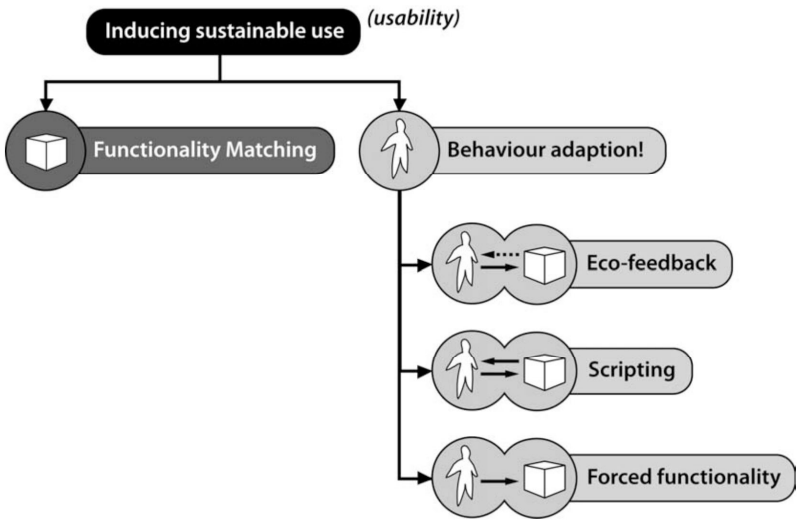


Figure 3: Typology of the Delft Model (Wever et al., 2008)

Wever et al (2008) suggest that how far a designer can go with regards to the level of 'intrusiveness' of an intervention is based on the context of application, and that a multidisciplinary team (engineers and psychologists) would be better positioned to make this decision. A design team would also have to decide which behaviours they wish to accommodate or abolish via functionality matching (Wever et al., 2008).

### 5.4 Loughborough Model

Lilley (2007, 2009) argues that there is an axis of influence between a product and a user, that determines where the decision making power lies, as illustrated in Figure 4. Towards the 'user agentive' end of this scale, is eco-feedback, a means by which to indicate environmental, economic, or social resource consumption to the user. Due to its non-coercive approach, eco-feedback is considered to be a guide to change, enabling control of decision making to reside with the user and their interpretation of the feedback (Lilley, 2009). In the centre of this axis is behaviour-steering (Lilley, 2009), an approach concerning the way in which a designer uses the physical characteristics of a product to prescribe a desired behaviour. By consciously 'scripting' a product through the use of affordances and

constraints, a designer can control the users interaction without forcing action (Jelsma and Knot, 2002). At the opposite end of the scale from eco-feedback is persuasive technology, such as intelligent context aware technologies and ubiquitous computing (Lilley, 2007, Lilley, 2009). A fourth proposed section includes emotional attachment (Pettersen and Boks, 2008b), the psychological attachment one has for a product, however its position is not defined within the literature.

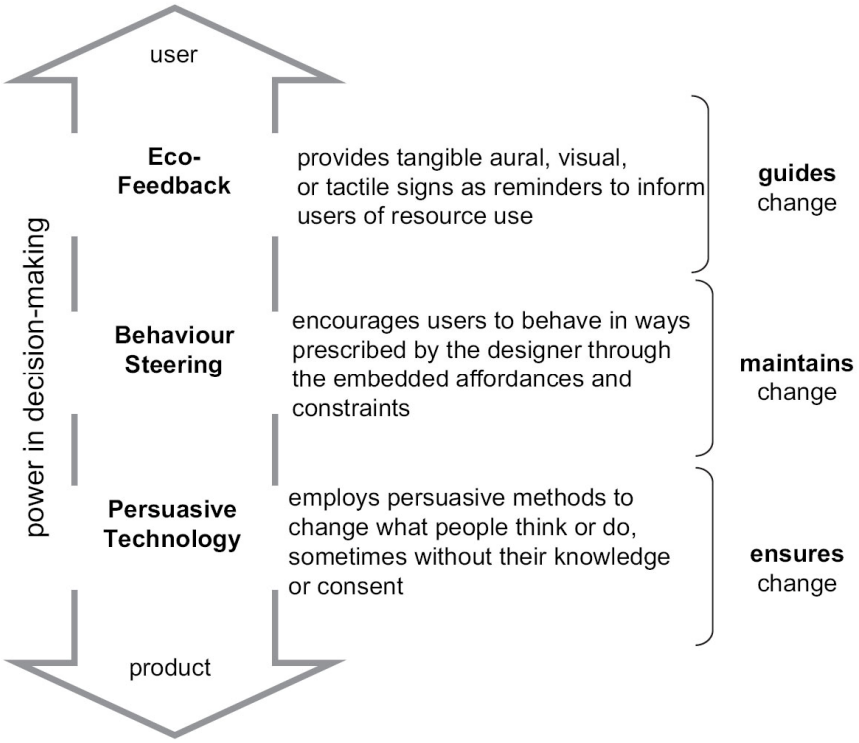


Figure 4: Designing for sustainable behaviour (Lilley, 2009)

Lilley (2009) suggests that the strength of behaviour change interventions should be categorised sequentially from passive (informative), to assertive (persuasive) to aggressive (coercive), and implemented based upon the context of the user-product interaction, the users willingness and ability to accept and operate the product, as well as the severity of consequences derived from the users actions. Lilley (2009) goes on to state that although further research is required in order to determine where specific interventions lie within this axis, it is important that the selection of a strategy considers the designers intent; the consequences of product (mis)use through observation of user and product interactions; as well as the associated ethical dynamics.

### 5.5 Consumption Behaviour and Design Interventions Framework

The work of Tang et al (2008) expands the framework of Lilley's (2009) axis of influence; integrating the user/technology agency structure with behaviour theory; shown in Figure 5. When the user is in the declarative stage, the early stage of habit formation when the user still maintains a sense of awareness and consideration of their actions (Anderson, 1982), feedback and information strategies can be applied to influence the user. If, conversely, the user has ingrained habitual routines and is in the procedural stage (Anderson, 1982), more coercive strategies should be applied.

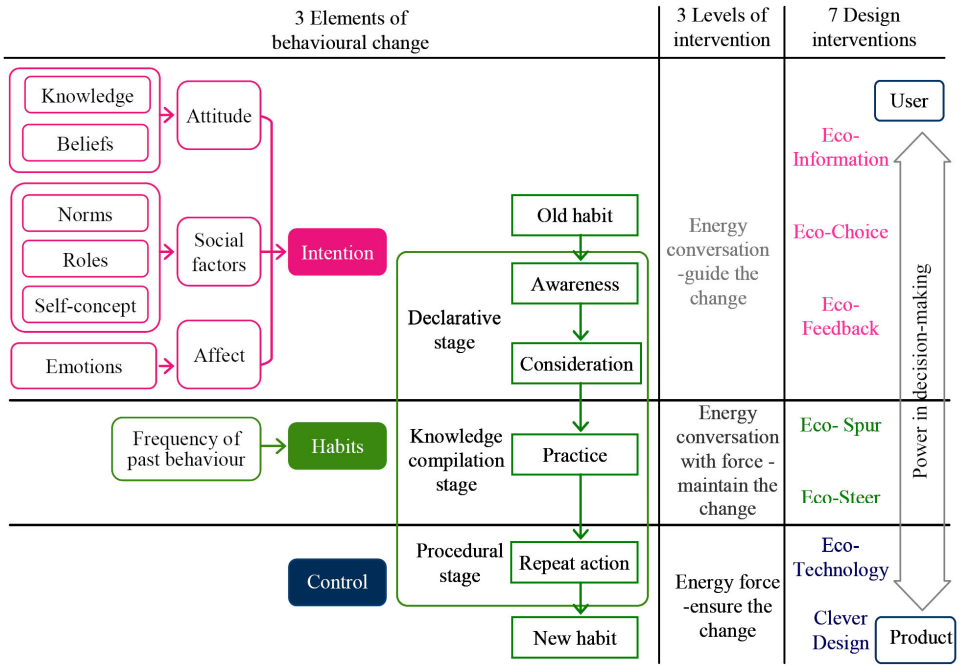


Figure 5: Framework linking habitual and intervention strengths (Tang and Bhamra, 2008)

The design interventions of Tang et al (2008), from user empowered solutions to technological agency, are categorised briefly as: Eco-Information educates the user through making consumables visible in order to provoke reflection; Eco-Choice by providing options encourages contemplation and responsibility; Eco-Feedback provides audible, visual or tactile feedback; Eco-Spur is concerned with the provision of incentives and penalties to guide user action; Eco-Steer deals with affordances and constraints; Eco-Technology employs technological means to persuade or control sustainable use behaviour; and Clever Design self controls technology, eradicating user engagement.

The consumption behaviour and design intervention framework provides a model by which to classify and dispense design interventions based upon the habitual intent of the user

(Tang and Bhamra, 2008), however, establishment of the 'strength' of the habit is at present unclear, as is the exact relationship between the habit, and the intervention required.

### 5.6 Technology's Four Roles in Resource Conservation

Midden et al (2007), suggest that by analysing the current interplays between technology and user, more specific methods can be pursued by which to use technology as an agent for invoking a change or reinforcement of a sustainable behaviour. The four technological roles identified are; as an intermediary, as an amplifier, as a determinant, and as a promoter.

As an intermediary, technology can be described as a mediator between one's behaviour and one's goal attainment. By understanding choices between technologies on a behavioural level and by providing appropriate guidance, more sustainable choices will be made. Technology as an amplifier may refer to the use of technology to amplify one's performances towards goal achievement, such as the use of computers to speed-up the completion of complex tasks; or it may be in reference to the increase in resource consumption generated through a rebound effect. Technology as a determinant is concerned with the shaping of an interaction by affording or restraining contextual actions or through the use of tempting opportunities or daunting obstacles to affect the psychological engagement and motivation of a user without necessarily increasing motivational awareness (Midden et al., 2007). The fourth role of technology, as a promoter, positions technology as a motivator through the increase in awareness of behavioural choices, reducing the gap between user understanding of action and consequences, motivating sustainable interaction (Midden et al., 2008).

The approach argued here is that the level of technological control is determined by the user's willingness to delegate that control to a technological system, not strength of habit or behaviour. The balance of decision making power should be appointed based on the willingness of the user to concede control to the system, with sensitivity given to the user's interactions, goals and the given context; provided via personalised feedback or through intelligent interactions to hone specific tasks or goal attainment (Midden et al., 2008). The level of trust, or distrust, between a technological system and its user is key, allowing for optimal system performance, and user acceptance of system control through cooperation (Midden et al., 2007). It is worth considering that given the complexity of human decision making, an automated system designed to be efficient and reduce human error may operate in an undesired manner (Midden et al., 2007).

## 6. DfSB Case Studies

Despite the literature presenting several strategies for implementing or categorising DfSB, at present there are no case studies that have taken a product from brief, through to extensive prototyping. As a result, there is a lack of information by which to fully assess the effectiveness of each theory, with each hypothesis drawing their own partial conclusions based on theoretical extrapolation or limited prototyping.

Existing concepts and prototypes are unable to provide a full and accurate analysis of the effectiveness of behavioural interventions as they don't fully provide the information or fulfil the criteria required to do so; such as a normative and motivational value baseline of the user prior to intervention, the total environmental impact of the product, the products affect on the users quality of life (Steg and Vlek, 2009), as well as the designers original intent (Lilley, 2009), research method, and design practice (Lilley et al., 2006). The lack of a unified framework by which to assess DfSB application in design highlights the difficulty in comparing and assessing DfSB projects in general.

## 7. Ethical Considerations

If the aim of DfSB is to influence the behaviour of a user towards a more sustainable practice through the designers shaping of the users perceptions, learning and interaction experiences (Lilley, 2009, Tang and Bhamra, 2009a), at what point, if any, does this practice become unethical, or is the very nature of DfSB, as a persuasive agent, an unethical practice from the outset (Fogg, 2003, Lilley, 2007, Pettersen and Boks, 2008a)? Fogg (2003) states "...the answer to the question "Is persuasion unethical?" is neither yes nor no. It depends on how persuasion is used." It is therefore important to consider the morality of the decisions made by the designer, and to understand fully the ethical issues surrounding this field of inquiry.

### 7.1 Individual Freedom

DfSB aims, in effect, to change or persuade the actions of an individual towards a prescribed set of goals and values not necessarily in line with their own (Pettersen and Boks, 2008a). In order to achieve the long term aim of sustainable action, individual freedoms may potentially over the short term be restricted, which may manifest itself in two ways; either through the manipulation and interfering with of activities by technological agency, or secondly by restriction of an individual's autonomy, such as through policy legislation (Pettersen and Boks, 2008a). Berdichevsky et al (1999) propose a set of principles, shown in Table 2., against which it may be possible to assess the ethical acceptability of an intervention (Lilley, 2007), however, the principles are subjective, and not necessarily all

encapsulating, such as regards the designers responsibilities when faced with unintended outcomes from a persuasive technology (Pettersen and Boks, 2008a).

Table 2: Ethics of Persuasive Technology (taken from Lilley, 2007)

| **Ethical Principles of Persuasive Technology** |
|---|
| I. The intended outcome of any persuasive technology should never be one that would be deemed unethical if the persuasion were undertaken without the technology or if the outcome occurred independently of persuasion. |
| II. The motivations behind the creation of a persuasive technology should never be such that they would be deemed unethical if they led to a more traditional persuasion. |
| III. The creators of a persuasive technology must consider, contend with, and assume responsibility for all reasonably predicted outcomes of its use. |
| IV. The creators of a persuasive technology must ensure that it regards the privacy of users with at least as much respect as they regard their own privacy. |
| V. Persuasive technologies relaying personal information about a user to a third party must be closely scrutinized for privacy concerns. |
| VI. The creators of a persuasive technology should disclose their motivations, methods, and intended outcomes, except when such disclosure would significantly undermine an otherwise ethical goal. |
| VII. Persuasive technologies must not misinform in order to achieve their persuasive end. |
| VIII. The Golden Rule of Persuasion. The creators of a persuasive technology should never seek to persuade a person or persons of something they themselves would not consent to be persuaded to do. |

Fogg (2003) suggests that there are three areas ‘worthy of inquiry’ when assessing the ethics surrounding the application of persuasive technology (in relation to computing). First, what are the intentions of the persuasive technology, why was the product created in the first place; secondly, what methods are employed to persuade the user; and finally what are the intended and unintended outcomes of the product?

### 7.2 Designers Intent

One criterion by which to assess the ethics of a persuasive product is to understand what the designers’ original intent was. Intentions may run an ethical gamut from a promotion of health and safety, through grey intentions such as its use as a tool for selling (which may increase the unnecessary consumption of goods or services), ending with unethical applications such as the promotion of violence (Fogg, 2003).

### 7.3 Methods of Persuasion

The method of persuasion may also have ethical connotations. Fogg (2003) states that certain methods are 'clearly unethical', such as the use of deception (false promises that never get delivered) and coercion (enforced change to the benefit of the product, not the user); that methods such as operant conditioning (the promotion of behaviour through reinforcement or punishment) and surveillance (a monitoring system with contextual repercussions) are ethically subject to the method by which they are implemented, such as whether they are overt and harmless or covert and harmful; and that strategies that promote the understanding of cause-and-effect relationships are generally considered ethical if they empower and benefit an individual. The use of emotion to persuade an individual may be deemed ethically questionable if it exploits or takes advantage of an individual's emotive reaction (Fogg, 2003).

### 7.4 Responsibility for Intended and Unintended Outcomes

A designer can only predict what the outcomes of an intervention are, as the user may interpret and interact with a product in unforeseen ways (Pettersen and Boks, 2008a). Such unintentional outcomes may include rebound effects such as; increased consumption; the bypassing of technology or its ignorance; and unintended use (Pettersen and Boks, 2008a).
Fogg (2003) suggests that the ethical dimensions may also be assessed by the outcomes of a users interaction with the product. If the designers intended outcome is benevolent towards the user, there tends not to be any ethical issues, however, if the intended outcome is unethical, then the designer must take ethical responsibility. By carefully anticipating and considering the ways by which a product may be unintentionally appropriated, overused or used by unintended users, the designer can be considered to be acting ethically (Fogg, 2003). If an unintended outcome could have been foreseen, the ethical responsibility to correct this over sight lies with the designer (Fogg, 2003).

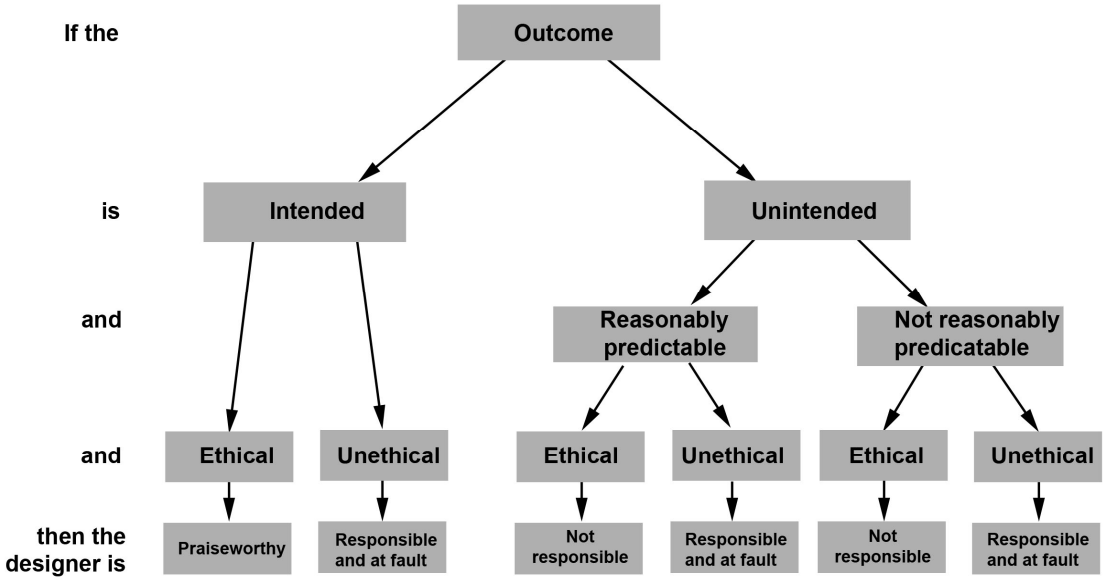


Figure 6: Evaluation based on Intended and Unintended Outcomes (Fogg, 2003)

Responsibility by the designer should also be taken with regards the level of mediation the product performs between the user and their actions, as the product itself cannot be held responsible for the decisions influenced by its use (Pettersen and Boks, 2008a). Such product mediation may also infringe upon privacy and civil liberties through 'smart' context-aware features (Lilley, 2007); or the total control or optimisation of a products operation may result in 'moral laziness', as the cognitive systems that learn and associate choice with action and consequence are disengaged (Pettersen and Boks, 2008a).

## 8. Conclusions and Next Steps

In conclusion, feedback is a method by which to generate a change in behaviour; a system where by the factors influencing household energy consumption can be suitably framed and made apparent to the consumer in order to promote efficiency and reflection. Through the use of DfSB theory as a mechanism by which to implement and generate appropriate feedback devices, it is anticipated that the aim of reducing domestic energy consumption in the context of social housing is attainable, whilst maintaining the tenants comfort expectations.

Despite the growing selection of DfSB strategies available, however, there remain several key areas that require further research and investigation. There is no clear selection strategy in order to determine the suitability and strength of an intervention. Although interventions have been typologically classified or grouped into 'lenses' and categories, the

selection of what is the most appropriate intervention, or indeed, what criteria and parameters constitutes the most appropriate intervention are not well defined. The lack of DfSB concepts developed through to prototype also generates a short fall in case studies by which to provide a robust assessment of any of the given strategies. Such an assessment may include a measure of the behavioural change generated by the intervention against a normative and motivational baseline; a quality of life impact assessment; a measure of the environmental impact caused; an evaluation of its integration within the design process, including research and design methods as well as the designers intentions; and furthermore, should include an evaluation of the interventions commercial aspects. Currently no DfSB project can provide such a level of assessment. The ethical issues pertaining to the application of DfSB have also yet to be resolved. At present there is little guidance available to support the ethical intention of an intervention by the designer; a lack of structure or criteria by which to 'ethically rank' or compare interventions; or provide an assessment of the ethical repercussions of its use, either in or out side of its intended context.

The next step for this research project will be to conduct an extensive ethnographic inquiry at two social housing sites in the UK in order to generate tenant derived definitions of comfort, and to understand the behavioural actions through which these definitions are attained. As part of a user-centred design approach, a combination of interviews, audio tours, and cultural probes will be applied and analysed to provide the normative and motive basis on which design interventions will be formed, and subsequently prototyped; whilst in parallel the field of DfSB will be further explored and built upon. Supporting the qualitative information with ongoing quantitative recording of environmental factors and energy consumption, prototypes will be evaluated with regards to their impact on both the tenant, and their energy consuming domestic behaviours to provide holistic conclusions. The aim of this project is to not only to save energy and change behaviour in this specific application, but to contribute and build upon the framework of DfSB and feedback theory so as to make the results from this project, applicable in other context.

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