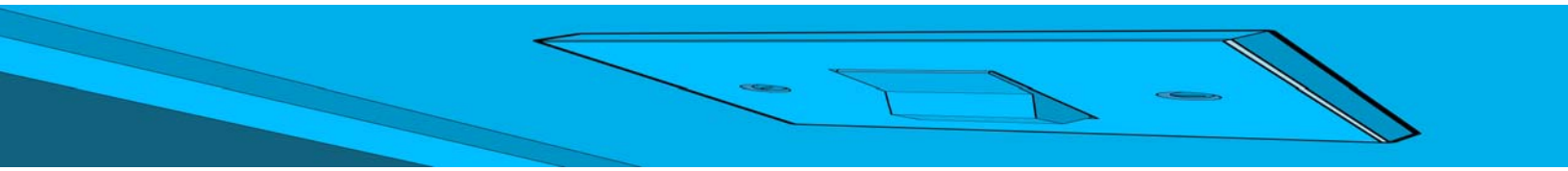

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Personal Carbon Budgeting:

What people need to know, learn and have in order to manage and live within a carbon budget, and the policies that could support them?

Working Paper

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Yael Parag and Deborah Strickland
Environmental Change Institute, Oxford University

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Key words: personal carbon trading, personal carbon allowances, carbon budgeting, energy demand reduction, energy policy

UK Energy Research Centre – Demand Reduction Theme
Environmental Change Institute
Oxford University Centre for the Environment
South Parks Road
Oxford OX1 3QY

www.eci.ox.ac.uk
www.ukerc.ac.uk

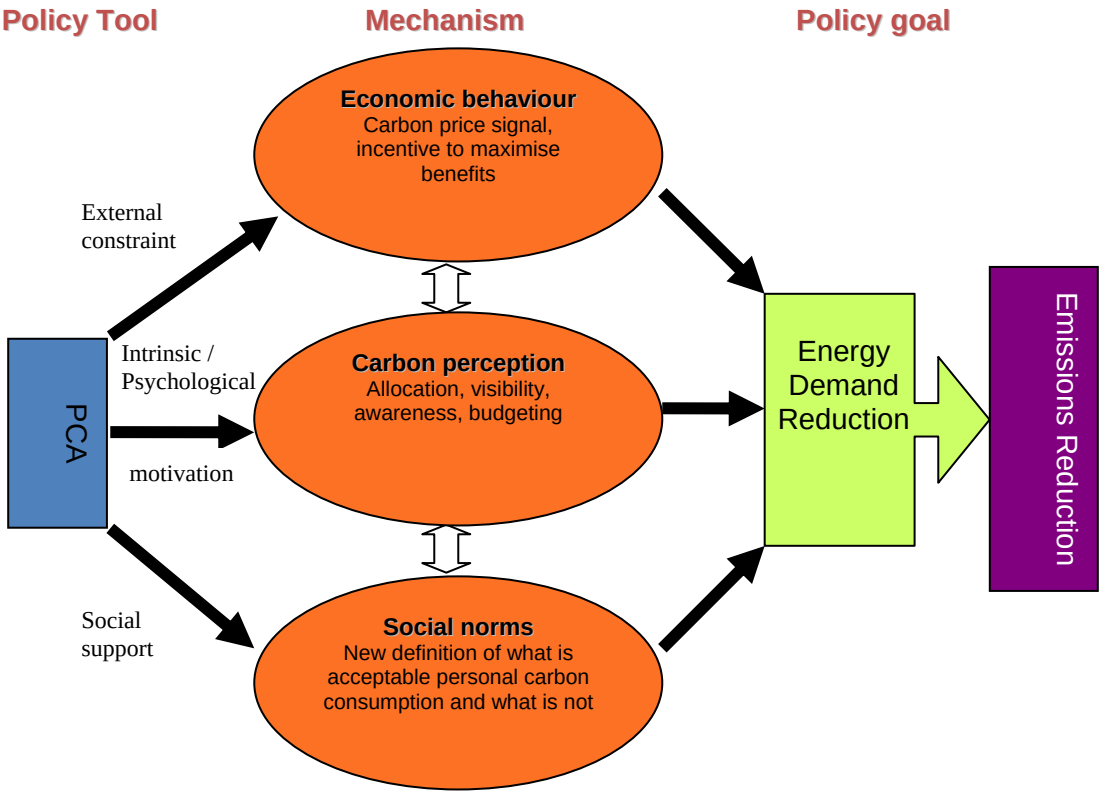
Executive summary

This working paper explores what people may need to know, learn and have if a Personal Carbon Allowances (PCA) scheme was to be implemented, and the kinds of policies, programs and initiatives that could support them.

PCA is a proposed downstream carbon cap and trade policy instrument suggested for the UK. It is a mandatory policy whereby all individuals receive an annual carbon emissions 'budget' for their personal use. A PCA scheme would cover emissions under individual's direct personal control, such as household energy use (mainly electricity and gas), private transport (not including public transport) and aviation. It would not include the carbon embedded in products and services purchased by the individual. People would be allowed to buy additional emissions or sell their surplus credits in the personal carbon market.

Defra conducted a pre-feasibility study into personal carbon trading in 2008 and concluded that it is an idea ahead of its time. Yet, the UK Government remains interested in the concept of PCA and welcomes further research.

It is suggested that a PCA instrument would lead to energy demand reduction through three basic interacting mechanisms: economic – via carbon price, psychological – via carbon awareness, and social – via new norms for carbon emissions.



The routes and mechanisms by which PCA can deliver emissions reduction

In this paper we suggest that framing PCA as carbon budgeting may encourage self control over personal energy consumption in the same way it does with money, and help individuals to remain within their carbon allowance limits. Hence, the budgeting process will help individuals prioritise their behaviours and may lead to emission reductions.

The paper discusses a number of prerequisites for personal carbon budgeting: acceptable budget limits; improved carbon literacy; affordable low carbon alternatives; opportunities to make low carbon choices; information, advice and support; and knowing how to trade. Special attention is given to vulnerable groups.

The limits of the budget are likely to be important for controlling individuals' emissions throughout the budgeting period. These would need to be set in advance and made known to carbon account holders so that they can budget for future emission constraints. To raise public support for PCA, it is important for the limits to be set by a trusted authority and be transparent in how they are calculated.

Carbon literacy needs to be improved so that individuals know their actual carbon footprints and the corresponding carbon income and expenditure from their budgets. This has implications for how we design labelling, give feedback on usage, display the carbon account and transaction information. Information presented to consumers needs to be meaningful, in consistent units, personal to the activity undertaken, and crucially timed in order to affect the behaviour before it happens.

Affordable low carbon alternatives are vital for budgeting because they give individuals the necessary options for minimising their emissions. These would aid budgeting by promoting market transformation; boosting low carbon innovations; gaining public support for emissions reduction policies; and changing social norms. Low carbon alternatives could be supported by encouraging social innovations such as car clubs; community engagement such as the Big Green Challenge; and choice architecture by manufacturers in favour of low carbon choices, such as lower default thermostat settings.

Individuals will need both the motivation and option to make low carbon choices. Schemes and policies are needed for the promotion of low carbon options and innovations as well as for the removal of barriers that obstruct people's ability to make low carbon choices. A variety of mechanisms can be used to help widen individuals' opportunities to make low carbon choices: economic incentives, new legislation, information campaigns, skills training, community led initiatives, and targeted schemes such as improving public transport or car sharing.

Introducing a PCA scheme will require accompanied information, support and advice programmes which explain the practicalities of living with the scheme and also provide guidance on how to reduce households' emissions. Formal advice to individuals and institutions needing to adjust to PCA could be provided through mass media and

information campaigns at all levels, from government down to local communities. Social support (both informal and organised community activities) would play a vital role in sharing experiences and changing social norms. Financial support would most likely be needed to give extra support to targeted individuals within communities.

Finally, this paper outlines how trading is an important prerequisite for budgeting. Trading allows flexibility over budget limits such that over-emitters can buy extra credits and under-emitters can sell their extra credits in the personal carbon market. Hence, knowing how to trade is important for those who want to take advantage of the economic benefits gained by reducing emissions. The trading procedures should be kept simple and well communicated, allowing people to learn how to trade as well as correcting errors. A 'pay as you go' option should be offered to those who do not wish to trade. Further thought should be dedicated to the effect of the following on the perception of the market, public support, and the likelihood of people participating in trading: market setting, design and governance; trading options such as speculating with 'futures'; and intermediate market makers.

Many of the insights proposed in this study will help to prompt carbon-conscious behaviour, recognise vulnerabilities and offer low carbon choices and societal norms. In this respect several of the suggestions outlined in the paper are not restricted to PCA but will be relevant to any effort made to reduce emissions from the domestic sector by helping to prepare individuals and society for a carbon-constrained world.

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Introduction

This working paper explores what people may need to know, learn and have if a Personal Carbon Allowances (PCA) scheme was implemented, and suggests ideas for policies, programmes and initiatives that could support them. A PCA scheme implies that individuals would have a personal budget of carbon credits, which they would need to manage, to some extent, in order to stay within its limits, and in the best case scenario earn some money by selling not-needed carbon credits. Thus, this paper looks at the budgeting process from the carbon account holder's view point and applies insights from how people budget under monetary and non-monetary constrains to the study of PCA. It also highlights related policy design issues.

The paper is composed of two sections. The first sets PCA in the policy context alongside other existing and proposed emissions reduction policies. Next it explains the mechanisms through which PCA supposes to change energy demand behaviour and then describes the current discourse surrounding PCA in the UK. The second section lays out the rational for examining PCA through the lense of budgeting and points at questions arising from the concept of living within a carbon budget. It then discusses in detail the prerequisites for carbon budgeting, which include: setting the budgetary limits; knowing personalised carbon 'income' and 'expenditure'; having low carbon alternatives; having the opportunity to perform low carbon choices; receiving advice and support; and learning how to trade. This is followed by a short concluding section.

1. PCA in the policy context

Climate change caused by greenhouse gas (GHG) emissions and their impact has brought the global community to formulate an international mitigation course of action, the Kyoto Protocol. Under the terms of the Kyoto Protocol, developed nations agree to limit their GHG emissions. In the Climate Change Act 2008 the UK has set itself an even more ambitious target of 80% reduction (based on 1990 emissions) in GHG emissions by 2050, with a 34% reduction by 2020. In April 2009 the UK has also put into place a system of legally binding targets for national reductions towards this long term goal, requiring national carbon budgeting[1].

Whilst the UK's GHG emissions have been reduced from 1990 levels, CO2 emissions have stabilised in recent years (Defra, 2007) and it is acknowledged that additional policy interventions will be needed to deliver carbon budget targets for 2020 and beyond (BERR, 2007). About 42% of the UK's CO2 emissions are emitted by individuals and households (hereafter domestic sector), of which 30% arise from space heating, 10% from water heating, 9% from appliances, 4% from lighting, 3%

[1] DECC press release: http://www.decc.gov.uk/en/content/cms/news/pn047/pn047.aspx

from cooking, 29% from personal travel, 12% from holiday air travel, and 2% from other travelling (BERR, 2007). In other words almost half of UK emissions are generated from energy-using activities that fall directly under the control of individual citizens, rather than corporations or Government. Although personal carbon emissions are individually insignificant, collectively they are very large. Delivering emission reductions by altering millions of individuals' energy-use choices and behaviour remains an unmet policy challenge.

1.1 Policies for emissions reduction

The array of existing and planned policy instruments to deliver cuts in emissions from individual end users in the UK consists mostly of information schemes, feedback and smart metering. Economic incentives exist to a lesser extent and include for example: grants (e.g. for installing solar photovoltaic panels), rebates (e.g. for stamp duty on low carbon homes), VAT reductions for some insulation materials, and soon - feed-in tariffs which pay individuals for electricity that they generate and export to the grid. In addition, market transformation schemes aim to eliminate energy inefficient electric devices from the market, and tighter building regulations aim to improve household infrastructure. More efficient homes and appliances can provide the same utility (benefit and comfort) while consuming significantly less energy. A voluntary agreement with the car industry is doing the same for cars. These and other policies/programmes tackle different aspects of individuals' energy-use, and thus contribute to the overall national emissions reduction. Yet, there seems to be no overarching approach to reducing personal energy consumption which could link together these policies and schemes.

Energy / Carbon taxation is one such 'umbrella' policy instrument option for attempting to deliver energy demand reduction across all end energy-uses. The mechanism through which taxation would lead to reduced consumption is fairly well understood; ultimately taxation is visible to the final energy user as a price rise which consequently leads to demand reduction. However, people do not necessarily react to price signals imposed by taxes in the manner predicted by neo-classical economics. Energy demand has been shown to be inelastic to price rises (e.g. Halvorsen and Larsen, 2001; Reiss and White, 2005) thus weakening the effectiveness of taxation schemes in delivering demand reduction. Further, energy costs constitute a relatively low proportion of the total household budget: energy consumption per unit of household disposable income fell by 44 percent between 1970 and 2000 (DTI, 2008). Consequently the price signal has a relatively weak impact on behaviour and may be largely overlooked by energy consumers (Baker and Blundell, 1991). However, the substantial price rises since 2003 might change this finding: between 2005 and 2006 a 4 percent fall in carbon emissions from the residential sector was recorded (Defra, 2008a).

An alternative overarching approach to energy demand reduction is a downstream carbon cap and trade instrument, namely Personal Carbon Allowances (PCA). PCA is a policy invention currently in its nascent stages of development. The concept of

capping personal emissions was first introduced by David Fleming in 1996 under the name of Domestic Tradable Quotas (DTQ) which later changed to Tradable Energy Quotas (TEQ) (Fleming, 1997). Several variants[2] have been proposed in which carbon is capped in different parts of the economy and with different allocations (for variations in schemes see: Roberts and Thumim, 2006). PCA, proposed by Mayer Hillman in 1998 (Hillman, 1998) is one option which is restricted to personal energy use. In short, it is a mandatory policy in which all individuals receive an annual carbon emissions 'budget' for their personal use. PCA would cover emissions under direct personal control, such as household energy use (electricity and gas), private transport (not including public transport) and aviation. It would not include carbon embedded in products and services purchased by the individual as this would be expected to be covered, very largely, by other carbon cap and trade schemes – the EU Emissions Trading Scheme (EUETS) and in the UK by the Carbon Reduction Commitment (CRC).

Under a PCA policy, for each purchase of carbon-based energy, allowances would be deducted from the individual's carbon budget. If people emit more carbon than their allowance they would need to buy additional carbon credits. On the other hand, those who emit less carbon than their allowance could sell the excess into the carbon market. The personal carbon allowance would be reduced periodically in line with UK emissions targets.

1.2 PCA mechanisms

Significant emission reductions could be achieved by reducing the carbon content of energy. However, this would require fundamental, expensive and time consuming infrastructural changes to our energy supply. The DTI's (2007) forecast for 2020 UK energy demand by energy sources indicates that the UK energy will remain fairly carbon intensive (40% gas, 39% oil, 14% coal, 4% renewables and 3% nuclear). Therefore, until low carbon energy is widely available emission reductions could be achieved by reducing energy demand, which will entail behavioural change. PCA is one such policy option that could deliver reduced energy demand and accordingly carbon emissions. It is suggested that PCA would operate through three basic interacting mechanisms (see figure 1), which broadly conform to different methodological approaches to behaviour change – economic, psychological and social.

[2] PCA is one of a number of varying Personal Carbon Trading (PCT) schemes that are mentioned in the literature. All versions of the schemes are similar in approach, but vary in terms of the participants, scope and allocation. The three main PCT schemes are: PCAs, Tradable Energy Quotas (TEQs), and Cap and Share. A brief summary of the key likes and differences can be found in Roberts, S. and Thumim, J., (2006). *Rough Guide to Personal Carbon Trading*. Report for Defra.

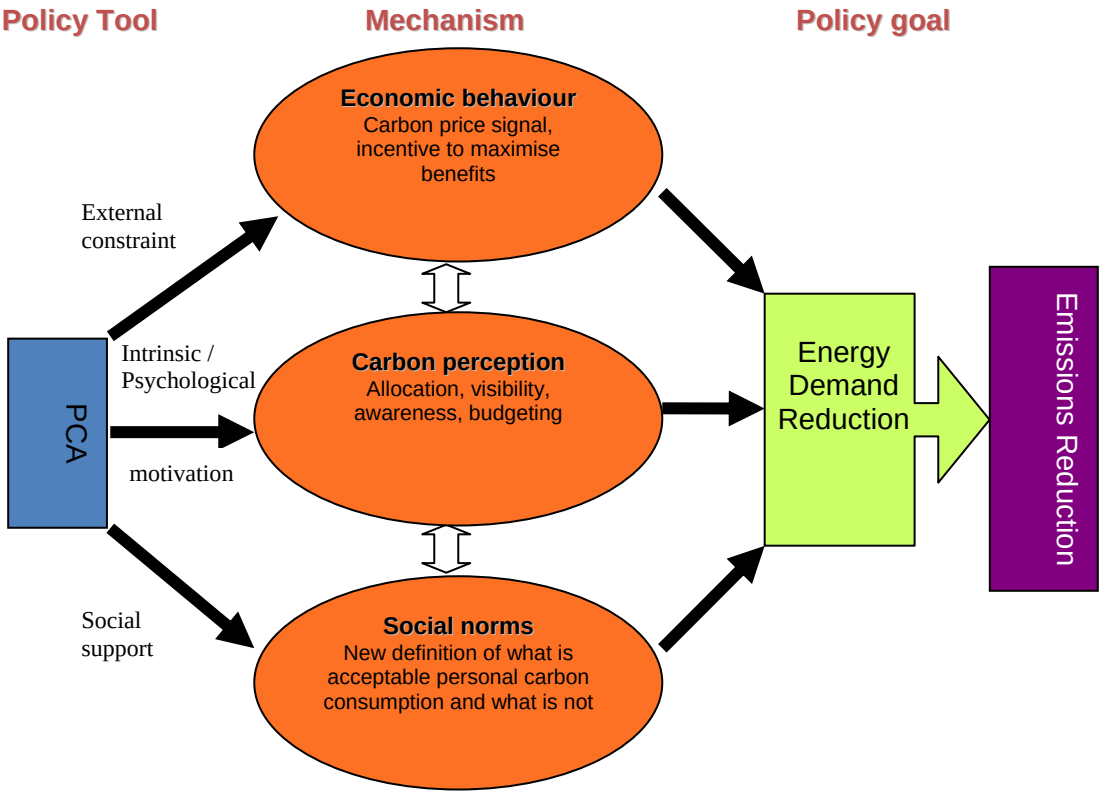

Figure 1: The routes and mechanisms by which PCA can deliver emissions reduction

The economic mechanism is driven by the price of carbon that arises in the market of traded allowances. The price is set by the following: the extent of the 'shortage'; the value of the services carbon-based energy can deliver; and the extent to which there is a well-behaved market. The price provides the economic incentive for reducing emissions and this is independent of the initial distribution of allowances. Steg (2008) argues that one of the obstacles for behavioural change is the economic cost related to improving energy efficiency and conservation. The economic mechanism of PCA tackles this obstacle by increasing the benefits.

The intrinsic psychological mechanism is driven through a combination of the carbon price, the scale of the individual allowance, and the visibility of the carbon emissions related to the individuals' actions. The economic paradigm within which carbon is interchangeable with other resources may not reflect the way that people actually manage their affairs. It is known that price effects are not always symmetrical: the willingness to pay for additional allowances may be different from willingness to accept payment for allowance sales (Capstick and Lewis, 2008). In this case, the distribution of allowances between individuals, as well as the personal cap, may affect behaviour, rather than merely the allowance's total value. Experimental work

carried by Capstick and Lewis (2009) provided some indication that people may be inclined to respond to PCA partly based on the absolute size of the allowance and whether they are in credit or debit, rather than responding with pure economic rationality.

The intrinsic route builds on increasing carbon awareness and the relationship between emissions and activities. Lorenzoni et al. (2007) describe different barriers to engagement in respect to climate change by members of the UK public. These include among others, the feeling of helplessness ('drop in the ocean'), concerns about free riders, and lack of enabling initiatives. Whilst other schemes – such as information campaigns, personal advice programme and more informative billing and metering – can help with reducing these barriers (see for review Abrahames, et al., 2005), it is reasonable to suppose that a cost penalty/bonus linked to other policies will increase the effectiveness of personal engagement. Additionally, increasing people's knowledge of their carbon emissions will help correct any wrong perceptions of actual energy consumed (Steg, 2008, Whitemarsh, 2009). Carbon visibility, awareness and correct information are crucial for promoting behavioural change. Their impact also has implications for political acceptability, which increases when people are aware of the problems resulting from their energy-use, feel responsible for it, and feel morally obliged to do their bit to help solve these problem (De Groot and Steg, 2008; Steg, et al., 2005). PCA's intrinsic motivation route has the potential to raise the perception and visibility aspects of carbon.

The social mechanism moves away from individualism and recognises that decisions, even about individually allocated resources, are subject to social forces (Schultz, et al., 2007). Energy conservation arising from normative concern – as opposed to hedonistic or cost reasons – is more robust against changes and therefore more durable (Lindenberg and Steg, 2007). The carbon 'budget' allocated to individuals suggests, to some extent, an acceptable and fair personal carbon footprint. The existence of PCA and consequent allowance trading will create new institutions, businesses and discourses that may alter social relations and the individual actions that flow from them. The acceptability of certain behaviours amongst different social fractions may change, for example through the existence of groups that promote alternative approaches to living within carbon budgets. PCA may increase awareness to climate change and its relation to carbon emissions, which could contribute towards social support in cutting emissions.

None of these mechanisms alone provide an adequate approach to understanding the impacts of PCA. The interaction between these mechanisms and the overall impact of the policy will be contingent upon a range of other factors. The same broad assessment might be made of carbon taxes as a policy instrument. However, while carbon taxes are designed primarily to target economic behaviour, through changing prices within existing markets and social frameworks, PCA is more likely to impact via the other mechanisms because of the use of a new carbon market, budgets, and the potential for social and institutional change.

Theoretically PCA avoids some of the taxation pitfalls. First, it increases the visibility of carbon, and delivers a message which is broader than pure supply and demand economics. Second, it also meets a basic standard of fairness, as all individuals receive equal allowance. In addition, PCA is broadly progressive, as the high emitters who will pay more have a propensity to be on higher incomes (Thumim and White, 2008). Fairness is important as policies which are perceived as fair are more likely to be politically acceptable (Bamberg and Role, 2003; Jakobsson, et al., 2000; Schuitema and Steg, 2005).

But PCA has its own weaknesses. The simple conception that PCA meets equity and fairness requirements is not unproblematic, as shown by Starkey and Anderson (2005) and Starkey (2007). Furthermore, a minority of the lower income deciles might find themselves worse-off under PCA (Thumim and White, 2008). Hence PCA has the potential, if designed without compensation mechanisms, to increase fuel poverty. In addition, policies which restrict choices (rather than increase), target absolute reduction (rather than efficiency) and aim to reduce energy from transport (i.e. restrict mobility, rather than focusing solely on energy use at home) are less acceptable (Poortinga, et al., 2003; Steg, et al., 2006). In these senses PCA could prove to be unpopular, because although it promotes efficiency the emphasis is on demand reduction. PCA not only puts current constraints on individuals but guarantees further restrictions into the future; inherent to the scheme, the budget will shrink over time. Yet, one could argue that favourably, PCA does not audit individuals' preferences and within a given cap – or budget – it allows for personal choice.

Several acceptability studies into PCA show that it is the least opposed option when compared against taxation and upstream cap and trade instruments (Owen, et al., 2008; IPPR, 2008), and that there is some degree of willingness for people to accept some level of responsibility over their actions. In particular, the DEFRA (2008) study found that "*resistance to behaviour change was less than expected*". Some participants felt ill-prepared for such a scheme, which they describe as too complex. This highlights the need for improving carbon literacy in advance of such a scheme, and building the capacity for personal carbon budgeting.

1.3 PCA status

PCA is a new policy instrument that is not currently implemented anywhere. Consequently, there is no comparable policy experience to learn from or to help predict the possible effects of PCA on the policy goal of reducing domestic sector carbon emissions. As a novel and radical instrument PCA introduces unfamiliar policy elements such as a carbon price for the domestic sector, cap-and-trade at the personal level, and carbon budgeting for individuals. It also raises many policy design questions such as: what would constitute effective and acceptable enforcement and monitoring mechanisms; how would the carbon allocation system work; what would the costs of the scheme be to the state and to individuals; and

who would be the governing institutions? All these issues, and others, need to be explored before such a policy could be implemented.

A PCA instrument has been (to some extent) discussed within the UK Government. In May 2008 Defra completed a pre-feasibility study into Personal Carbon Trading that looked at the following aspects: social acceptability, economic and technical feasibilities, equity and distributional impact, and the scheme effectiveness in the context of the existing policy landscape (see summary report: Defra, 2008). It concluded that "*personal carbon trading has potential to engage individuals in taking action to combat climate change, but is essentially ahead of its time and expected costs for implementation are high*". Accordingly, Defra announced that "*the Government remains interested in the concept of personal carbon trading and, although it will not be continuing its research programme at this stage, it will monitor the wealth of research focusing on this area and may introduce personal carbon trading if the value of carbon savings and cost implications change*"[3].

The UK Parliament Environmental Audit Committee, which published its own report on PCA few weeks later, concluded that "*carbon trading could be essential in helping to reduce our national carbon footprint. …Although we commend the Government for its intention to maintain engagement in academic work on the topic, we urge it to undertake a stronger role, leading and shaping debate and coordinating research*". Both reports agree that PCA remains un-exhausted field of research, and offers a promising prospect to aid the UK to meet its targets.

Theoretically, a PCA scheme holds a great potential to deliver emissions reduction via multiple mechanisms. At the same time because of the lack of experience, and with only limited ability to trial PCA as a whole before its introduction (Fawcett, et al., 2007), PCA is both a policy and political risk.

Summary

- A PCA instrument provides an overarching policy approach for reducing emissions from the domestic sector.
- A PCA scheme builds on three linked and synergistic mechanisms: economic – via carbon price, psychological – via carbon awareness, and social – via new norms for carbon emissions.
- PCA is an untried policy with no evidence base and therefore it raises many design questions and challenges.
- Defra conducted a pre-feasibility study into Personal Carbon Trading in 2008 and concluded that it is an idea ahead of its time, yet the government remains interested in the concept and further research.

[3] Defra news release http://www.defra.gov.uk/news/2008/080508c.htm

2. PCA and budgeting

In effect, PCA introduces a new currency into our lives – carbon. Under PCA everyone receives a sum of carbon credits, or units, which they need to administer. In order to manage a personal carbon allowance, it is likely that people will need to start budgeting carbon emissions from household gas and electrical activities, personal transport and flights. This will involve making rational tradeoffs between competing demands which emit carbon. While budgeting is a familiar act to many individuals in their daily lives, some might find it a more conscious process than others. One challenge for policy designers is to understand how people would manage their carbon budget, what assistance they might need, and what schemes could assist/advise them. In this working paper we try to explore what people need to know, have, and learn in order to successfully understand PCA and manage a carbon budget.

To illustrate: people need to know what their budget limits are, as well as what their current carbon balance is and how much they use for any given purpose. To enable informed choices, activities and services need to be labelled not only with their monetary cost but also with the carbon units they consume, i.e. their carbon cost. In order to stay within their carbon limits, many people will need to have low-carbon alternatives to their current choices such as public transport or energy efficient appliances. For these alternatives to be valid and attractive they need to be easy, accessible and cheap (or at least not excessively more expensive). People might need advice, such as how to reduce electricity consumption; options for optimal insulation material; availability of credible suppliers and installers; and knowledge about grant availability. Consumers will also need clear information explaining how to live with a personal carbon allowance and trade in the new carbon market. Inevitably some people would need financial support to improve their home's energy efficiency in order to reduce their carbon emissions.

As with any new policy, the above raises questions such as who should supply the information, how the information should be presented, who should bear the costs, and what is the most appropriate level to manage such scheme. There is clearly scope for involvement at all levels, from households, to communities, local authorities and ultimately central government. However, it is largely unknown what the required interplay and responsibilities between the relevant bodies should be in order to maximise the impact of PCA, let alone the impact that the new distribution of power resulting from the new policy (e.g. institutions, citizens, utilities) will have on public acceptability. Many of these unknowns could be better explored, yet, without direct experience there is no empirical evidence available to do so. Because of the lack of direct evidence, this working paper draws on other experiences which require budgeting and accounting, in order to learn more about the infrastructure required for introducing personal carbon budgets. In Parag (2008) the concept of cross policy learning is applied to help understand specific aspects of a PCA policy in

the absence of direct evidence from which we can learn. Parag proposes that cross policy learning is a useful tool to evaluate the effectiveness of PCA and draw lessons from other policies, schemes or examples which may have different goals but some similarities in their means or ends.

Here we give a rationale for looking at carbon allowances through the lens of budgeting and where possible we apply a cross policy learning approach to look closer at how a carbon budget will affect peoples' daily lives and the prerequisites to facilitate effective budgeting. The required behaviours, knowledge, information and assets are examined to gain useful insights into how individuals might budget carbon in a proposed PCA scheme and live within its limits. The examples used have been chosen because they involve budgeting under some kind of non-monetary constraint. Insights are taken from how people budget money, particularly drawing on behavioural economics and mental accounting; calorie intake, water during times of shortage, and energy (when using prepayment meters).

2.1 Framing PCA as carbon budgeting

Our assumption is that people would find is easier to understand and manage a personal carbon allowance if it was framed as a budgeting process. Budgeting is already familiar to many individuals through other aspects of their personal administration such as income management. Budgeting money requires mentally assigning payments to different accounts as a means of keeping aware and in control of spending (Heath and Soll, 1996). It is therefore possible that budgeting carbon may encourage self control over one's carbon emissions in the same way. Further reinforcing the possible advantages of framing PCA as a budgeting process, the mental accounting literature suggests that money is more likely to be spent in the way that reflects how it was received: money received as a gift is more likely to be spent frivolously than money earned (Thaler, 1999). Carbon budgeting may therefore avoid the possible association of the personal carbon allowance as windfall that can be frivolously spent. Budgeting also has the potential to help give individuals a sense of ownership of the problem of climate change and may empower them to take part in reducing their emissions. Taking ownership of a problem improves the public acceptability of policies which tackle it (Steg, 2008), and public support is crucial for policy success.

Heath and Soll (1996) use psychology to show that individuals mentally label money in order to categorise expenditure. The process of budgeting affects consumption decisions when expenses have been noticed and assigned to a particular account (Heath and Soll, 1996; Tversky and Kahneman, 1981). Tversky and Kahneman (1981) demonstrated that once a mental account has been spent to capacity, further money is not likely to be borrowed from another mental account. Allocation of money into different mental accounts therefore reflects the likelihood of spending it on that use only and can help facilitate self control. If mental accounting could be applied to energy-use or carbon emissions then the natural cognitive process of budgeting

might help control individual's energy-use and carbon emissions and keep them within their allowance.

Many individuals are well aware of the ongoing flow of money through their lives and therefore will be able to allocate carbon expenditure into mental accounts, in the same way that money is allocated between rent, food, bills, entertainment and savings. Further, Seyfang (2007) has argued that consumers are already familiar with complimentary currencies such as air miles or loyalty points and are well prepared for understanding currencies other than money. Many individuals are also familiar with budgeting non-monetary commodities such as calorie intake, alcohol units, and mobile phone time credits. For the case of budgeting with carbon, as supported by Lewis and Capstick's (2009) experimental work on carbon budgeting, it is reasonable to assume that people will need to allocate expenditure between household related energy (e.g. appliances, heating and water), personal travel and airfares. To achieve this, individuals will need to know what proportion of their budget is required for each pool. This requires understanding current consumption for each segment with respect to the total budget allocation. Hence the following chapters studies PCA through the lenses of carbon budgeting process.

Summary

- The process of budgeting is already familiar to many individuals through other aspects of their personal administration such as income management.
- The budgeting process affects consumption decisions when expenses have already been assigned to a particular account.
- Consumers are already familiar with complimentary currencies such as air miles or loyalty points; therefore it is likely that they are prepared for understanding currencies other than money.
- Framing PCA as carbon budgeting may encourage self control over personal energy consumption in the same way it does with money and help individuals to remain within their carbon allowance limits.

2.2 Living with a carbon budget

Carbon is emitted as a consequence of our direct actions such as heating our homes, using appliances, and driving cars. Yet, despite the regularity with which our actions generate emissions, under PCA the carbon transactions (where we surrender credits for these emissions) would be relatively minimal and made up of only three main transaction types: filling up a car with petrol, payment of utility bills (gas and electricity), and purchasing air tickets. It would therefore be quite feasible to channel information about an individual's carbon budget through these relatively few transactions. However, within these transactions, there are behaviours and activities which occur day by day, or even minute by minute which will affect our carbon

budgets, and ultimately dictate the carbon units we are charged for. Behaviours include whether we choose to drive or walk, if we wash clothes at 30°C or 40°C, if we turn down the thermostat, or if we drive in the most efficient gear. Aside from emissions linked to individuals' own behaviours, there are also emissions derived from contextual factors over which the individual has little direct control. For example, individuals have only negligible control over the availability of public transportation, the proximity of local shops or the energy efficiency of their rented home.

Many of the individual behaviours, such as whether to dry laundry outside or in the machine, are miniscule in the carbon they emit, but when grouped into a single transaction such as a monthly or quarterly electricity bill they become a more noticeable part of the carbon budget. To illustrate, deciding to wash all clothes at 30°C rather than 40°C (based on 2 loads of washing per week, an average A rated machine and 3000 carbon credits per year) will save almost 1kg of CO2 per month and more than 4% of a monthly carbon budget. Importantly for budgeting, both these daily behaviours (choosing which temperature to use for washing clothes) and the more carbon intensive decisions (whether to take a flight for your next holiday) need targeting.

Mental accounting gives insights into how individuals might deal with budgeting every day actions and larger one off transactions (such as holiday travel bookings, simultaneously (Thaler, 1999 ; Yamamoto, et al., 2008). A study on decision making in electrical appliance use in the home has shown that individuals tend to group together electricity consumption in terms of monthly bills rather than itemised activities (Yamamoto et al, 2008). Thaler (1998) suggests that this is because the budgeting of small amounts does not need to go under the usual scrutiny and assignment into a mental account, but can be accumulated into a larger fund. This is similar to the way that very small company transactions, e.g. a pint of milk, does not withstand the usual accounting scrutiny that larger transactions require, but rather get accumulated and assigned to a petty cash fund.

Some of the easiest and zero cost changes to individual energy-use will come from simple behavioural changes such as turning down the thermostat, leaving lights off in vacant rooms and washing clothes using eco-settings. These are the same daily behaviours which when considered in isolation generate minimal emissions, but when grouped into a monthly or quarterly utility bill become a more significant proportion of the total carbon emitted. While we are not suggesting that individuals try to account and budget for every decision made in the home, it is worth making consumers aware of the potential these daily behaviours have in the context of their overall carbon budget. This has implications for how we apply carbon usage labels to appliances in terms of which benchmarks should be displayed to give the most informative messages; and how we inform consumers about their actual consumption. How we could apply carbon labels will be covered in detail in section 2.3.2.

To budget carbon effectively we need to recognise that while many small actions will be paid for in a single carbon transaction through energy bills or at the petrol pump, the everyday choices and behaviours we make will affect the cost of this transaction. Feedback is needed at the point decisions are made, and again at the point the transaction is paid to reinforce this matter to consumers and enable them to prioritise their future carbon emissions.

Summary

- PCA may be framed as a budgeting process to give individuals ownership and control over their emissions and because it is a familiar process.
- Both changes to small daily behaviours as well as larger more significant ones will have an impact on overall carbon emissions. Knowing the energy use associated with our choices will help consumers make rational decisions as to which can be targeted for making carbon reductions.
- Budgeting skills can help individuals prioritise their behaviours.

2.3 Prerequisites for budgeting

2.3.1 Setting carbon limits

As a rule of thumb, people are more likely to be wasteful of things in abundant supply and resourceful with those in limited supply (Thaler, 1999). Providing limits to consumption through a PCA scheme will, it is hoped, steer people towards treating carbon-emitting energy as a resource which needs to be consumed with caution. Budgeting is an important tool for tracking and forecasting expenditure when resources such as money or carbon-credits are in finite supply and setting budgetary limits is a means of providing a benchmark for consumption. Without limits, there is no reference to signal the need to end consumption and this can lead to dangerous consequences. Recent over-lending to sub-prime mortgage customers and the consequent disastrous implications for international money markets is one example of the risks posed by inadequate limits, in this case applied to borrowing. Tighter regulations by national governments have been called for to prevent money being so freely available without safeguarding limits in the future. Another example is the increased consumption of water in places where it is a scarce resource. In these circumstances excessive consumption can lead to severe shortages of water and become a real threat to supply, especially in times of droughts. Mechanisms to restrict water consumption, such as pricing, water-use feedback and water rationing (e.g. in Pennsylvania, Australia, Israel) are being suggested and introduced in time of severe scarcity as a means of setting limits and reducing demand.

Legitimacy of limits

If limits and budgets are to function as a means of control, they need to be legitimate, accepted by consumers, and the penalties on non-compliance clearly signalled to the consumer. One factor that influences acceptability is the legitimacy of the authority that sets the constraint. The limits of the budget need to be set by a relevant credible authority in order to be viewed as legitimate restrictions on consumption and these should be clearly signalled to consumers. As discussed below, various authorities who rely on different sources of legitimacy provide different limits in regard to diverse resources.

The legitimacy for setting limits and restrictions in the case of water shortage (e.g. water rationing and block tariffs) relies on scientific credibility and political accountability. Scientific credibility ensures that the limit is based on accurate calculations and estimations of how much available water exists and how much is needed by different users. Political accountability means that the public trust and support government decision about the distribution of water between agriculture (which is in most places the largest consumer of water), industry, and residential sectors, and people accept the ration or low allocation to be sufficient for basic needs. In addition, people are more likely to support self restriction if they believe that by limiting their consumption they are improving the water situation or preventing severe water crisis (see for examples Rouse, 2007).

Legitimacy is also vital in the banking sector, a fact that has been reinforced in recent times of banking crises. Banks set credit limits to the amount people can borrow. These limits are agreed in a contract signed between the bank and the account holder. This contract, which is legally binding for both sides, reinforces the legitimacy of the constraint. Banks maintain credibility through stringent criteria for keeping customers accounts in order. Sending monthly balance sheets and providing online access to accounts reassure consumers that the bank is trustworthy in keeping their money and this contributes to the bank's legitimacy. In most cases it is not possible to go significantly overdrawn without prior consent from the bank and with clear communication of the financial penalties for doing so. This does not stop all individuals from getting into debt, but it does act as a signal to many of where the limits are when consuming. In times of recent banking crises, this credibility has been maintained by third party reassurance from the state as a lender of last resort.

For the case of dieting (for weight loss purposes), daily calorific allowances such as the Recommended Daily Allowances (RDA) are set by professional authority and calculated based on current scientific understanding about calorie intake and weight gain/loss. This scientific principle is the basis for both setting and enforcing the dietary limits, since the penalty for non-conformance is that the dieter is unlikely to lose weight. The rewards of weight loss are also known to the dieter if they stick within the limits of the daily food budget over a given period. Consequently, being able to apply self control comes from knowing that these limits are set, based on

science, and that the penalty will be felt by the individual if they do not effectively budget. The fact that the eater is directly affected by their own behaviour reduces the importance of the legitimacy and accountability of the authority that provides the guidelines. Yet for people to actually lose weight in a sustainable way, accurate and credible information about the calorific content of their food and the amount they should eat given by a credible authority is important.

For prepayment meter energy customers the consumption limits are not set for individuals by a wider authority but are instead bound by the amount of money put into the meter by the individual. In this case there are no fixed limits to aid budgeting (energy will always be available if there is money to charge the meter), but the implications of not budgeting when there is limited money available to charge the meter will lead to the gas/electricity being cut off. The constraint on supply is therefore still felt and there are stringent penalties when the limits set for the meter are exceeded - energy is not available unless the meter has been pre-charged[4]. The example of prepaid energy shows that self-setting limits which are legitimate (as they are set by the individuals under the confines of their income) and enforceable do help to facilitate self control and may well benefit from budgeting. Two studies into the attitudes of prepayment customers show that not only are these customers more aware of their energy use than those billed monthly, but most were satisfied with their prepayment meter, despite both the risk of disconnection and the premium tariff charged for these meters (Electricity Association, 2001; Ipsos Mori, 2007). One of the main reasons given for the preference towards this payment type in both these studies is in the control it gives consumers to keep out of debt compared to the risk and ignorance associated with quarterly or even less frequent billing.

Limits in the context of PCA

We turn to look now at limits, legitimacy and acceptability within the context of PCA. The national carbon cap needs to be aligned with the UK emission targets: 80% reductions by 2050. It is most likely that the value of the personal carbon allowance – or the budgetary limits - would be set as a proportion of the national cap on individuals' direct emissions, as dictated by the size of the population. The cap on individuals would be determined by circumstances, such as birth and death rates, and by decisions which include defining the eligible population, whether children are entitled to all or part of an allowance, and whether special groups should be credited with an additional allowance or compensation. Informing and consulting the public about these considerations would be important for increasing public support (Jagers and Hammar 2009). Such decisions may impact the acceptability of PCA if they are perceived as unfair, harming vulnerable groups, or unnecessarily reducing the value of the allowance for the masses (Roberts and Thumim, 2006).

[4] A small emergency credit of is usually available to prepayment consumers after which point disconnection occurs. The deficit will then need crediting back to the meter before energy is made available. The overdraft is therefore used as a warning that disconnection is imminent.

PCA would most probably not be publicly acceptable if people feel that their carbon budget does not allow them to meet what they perceive to be their basic energy needs without buying extra carbon credits on the market; that they are unable to make the changes needed to stay within the limit; that the government who set the constraint does not provide enough help, assistance, and low carbon alternatives to help them stay within the carbon limit; and that under the constraint their situation is worse-off compared to people in other countries.

No doubt, trustworthiness and the political credibility of the government, would also affect the acceptability of such a radical policy (Hammar and Jagers, 2006) as well as the willingness of people to change their behaviour in order to comply with it (Parag and Roberts, 2009). For example, people might be less reluctant to invest in low carbon technologies to reduce their energy demand and comply with the policy if they anticipated that the following government would disregard and change the policy. Other factors affecting acceptability include scientific uncertainty, the intangibility of carbon emissions, the belief that other energy users (e.g. industry) cause the problem and the feeling that constraining personal consumption will not help solve the problem (Lorenzoni et al, 2009). Unlike the limits discussed above, carbon emissions are intangible and therefore determining acceptable levels for emissions needs to be done by a highly trusted scientific community. Whereas it is fairly easy to understand that if water demand is greater than water supply there will not be enough water; that if income is smaller than expenses debt will increase; that if the amount of energy consumed is greater than the amount charged to the prepaid meter then energy will be disconnected; and that if calorie consumption is greater than calories burnt then weight will be gained; it is not so straightforward with carbon emissions. The uncertainty of climate change predictions and disagreements between climate scientists may raise doubts regarding the necessity of such a radical instrument that restrict personal choice. The fact that people cannot see or feel their emissions and that the effects of their restricted behaviour would not be felt for many years means that they need to rely heavily on information given by a third party. The trustworthiness and legitimacy of this third party is crucial and scientific uncertainty is an obstacle for this. People need to know that living with this constraint is likely to deliver a positive outcome for future climate change. They need some feedback to show them not only that it is possible to stay within the budget but also that this constraint actually helps to solve the problem or encourages other states to follow. The scientific community need to provide the necessary evidence to reinforce the legitimacy of the government's limits but this will depend on whether the public perceive there to be a scientific consensus in the first place. The importance of legitimacy when setting limits is summarised in table 1 for each of the examples given.

Table 1: The characteristics of the budgetary limits applied to stated examples

Budget	Constraint / limit	Who applies the limits / constraint	Type of legitimacy	Who benefits from the limit	When the effect would be felt
Money in bank accounts	Borrowing (credit)	Bank	Legal (contract)	Self	Immediate / short term
Calories (Daily Recommended Allowance , RDA)	Food consumption	Self	Scientific	Self	Immediate / short term
Energy use (prepayment meter)	Energy consumption	Self	Legal (contract)	Self	Immediate / short term
Water	Water consumption	State	Legal, scientific, political, public support	State	Medium / long term
PCA	Carbon emissions	State	Legal, scientific, political, public support	State/world	Long term

Summary

- Limits are likely to be important for controlling individual emissions throughout the budgeting period.
- Limits will need to be set in advance and made known to PCA account holders so that they can plan for future budgeting.
- Limits need to be set by a trusted authority and be transparent in how they are calculated in order to help public acceptability, and enable forward planning by consumers. They also need to be set at an appropriate level and with the appropriate aids to make it possible to live within the limits.
- The public should be convinced that scientific rationale for emissions reduction is sound and for the collective benefit.

2.3.2 Budgeting: knowing your income and expenditure

Effective budgeting even at a very simplistic level relies on knowing the value of funds within the budget as well the ongoing income and expenditure from within it. This applies to a proposed carbon budget and is core to helping individuals effectively manage and live within its limits. However, one obstacle for carbon budgeting is the intangibility of both energy and energy related carbon emissions. While it is relatively easy to understand and account for energy services e.g. light, warmth, speed, it is rather complex to account for the energy units such as the kWh behind them. People may enjoy a warm, bright room but rarely know how much gas is needed to achieve this temperature and how much electricity is needed to supply this level of lighting. The translation from energy to carbon emissions is even more complex and indirect because it depends on the carbon intensity of the energy source. A given level of warmth at the constant level of home energy efficiency, would emit a certain amount (kg) of carbon if the energy source was gas, this would double if the energy source was coal based electricity, and would be nothing if the source was solar photovoltaic (PV).

Many people are currently unaware of their personal carbon emissions and might not have a feel for whether they are a high or low emitter, or to what degree. Regardless of the limits on emissions which have been set by the chosen authority, individuals need to know where they fit on the scale in order to assess their options for living within them. The same can be applied to dieters on weight-loss programmes. In weight-watchers, for example, all new dieters are assessed, weighed and set a personal target for reduction, based on their gender, height, and present weight – i.e. they know their income and expenditure (how much they are required to consume each day in order to lose weight) and overall balance (their weight) each time they attend a meeting. Diets also allow for individual's differing needs regarding their food intake and exercise programme and can therefore be tailored to the individual's preferences without restricting all freedom over choice. One challenge for PCA policy designers will be to improve individual's capacity to 'tailor' their own carbon reduction diet. This could be achieved by improving both carbon literacy and the knowledge held by individuals about their direct carbon footprint. Consumers will need to be introduced to carbon over time if they are to be able to relate to carbon as a new currency. To aid this, carbon will need to be more visible to consumers, for example appearing on transaction receipts for petrol, electricity bills, flight tickets etc as well as through feedback within the home – smart metering, labelling and websites. Increasing visibility offers the potential to move individuals towards a more carbon literate society.

Improving carbon capability / literacy

A number of aids exist to help improve carbon literacy including online tools, labelling, feedback and social initiatives. The *Transition Town*[5]*s* movement, and *Carbon Reduction Action Groups*[6] (CRAGs), are two such examples of community-based groups of carbon conscious citizens who seek to reduce their carbon footprint and in doing so have the potential to raise the carbon capability of those involved. A recent study by Howell (2008) looked at the impact of membership in local CRAGs on carbon reduction, and found that many participants reported improvements in their carbon literacy from monitoring their carbon due to their involvement in the CRAG. Most interviewees said they gained a greater understanding of how much they emit and which activities the emissions come from. Yet, it should be kept in mind that CRAG members are not representative of the general population but are a highly motivated and generally well-educated sample.

There are also a growing number of online tools which raise public visibility and literacy around carbon, for example the UK Government's *Act on CO2 calculator*[7], which is used to estimate an individual's carbon footprint; *imeasure*[8], Oxford University's household gas and electricity monitoring tool; and *Carbon DAQ*[9], the Royal Society of Arts' (RSA) simulation of a personal carbon account. Such tools offer individuals some insights into their estimated or actual carbon emissions from varying parts of their lives (household activities, personal travel or flights) in order to heighten awareness and understanding of where emissions come from. A review of thirty of these internet-based carbon calculators (Bottrill, 2007) concluded that all calculators in the sample fell short in a number of aspects: carbon accuracy, ongoing monitoring, personalised feedback and social networking opportunities for sharing experiences online.

Imeasure was one of the few 'next-generation' online tools at the time of Bottrill's (2007) review to take actual meter readings, and provide weekly personalised information on carbon emissions from an individual's home. This particular tool also allows for comparison between similar households, and takes into account the fabric of the house, heating type, and various other meta-data about the dwelling and occupants. However, despite the benefit of real data, even imeasure fails to feedback to the individual where specific emissions in the home come from. Currently there is no commercially available feedback tool which provides information on how much emissions come from appliances over which the individual has no control (fridge, freezer); how much comes from appliances which the user does apply control (washing machine temperature, heating controls, lighting); which appliances account for most emissions; and which are negligible. It is this level of

[5] See: http://www.transitiontowns.org/
[6] See: http://www.carbonrationing.org/
[7] See: http://actonco2.direct.gov.uk
[8] See: http://www.imeasure.org.uk/
[9] See: http://www.rsacarbonlimited.org/default.aspa

detailed carbon literacy that is likely to be necessary for comprehensive budgeting, even if the chosen response is to carry using some appliances as before.

Direct feedback from a meter or associated display leads to energy savings of between 5-15% (Darby, 2006). Smart displays are one option which can give feedback on actual energy use at a given time from a specific appliance. New technologies are advancing which can disaggregate the specific emissions from each appliance, but few such products are commercially available. Crucially, information needs to be presented to consumers in ways that they can see, absorb and act upon. The challenge remains to identify the timing and location in which such tailored information needs to be displayed in order to affect the next energy consumption decision. Smart meters, carbon labelling and informed billing needs to be utilised in a way that aids the budgeting process at the right time to influence behaviour, and without presenting so much detail that consumers are not able to absorb the underlying messages.

Meaningful information for consumers

Feedback tools and other informative mechanisms need to, and often can, tell consumers more than just how much carbon the average household emits and an average car journey releases. When people receive personalised information, i.e. what they personally consume in their own house and when driving their own car, the subsequent changes towards more energy efficient behaviours are more durable (see for example, Bender, 2006). Garnering specific details such as these relies on significant changes to the way we display and make available carbon information. Few of us, for example, will have any idea of the carbon emissions from daily activities such as leaving appliances on standby rather than switching off at the mains, from cooking a pizza or driving to work. But if we are to make rational tradeoffs between, for example, heating food in the oven or in the microwave, then we need to be aware of the carbon intensity of the two options.

One common tool for informing consumers is via labels. Energy and carbon labelling already exist but, as we will show, in their current form are not sufficient to support carbon budgeting. The EU energy labelling for most white goods, light bulbs and cars (e.g. 92/75/CEE, 94/2/CE, 95/12/CE, 96/89/CE, 2003/66/CE) provides information about the item's energy efficiency, ranging from A to G, where A is the most energy efficient. This sort of energy efficiency rating display, as well as other methods used for energy labelling (e.g. energy stars in Australia), was designed, and is indeed very helpful for comparing appliances' energy efficiency when purchasing new ones. But such labelling is not very useful for carbon budgeting for a number of reasons. Firstly, most labels on white goods, such as the washing machine label presented in figure 2, display information only in energy terms with no conversion to carbon[10]. The energy consumption in this example is given in

[10] Converting energy to carbon is problematic and far from being straightforward because the carbon variation in the grid is significant: a point discussed further later in this section.

kWh/cycle and refers to only one operation option: a 60°C cycle. Despite the problems in calculating accurate carbon values (which are addressed in full later), if people need to budget with carbon, the information should be displayed in carbon terms. Secondly, providing information about only one operation option does not allow people to make informed choices between the various running options. People might not be aware that a significant amount of energy is used in a washing machine cycle is for heating the water and that using a 40°C wash cycle rather than 60°C results in about a third less carbon being emitted. Finally, the current labelling might even be misleading because sometimes efficient but large appliances such as an oversized 'A' rated fridge might emit more carbon than a smaller less efficient one.

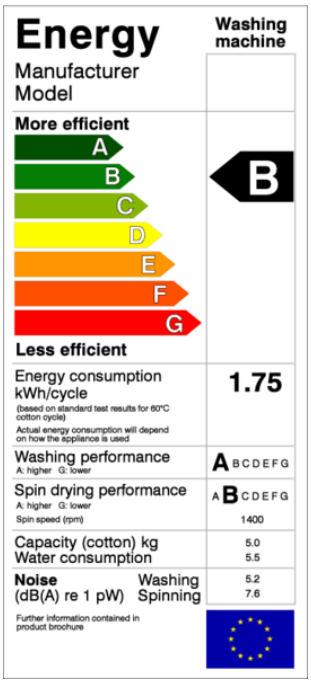

Figure 2: Energy label for washing machine

Even when information about carbon emissions is displayed on a label, such as in the example of EU suggestion for Fuel Economy labelling for cars (see figure 3) it is not necessarily helpful for carbon budgeting. The fact that a car emits 121-150g of CO2 per kilometre is given out of context of carbon emissions and therefore not very meaningful for most people (although it allows for comparison between cars). As demonstrated in the 'Miles per Gallon Illusion' study (Larrick and Soll, 2008), sometimes a simple and inexpensive action such as changing a scale or a benchmark helps people make better energy saving choices. A change in the traditional way information about car efficiency is displayed from miles per gallon to gallons per mile resulted in more informed and energy efficient car choices[11]. Similarly, if 121-150g

[11] The research in the *Science* article showed that many people underestimate the value of removing the most inefficient cars from the market because they falsely assume that *miles per gallon* (MPG) is linearly related to gas savings across all vehicles, when in fact the gas consumption savings are much greater when an inefficient vehicle's MPG is improved compared to a more efficient one. .The authors argue that

of CO2 per kilometre is presented with reference to average daily personal emissions, roughly 13.5kg/day it becomes more meaningful to consumers. In order to prevent confusion, policy designers would need to decide if the budgeting currency is carbon or CO2 and carbon labelling should stick to the chosen units (Bowman et al, 2009). Since CO2 is 3.67 times heavier than carbon, presenting information per activity in carbon weight (e.g. kg of carbon emitted per driven mile) will result in a smaller number than presenting the same information in kg of CO2 and may impact the way it is perceived.

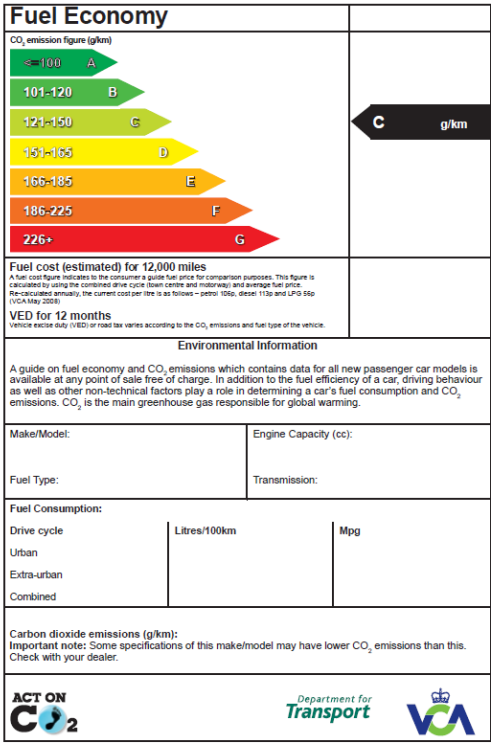

Figure 3: A suggested energy label for fuel economy

Labels are also used to reinforce the items' energy efficiency by relating them to the subsequent financial gains. In some cases they simply translate the energy figures into their monetary value. In figure 4 the yearly operating cost of running a refrigerator is given in terms of US$. The conversion to money helps people translate the unfamiliar energy units into something they understand and can therefore take into consideration in their purchasing decisions. Under a PCA instrument carbon units will serve as a new budgeting currency which could be exchanged for money. Emission reductions could therefore be translated to both carbon currency and monetary savings. Further studies would be required to find which currency type

removing the most inefficient vehicles is where policy and popular opinion should be focused and that representing fuel efficiency in terms of amount of gas consumed for a given distance -which is the common representation outside of the United States (e.g., litres per 100km) - would make the benefits of greater fuel efficiency more transparent

would encourage people to save more energy and may affect the specifics of how labelling should develop. Oxera (2006) found that estimated future savings from efficiency do not play a huge factor when people make purchasing decision on new appliances. It might therefore be the case that under a PCA instrument (and living with a carbon budget) displaying running costs and future savings in terms of carbon units will have a greater impact on decision making and result in further emissions reduction. One problem in presenting information in terms of money is that the running costs/future saving are a direct function of fluctuating energy costs. It might therefore be more straightforward and meaningful (where possible) to present information in carbon units.

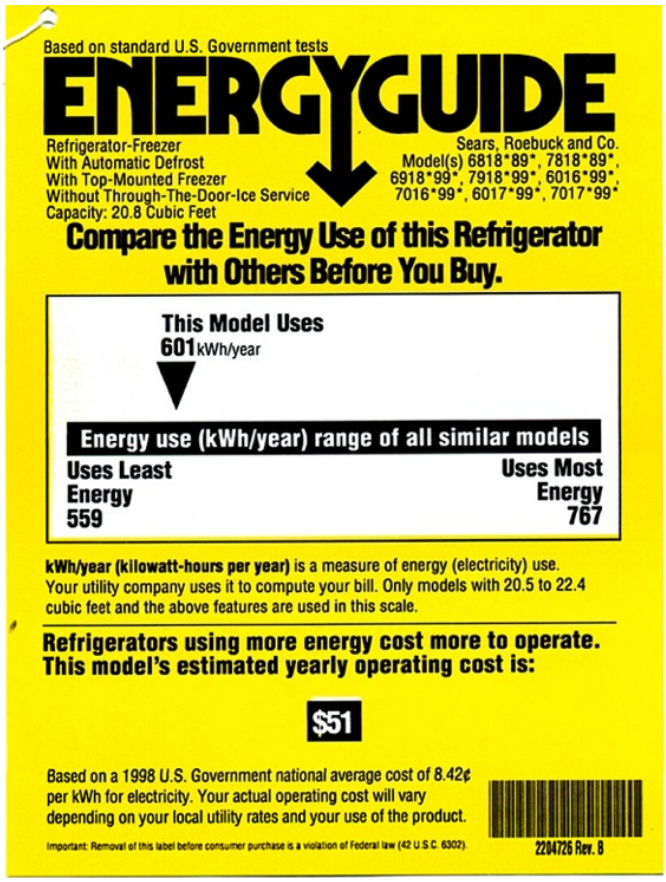

Figure 4: Energy guide for refrigerators

For information to be utilized by consumers it needs to be displayed in a way that enables people to process the information, apply it to their daily activities, and supports well informed decision/behaviour. As carbon budgeting has some similarities with caloric budgeting for people who watch their weight, a few relevant lessons for carbon budgeting about effective, timely and meaningful labelling could be drawn from the experience gained with food labelling.

The food industry has introduced, in addition to the detailed list of ingredients and values, simplified labels to help consumers make choices between the competing health impacts of food. Food labelling is built on the premise that many people find it hard to make healthy purchasing decisions based on too much and sometimes contradictory information (e.g. an item which is high in sugar but low in fat). Labels aim to simplify the information to consumers and aid them to make more informed choices in order to eat healthy diets and watch their weight. Surveys and studies have shown that the majority of the public do look at food labelling (MORI, 2005) and that food labelling is important when making decisions about which food to buy and eat (Heller, 2006; Thomas, 2007). The Recommended Daily Allowance (RDA) is one metric used by the food industry to suggest daily recommended caloric budget guidelines for individual food categories.

Carbon budgeting, like caloric budgeting requires making fairly frequent decisions and choices that could benefit from timely, clear, and 'digestible' information. The challenge for carbon labelling is to identify the situations where information about carbon emissions is relevant for decision making and think of a way to provide the information at the appropriate time. Although information about emissions could be found on the internet, this is likely to require more effort than most people are willing to make. The internet is unlikely to be an adequate substitute for feedback via a direct display (Darby, 2006). As discussed above, decisions such as using the dishwasher or using a tumble drier have an impact on our personal carbon emissions but currently this impact cannot be easily quantified by users. A label put on the appliance itself or nearby with some sort of information related to the activity - even if it relies on average figures or depends on approximations for fluctuating values such as carbon intensity - could help support informed decision-making and carbon budgeting. Smart metering and smart displays may enable the provision of better tailored and accurate information directly to the consumer but in their absence, some sort of detailed labelling could also offer this information, in a similar way to how food labelling informs those who budget their calorie intake.

Meaningful information and carbon budgeting

Studies have shown that providing benchmarks for comparisons (Mackison, et al., 2008) and adding non-numerical interpretational aids (Cowburn and Stockley, 2005) lead to better informed choices when it comes to food and diets. People find it easier to budget calories when they are given not only per 100g of product but also per serving size (Lando, 2007). It is easier, for example, to count calories when the label provides information about calories per teaspoon of honey and not only per 100g of honey. Likewise, a slice of pizza makes more sense to people than 100g of pizza, given that you know how many slices there are per pizza. It is also easier for people to budget their calories if they have some sort of benchmark, such as the contribution of the food item in reference to the RDA. Decisions are better informed if one knows that a slice of pizza provides 30% of a recommended daily calorie intake.

The parallel in carbon labelling is to provide information about emissions per meaningful unit of activity and also give the fraction of the specific activity relative to the periodical carbon budget. A key challenge is identifying the meaningful unit of activity and the most appropriate benchmark for supporting carbon budgeting. Obviously there is a need to differentiate between appliances which are 'always on', such as fridges and freezers, and appliances which are 'switched on' by consumers, such as dishwashers and central heating. In the first case there is nearly no user influence and emissions are relatively constant, while in the second case emissions are controlled by users' behaviour and choices. To evaluate the impact of these decisions on the carbon budget and use it in the budgeting process people need assistance in the form of relevant and timely information. Referring back to figure 2, appropriate information provided to users would be the carbon units emitted for each washing cycle option, and not only to 60°C. Some information is meaningful when it is given per unit of time, such as one hour with the TV switched on, half an hour using an electric cooker at 180°C, or as presented in figure 3, in units of distance.

Identifying a meaningful benchmark for carbon budgeting is a complex task as shown in the summary given in table 2. Under PCA carbon credits are allocated periodically, possibly yearly. Presenting information about a meaningful unit of activity with reference to one year's credits might not be very useful for budgeting as it is most probably only a small fraction of one percent (it is similar to budgeting daily calorie intake with reference to a recommended monthly allowance). Consequently, individuals might get confused or disempowered by the insignificant contribution of each activity compared to their yearly budget. Using a smaller benchmark of an average week, month, or quarter might be more meaningful, depending on the activity type. Alternatively, making the units of the currency smaller (e.g. instead of 1 kg of carbon emissions = 1 carbon unit, 1000 grams = 1000 carbon units). This might be confusing as it requires calculation with big numbers, which some might find difficult, but could be tested with further research. For 'always on' appliances the benchmark period does not matter, as the fraction remains the same. For other appliances, however it does. If one knows that the 'eco' programme cycle on their dishwasher emits X units of carbon and this represents Y% of their average week's credits, their budgeting choices are better informed. While this sort of information will never be completely accurate for reasons outlined below, it can still be used as a helpful guideline figure.

The carbon label suggested for a washing machine in figure 5 presents some of the above mentioned features and considerations which are likely to be useful for carbon budgeting. These include a meaningful unit of consumption with multiple operating options; reference to the weekly (highlighted in grey) and annual budgets; reference to the future budgetary limits; simple non-numerical facts that may help consumers who are confused by the numbers to interpret key information and utilise it in their budgeting and decision making processes. However, this label also demonstrates the challenges carbon labels designers would need to overcome. For example, the percentages might be too small to make people care; using small decimal points with many zeros might be confusing; the 60% scenario might be too distant to influence

current decision making; the label might also display too much information and mask the key messages. There is scope for research to be carried out into the impact of various labelling options and to assess people's ability to absorb the meaningful messages.

Figure 5: Carbon labelling for carbon budgeting

Carbon label for a washing machine
Energy rating: A

kWh per cycle type	Carbon units (kg/g)	% of weekly allowance (under a 20% emissions reduction cap ~3074 units / yr)	% of yearly allowance under a 20% emissions reduction cap ~3074 units / yr	% of weekly 60% allowance under a 60% emissions reduction cap ~2000 units / yr)	% of yearly 60% allowance under a 60% emissions reduction cap ~2000 units / yr
40°C cycle (0.6kWh / load)	0.31/310	0.53%	0.01%	0.82%	0.016
60°C cycle (1kWh / load)	0.52/520	0.88%	0.017%	1.35%	0.026
90°C cycle (1.3kWh / load)	0.68/680	1.15%	0.022%	1.77%	0.034

A significant amount of energy is used in heating the water.
Using a 40°C wash cycle rather than 60°C means you emit about a third less carbon.
A family of 4 washes approximately 4-5 loads per week.

Unlike food budgeting, in which a given food item provides the same calories in all circumstances, emissions are more complex. A kWh is a constant unit whatever the energy source, but carbon emissions vary according to the composition of the energy source. Specific appliances connected to a grid fed by renewable energy emit significantly less carbon than the same appliance connected to a grid fed by gas or coal. What's more, grid carbon intensity varies between countries, within countries, and sometime within the same day (Boardman and Palmer, 2007). This problem could be addressed using a table close to the appliance which shows the variation in carbon emissions according to the different grids or energy companies. Using labels in this way may also put pressure on suppliers to increase their efforts to decarbonise their electricity in order to improve their ranking against other suppliers (Boardman and Palmer, 2007).

It is well understood that different people need different aids to help them achieve their goals, be it dieting or carbon demand reduction. While some can deal with detailed budgeting, others will require a much simpler means of achieving the desired reductions. One attempt to simplify the calorific budgeting process is presenting the information on a new uniform scale. The Weightwatchers programme[12] simplifies messages regarding the health impact of foods using a single points matrix which becomes the meaningful unit of measurement for the dieters. Food/meals are assigned a corresponding point value which counts towards the dieter's daily point's allowance. All foods, regardless of types (carbohydrates, sugars, fats, proteins) are valued under the same metric for ease of calculation, and to help dieters monitor their daily food allowance regardless of what they choose to eat.

The simplicity of budgeting with points does not make the weightwatchers programme more effective than other diets in reducing weight, indeed little evidence exists to suggest the relative success of this programme compared to others (Heska, et al., 2003). However, its simplicity as well as other components such as the group support, online tools and frequent meetings, were shown to be effective aids in losing weight and maintain it loss over time (Lutero, 2004). Another commercial diet, Slim Fast, is chosen by some because it restricts choice to a number of products which are already measured into appropriate portions to deliver weight loss. Some individuals prefer the certainty and ease of having these decisions made for them. While it is not reasonable or desirable to restrict individuals' energy choices in this way, it is important to recognise that some people will want easy solutions to indicate how they can live within a carbon budget without the need to consciously budget. Some will find budgeting with actual emissions too complicated and confusing. It might therefore be useful to find simple ways of introducing a comparable points system for carbon which could apply to both travel and household emissions. The MPG illusion study referred to earlier demonstrates that sometimes a simple and costless act helps people make a better energy saving choices. Table 2 summarises the implications and options for carbon labelling that have been raised in this chapter.

[12] See: www.weightwatchers.co.uk

Table 2: Issues relating to meaningful information and carbon labels

Important issues for carbon budgeting	Implication for carbon labelling	Options (partial list)
Displaying information in terms of a meaningful activity	What is a meaningful unit of activity?	Consumption per cycle of washing machine at 40 / 60 / 90°C; One hour of heating at 20°C; 5 minutes of microwave operation
Defining a meaningful benchmark for comparison	What is a meaningful benchmark?	Choosing between weekly / monthly / yearly allowance benchmark; Including reference to future reductions in the allowances
Ensuring individuals are given actual carbon emissions	How to deal with variation in grid's carbon content?	Referring to the average carbon content of grid; Detailed information about impact of different energy source (by energy provider) on carbon emissions
Information displayed nearby the appliance	What is nearby? What sort of display?	A list displayed in the kitchen; Electronic smart display
Expressing the benefits in clear and most influential form	Should the emphasis be on energy, Carbon or CO2?	Emphasis on (1) money saved due to energy saving; (2) monetary value of carbon units saved (3) wider environmental impact
Giving timely information	How to make consumers aware just before they make their next decision	Label close to the appliance so that feedback is before the action.

Summary

- Carbon literacy needs to be improved so that individuals know their actual carbon footprints and the corresponding income and expenditure from their budget. This has implications for how we use labelling, give feedback on usage, display the carbon account and transaction information.
- Information presented to consumers needs to be meaningful, in consistent units, personal to the activity undertaken, and crucially timed in order to affect the behaviour before it happens.

2.3.3 Low carbon alternatives

Placing obligation on individuals to reduce personal carbon emissions without providing additional low carbon (LC) alternatives for goods and services is unlikely to deliver actual reductions in emissions. Without LC alternatives the introduction of a new carbon currency to budget with, would be somewhat pointless. Thus, the next requirement proposed for effective budgeting is the availability of LC alternatives from which to choose, tied with encouragement towards the best energy conserving choices and taking into account other costs which are associated[13]. Having LC alternatives for goods and services is important for many reasons, which include: promoting market transformation; boosting low carbon innovations; gaining public support for emissions reduction policies; and changing social norms.

Market transformation and energy efficiency

LC alternatives are good for increasing competition over better efficiency. For many goods, there is a legal requirement for EU sellers of white goods to display a specific label which states the efficiency level of items and enables an easy comparison for consumers. As a minimum, this at least raises the awareness of energy efficiency issues, and at best could result in choices made upon this piece of information. In reality, as demonstrated by Oxera (2006), energy efficiency is not the most important consideration by consumers when choosing new appliances. Yet, Oxera also found that people are inclined to prefer an 'A' energy rated appliances over a 'B' rated one. This is not because energy efficiency is priority for consumers but rather because they perceive the rating as some sort of quality assurance: interpreting A as better than B.

The combination of the obligation to display the energy label, the consumers' perception of efficient items as better in quality than inefficient ones, and the competition between firms for consumers; encourages firms to offer more and better LC alternatives in the market. This in turn boosts the market transformation process by promoting a faster elimination of energy-inefficient appliances from the market. It is reasonable to assume that under a PCA scheme, when people need to budget their emissions, the efficiency rating might become a more dominant consideration in the decision over the purchase of goods and services. This would probably lead to further increases in low carbon innovations and significant market transformation towards LC alternatives – as has been experienced for white goods since the introduction of the EU energy label (ANEC, 2007).

Having LC alternatives is also important for gaining both public support for the imposed budget and public engagement with the budgeting process. As mentioned

[13] Other costs are for example: money - efficient goods may not always be the cheapest to buy; time – getting from A to B using public transport might take longer than by car; convenience – using a tumble drier for some is easier than using the washing line; or comfort – reducing a your indoor temperature might require you wearing extra layer of clothing.

earlier, public support tends to be greater for policies which do not restrict choice (Steg, 2008). Over time, without LC alternatives the only way people could live within their shrinking carbon budget is by doing less than they are doing now. Doing less could be perceived as choice restriction which, as argued, may raise antagonism to the policy. However, PCA may not seem as restricting on choices if LC alternatives are available since individuals can still benefit the same utility with the LC alternatives that they gained with the more carbon intensive option.

The underlying assumption of the above emphasis on energy efficiency and market transformation is that improved efficiency will be translated to emission reductions. This assumption is somewhat problematic as it ignores the rebound effect, which stresses that a significant amount of the efficiency gains are being lost to the overall increase in consumption[14]. For example, car fuel efficiency has improved significantly during the last decade, but overall emissions from the transport sector have been rising over the same period. The reason for this is that these more fuel efficient cars are driven longer distances and on more congested (slower) roads.

Theoretically a PCA instrument should limit the impact of the rebound effect by moving the focus from energy to carbon. Moving the emphasis towards carbon and the need to budget carbon would ultimately encourage people to consider efficiency (in relative terms) as a means of conservation (in absolute terms), which is the objective. For some initially and many over time, it would be unlikely that energy efficiency alone would be sufficient to keep within the limits of a carbon budget. Therefore, it is useful to think about low carbon as more than efficiency gains and to concentrate additionally on social innovations, social norms and changing habits.

Social innovations and norms

'Social' alternatives (i.e. alternatives that are not related to the appliance but to the way it is used, managed, or not used) challenge the conventional wisdom, which government and industry seem to take for granted: that people wish to maintain their current level of utility from ownership and energy such that any 'reduction' in these utilities would be seen as worsening quality of life. Instead, social alternatives highlight the new gains and utilities encapsulated in social innovations. Car clubs, such as Streetcar[15] in London, Oxford and elsewhere, are one example where cars are shared between people in the same geographical area (street, neighbourhood). Members can book a car from 30 minutes upwards and pay as they go, with all insurance, 30 mile free petrol allocation, and maintenance being handled for them centrally. Sharing a car might not be as easy as using your own car, but it saves a lot of other related costs, such as the hassle, time and money related to parking permits, road tax, MOT, insurance, and vehicle depreciation. If the procedures for

[14] More on the rebound effect see Sorrel, S. (2007) *The Rebound Effect: an assessment of the evidence for economy-wide energy savings from improved energy efficiency*. A report produced by the Sussex Energy Group for the Technology and Policy Assessment function of UKERC. Available at: www.ukerc.ac.uk/Downloads/PDF/07/0710ReboundEffect/0710ReboundEffectReport.pdf

[15] See: www.streetcar.co.uk

sharing cars are simple and the cars are available and adequate this new arrangement could become desirable and possibly even more attractive and affordable than owning a car for many. The environmental gains are significant as well with data gathered from car clubs suggesting that those who join and surrender their own cars decrease their mileage by up to a third (Ledbury, 2007). PCA might add another advantage to the existing ones: it would be easier to stay within a carbon budget and yet individuals could still enjoy the utility of a private car. Other social innovations include workplace and school travel planning, journey sharing with priority parking at destination and the added privilege of being able to drive in segregated lanes in congested areas; or the Paris bike rental scheme for low-carbon, easy access around the city centre (for more examples see Cairns et al, 2004).

The acceptability of, and public support for, new social arrangements such as car sharing, could be determined by social norms, i.e. if these arrangements are perceived as acceptable by different communities. Schultz et al. (2007) showed that people do consider social norms when making energy decisions. In their study they demonstrated that normative messages about personal energy consumption, when given with reference to others' consumption and to average consumption, helped in changing consumer behaviour and resulted in energy conservation.

Social innovations and arrangements could be introduced and facilitated in many ways: personal arrangement between friends such as competition over increased home efficiency; community organized alternatives, such as promoting community heating or street by street low carbon installations; work place arrangements, such as car sharing; and governmental acts such as subsidising public transport. Some high profile campaigns have been used to prompt pioneering responses, such as NESTA's "Big Green Challenge" which has pledged a £1 million prize fund to empower communities to come up with novel methods to achieve large cuts in their carbon emissions. The funding will be awarded to the winning project in 2009, with 10 finalists all receiving £20,000 to trial and promote their approaches for one year. By attaching 'carbon emissions saving' tags to the above innovations, under a PCA scheme, the attractiveness of these low carbon arrangements would most probably rise.

As mentioned in the PCA mechanisms figure 1 the 'social route' is important for PCA's success. It is hoped that the personal carbon budget would set an acceptable new social norm for the size of a personal carbon footprint. If the accepted emissions norm is coupled with encouragement of new social innovations and arrangements, such as car sharing, these LC alternatives would likely become popular and acceptable.

Habits and defaults

Habits are a different sort of obstacle to changing behaviour. Many of the alternatives that are available to consumers will go unnoticed because of habitual behaviour or the acceptance of default appliance settings and the routine way in which we use them. Individuals could therefore benefit from being aware of the low

carbon choices that are available, especially those relating to otherwise unnoticed behaviours. Much behaviour exhibited in the home fall into these habitual behaviours because they represent routine tasks, often requiring no conscious thought. Examples include the setting used on dishwashers and washing machines, standby options, pre-set thermostat temperature, and driving short distances. Consequently, default settings have a significant impact on in-use behaviour. Research shows that individuals are very accepting of default setting and often do not bother to change them even when a particular default does not work in their favour (Thaler and Sunstein, 2008). Choice architects – those who guide behaviour by carefully presenting information - can maximise consumers' apathy to change default settings by prompting choices in a given direction. One example is when insurance companies benefit from the automatic renewal of policies which only require action to disconnect. Similarly choice architects could push for default setting which avoid trapping individuals into high energy choices, such as using lower temperatures as the default settings applied to heating thermostats by manufacturers; or making sure public transport directions always appear before directions by road on published documents and websites.

Once introduced, and for some time after, PCA would represent a major contextual change within which decision are taken. This sort of 'window opening' has the potential to interrupt individuals' habitual behaviour and encourage active consideration of choices (Verplanken et al, 2008). Default setting, by individuals or manufacturers, might be noticed for a while and accordingly altered to fit with the new context – the need to budget carbon. It is important that during the time when individuals are more aware of their behaviour and may wish to change their habits, they will be well and accurately informed about the available options and the carbon / budget implication of each choice.

Summary

- Affordable low carbon alternatives (LC alternatives) for goods and services are vital for budgeting because they give individuals options for minimising their emissions.
- LC alternatives will aid budgeting by promoting market transformation; boosting low carbon innovations; gaining public support for emissions reduction policies; and changing social norms.
- Policy designers can help promote LC alternatives by encouraging social innovations such as car clubs, community engagement such as the Big Green Challenge, and choice architecture by manufacturers in favour of low carbon choices.

2.3.4 Opportunity to make choices

A PCA instrument has the potential to boost the demand for low carbon choices through various mechanisms such as increased carbon visibility, stop and think moments when making transactions, emerging low carbon social norms, and price signals (figure 1). For informed low carbon choices to be made, two things should come together: first, the 'carbon' cost should be visible, i.e. the information about the choice's related carbon emissions should be available; and second the low carbon choice should have at least one advantage over the more carbon intensive one in terms of cost, convenience, legitimacy or effort. When the advantages are tangible and clearly conveyed to the consumer there is more chance of individuals making low carbon choices.

Having LC alternatives for goods and services is a crucial part of the budgeting process as discussed above, but alternatives are only going to assist with budgeting if consumers have a real opportunity to make choices between them. There are many examples of situations which inhibit individuals from making energy and emissions saving choices such as: restrictions on budget when purchasing new appliances; lack of information about which is the most efficient appliance; tenants unable, and with no incentive, to make efficiency alterations to the building fabric; rural populations having restricted public transport options for travel and forced to take many journeys by car.

From these examples and others it could be deduced that the opportunities individuals have to make choices are constructed and determined by factors such as income, knowledge, education, internet availability, locality, local support networks, and emerging social norms (see table 3). Some of these determining factors can be foreseen and consequently tackled by schemes developed to make the spread of options more equitable between all individuals. There needs to be emphasis put on targeting those groups that might be unfairly restricted in their opportunities to make choices and novel ways developed to catering for their needs either directly or indirectly.

Prepaid electricity consumers are one example where constraint (usually on their ability to pay) limits them in their opportunity to choose. These customers are usually on low incomes often unable to afford the most efficient products. Hence, despite their relatively good awareness of the need to reduce energy usage (spend money wisely) achieved by feedback from the meter (Ipsos Mori, 2007), their poor purchasing power restricts them from making the often premium priced energy efficient purchases. They may still choose less efficient second hand or lower-priced appliances despite the low carbon alternative proving cheaper to run over its lifetime because at the time of purchase money is restricted. One helpful indirect piece of legislation in view of this has been the introduction of EU white goods, ovens, and light-bulb labelling. The benefits to consumers have been multiple: labelling helps

shift weaker products from the market through the competition element of the market mechanism; labelling also provides direct information on efficiency and energy saving (which is otherwise difficult to obtain), as well as a benchmark for comparison. Such schemes can help benefit consumers and enable them to make better choices. To encourage competition and opportunities for choice, schemes such as white goods labelling are being applied more widely. Energy Performance Certificates for homes, car efficiency labelling, and product carbon labelling are three examples, but there is a scope for more, including: air ticket emissions ratings, services energy rating and all electrical goods labelling.

The landlord-tenant split incentive[16] is yet another recognised example where choice is limited. Tenants are one group whose options are constrained when it comes to improving the efficiency of the household appliances and the fabric of the home they occupy. In this context the split incentive means private landlords are discouraged from making household efficiency improvements as their investment is recouped by the tenants (through lower energy bills) and not by themselves. Meanwhile, tenants that live in inefficient homes bear the costs of higher energy bills but do not have the incentive to invest in improving the fabric of the house, as they are unlikely to reside in the house long enough to recoup the gains from their investment. To encourage landlords to make efficiency investments the UK Government has introduced a tax relief scheme of up to £1500 per property leased in return for investment in projects such as insulation and draught proofing (the Landlords Energy Saving Allowance). This scheme provides the incentive for landlords to make a win-win choice: the landlord improves the value of the property, the tenant pays less on energy, and as a result less carbon is emitted.

New low carbon schemes and incentives

Policy designers will need to come up with schemes and incentives which make energy conservation and efficiency choices attractive, viable and more widely available, as well as tackling the constraints on individuals' freedom to choose. One straight forward example is providing better local facilities and services in addition to a favourable community layout that allows getting to these facilities by means other than cars. Another example is car sharing which provides opportunities for low carbon choices in places where public transport is insufficient. Similarly, widespread, cheap, and easy to rent bike schemes (e.g. Paris), make the choice of moving around by bike attractive to some. These schemes, as discussed in the previous chapter, could be facilitated by local government or through community support.

In many cases it will not just be single policies or schemes in isolation which open-up and promote widespread energy conservation and efficiency options but a whole policy package. One such package has been proposed within the building refurbishment sector in a report which examined the policy interventions needed to

[16] Further details about split incentives available from the following report: International Energy Agency (2007) *Mind the Gap: Quantifying Principal-Agent Problems in Energy Efficiency*. Available at: www.iea.org/Textbase/publications/free_new_Desc.asp?PUBS_ID=1954

achieve deep cuts in CO2 emissions from the existing UK housing stock (Killip, 2008). The report suggests that a whole policy package founded on incentives, information and regulation is needed if the system is to deliver the required cuts. This includes training, voluntary and mandatory standards, VAT rebates, grants, new supply chains, and communicating benefits to customers. Improving training and skills as well as widespread accreditation schemes would enable the industry to offer the necessary low carbon building refurbishments; VAT rebates and grants will help customers to finance the projects; and communication strategies will help generate informed customer demand for low carbon refurbishment. The challenge remains to identify who is best placed to deliver these joined up policies, and who is responsible for making sure as many people as possible have the ability to make low carbon choices in their homes.

In order to maximise novel schemes and incentives towards energy conservation and efficient choices, policy designers will need to spot promising innovation as it is emerging and facilitate its widespread application throughout society. This will include foreseeing and removing possible barriers. For this to happen, a quick response to new innovations will be required so that barriers are not left restricting social creativity. For example car clubs may need designated parking bays in city centres which are exempt from usual parking restrictions or congestion charges in order to locate them in useful positions within the city and to facilitate membership of such schemes.

Another possible barrier to innovation is the flexibility by which individuals can share allowances. Informal car sharing between friends and colleagues, or other activities which spread the emissions between individuals without money exchanging hands, may require individuals to be able to transfer credits from one person to another for-free in order to make schemes such as these easy and appealing. In this case, emissions may not be created by the individual responsible for surrendering carbon units and since money has not transferred between hands, the allowances should be transferable. Such flexibility over allowance transfers should be organised in way which does not undermine the legitimacy and authority over which PCA is administered.

Table 3: Constraints that shape opportunities to choose

Constraining factor	Hindrance caused by the constraint	Ways to make low carbon choices available
Low income	Unable to improve efficiency or invest in low carbon alternatives	Economic incentives (e.g. grants, VAT reduction, rebates); encourage competition in price and product efficiency
Lack of knowledge/ information/education	Not aware of how to reduce emissions	Information scheme, advice centres, schools' curriculum
No access to internet	Restricted in getting information on the alternatives and options	Offline information distribution; improved public internet availability (libraries, post offices, schools)
Limited public transport	Reliance on private car	Improve public transport; car sharing schemes; bike rent schemes; support community layouts that do not make residents car dependent (e.g. better local facilities)
Lack of local networks	Less opportunity to join forces and reduce emissions by sharing transport and services	Community facilitated schemes; online communities
Carbon intensive social norms	Changing behaviour goes against norms in society	Making low carbon choices widely spread
Not the decision maker (e.g. tenants, lodgers, care home)	Unable to make changes even if desired	Economic incentives to land lords / decision makers (grants, rebates); regulation of energy efficiency

Summary

- Individuals will need both the motivation and the option to make low carbon choices.
- Novel schemes and policies will need to be introduced and encouraged to promote low carbon options and innovations. Barriers to such schemes will need to be minimised in order to enable individuals to make low carbon choices.
- A variety of mechanisms can be used to help widen individual's opportunities to make low carbon choices including: economic incentives, new legislation, information campaigns, skills training, targeted schemes such as improving public transport or car sharing, and community led initiatives.

2.3.5 Advice and Support

Implementation of an innovative and radical instrument such as PCA is far from straightforward. This is true for individuals who need to adjust to living within a carbon budget, for the authorities who need to run and govern the scheme, and for the policy designers who need to put in place the right incentives and schemes to introduce PCA, make it enforceable and effective.

PCA is an unfamiliar policy which introduces new constraints on individuals and would most probably raise lots of uncertainty, ambiguity and questions. Hence, support would be needed to facilitate the transition from carbon as an ignored resource to one which is valuable and should be used carefully. Advice and information to allowance holders would be essential to facilitate the introduction and implementation of a PCA scheme. Obviously people would need information about the scheme and its procedures, such as who provides the allowances and when, how to surrender carbon credits, and how to trade in the carbon market. People will also need advice about what can they do in order to reduce emissions from their home and car and remain within the carbon budget.

Formal providers of information, advice and support

'How to' questions regarding PCA's procedures could be answered through information schemes, which accompany the introduction of any new policy, even those not as innovative as PCA. Mass media communication tools such as TV, internet, newspapers, and mailings could be used to introduce the scheme widely and spread the 'how to' information. Call centres could provide additional assistance. Simulation programmes might also be useful to explain PCA's procedures. This sort of information and advice would also most likely be required by energy utilities, petrol stations, or any other institution to whom carbon credits would need to be surrendered. Similarly the people working in institutions that govern and run the PCA

scheme would need access to 'how to' information. Organizations that manage the carbon accounts may run training programmes and simulate different scenarios in order to better understand their role and fulfil it efficiently.

'How to' questions as regard to reducing personal carbon emissions will to some extent already be partly answered by information scheme via the above mentioned channels (e.g. Defra's Act on CO2[17] carbon calculator, the Energy Saving Trust[18] website and campaigns). In addition, under the UK Government's Carbon Emissions Reduction Commitment (CERT) energy utilities are already providing information and advice to people on how to improve their home's energy efficiency and save emissions. Utility companies are in a good position to provide tailored advice about reducing emissions as they know the energy consumption of households. It is reasonable to assume that information on how to reduce personal emissions would be more valuable and sought after once the reduction is tied to budgetary constraints; and when there are various incentives - economic, social and psychological – to remain within the budget, and penalties for exceeding it. Hence, it is likely that the information and advice schemes already in place would be used more often and effectively under a PCA instrument.

In providing advice and support there is scope for the involvement of actors who are closer to individuals – geographically or socially - and are more familiar with local and circumstantial factors which effect energy consumption, such as typical weather conditions, time constraints, or availability of public transport. For example, local councils are familiar with vulnerable groups and individuals in their region and will have better access to those who may need special help in understanding the new scheme and in reducing their energy demand. These populations, who might be missed by the information and advice schemes given via traditional channels, could be targeted by local authorities.

Informal providers of information, advice and support

Local institutions and organisations, such as local councils, communities and neighbourhoods grassroots groups, offer a promising resource for delivering information and advice. Such organizations can recommend certified professionals in the area, for example those who insulate homes, install low carbon technologies, provide good services, and charge good rates. These groups and organisations are often more powerful than individuals in putting pressure on professionals to reduce service charges and therefore can help lowering the costs of staying within the carbon budget. They can also be potentially powerful in pushing local government to improve low carbon services, for example, public transport provision in the area; a new/expanded community heating scheme; or organising and coordinating activities, such as insulation schemes at the neighbourhood level, which benefit individuals by saving both money and time.

[17] See: http://actonco2.direct.gov.uk/index.html
[18] See: http://www.energysavingtrust.org.uk/

Accessibility to, and trustworthiness of, the information source are factors that influence the way people utilise information and advice. People use different sources when seeking information, including documents, other people, and virtual agents. However, they will often choose the information which is most accessible and requires the least effort (Gerstberger and Allen, 1968) and will be more likely to read a document or go to a website when referred by a person they know and trust (Morten, et al., 2002). Hence, social networks and virtual communities offer potential as an important and perceived reliable source of information, support and advice (see for example: Botrill, 2006). Information and opinion when given by members from the same social networks is often perceived as more trustworthy and influential than the same information supplied by a formal authority, and therefore has the potential to be more effective (see for example: Sunstein, 2003). One challenge is to make sure that the information provided by these networks is accurate and not misleading.

In addition virtual communities allow for informal two way communication between people who are geographically apart but sharing same concerns or interests. This makes it easy for people to consult similar people on the one hand, and share their experience on the other hand. Sharing experience would be valuable under a PCA scheme as it enables building foundations and evidence base for the innovative policy.

Being part of a group or community – be it virtual or real - is useful not only for sharing experience but also for receiving social and psychological support and for feeling that you are not the only one who struggles with the challenge. This notion is one of the foundations of the weightwatchers diet programme: although the actions to reduce weight are taken by individuals, many find that dieting with the support of a group is easier. This also applies for emissions reduction. Howell's (2008) study on Carbon Reduction Action Groups (CRAGs), the groups that voluntarily set themselves emissions reduction targets, suggests that the group serves as more than a source of information. CRAGs also provide their members with social support, the opportunity to share difficulties and encouragement, reference to comparison, and the opportunity to take action with people who share similar values and norms. Similarly, recognizing the significance of group support, the Unitarian Universalist congregation in California set it members a goal to collectively lose one million pounds of carbon dioxide emissions by Earth Day 2009. They formed 'Carbon Rings' which are groups comprised of 5 to 8 households. These Carbon Rings meet for eight sessions where they discuss climate change in a structured manner and then go on a 'Low Carbon Diet' - a programme to lose 5000 pounds of carbon per household in 60 days[19]. Seeing children as an important part of the community and taking part in the shared effort, the Carbon Rings programme dedicate special attention to children and provide them with targeted information and activities related to climate change

[19] See: http://uulmca.org/programmes/climate_water/low_carbon_challenge.html

and emissions reduction[20]. The Global Action Plan (GAP) Eco-Teams are yet another example of the potential for collective action. The basic programme is delivered through a limited number of team meetings supported by a coach and using an online workbook. While the internet versions of the workbook reaches far more people, the team meetings produce the biggest individual results. The impact of the group goes beyond reducing its members emissions: According to GAP website[21] "*it has been demonstrated that, given effective leadership, engaging as few as 5–10% of the households in a housing estate in the EcoTeam programme will influence the behaviour of the whole community*".

Financial support

Financial support is another sort of assistance that some will need in order to reduce their emissions. Although there are already incentives in place, such as stamp duty rebates for low carbon homes, VAT reductions on some insulation materials, forthcoming feed-in tariffs for renewable energy, the 'Warm Homes' scheme for poor populations, and landlord allowances to improve rented homes' efficiencies, there is still scope for more. Identifying those who without additional financial help will not be able to reduce their emissions and stay within the budget may be best done at the local level. Thought should be dedicated to who is the best agent to locate these individuals and who is the best agent to provide them the adequate financial support.

A challenge for policy designers is to recognize the different channels that can provide information and support; recognise the vulnerable groups who need more help or different forms of help to that already provided by conventional channels; empower the organizations, institutions, formal/informal groups and communities who provide the information, advice, financial support and social support; and ensure that assistance is targeted at individuals' specific needs. Ultimately these advice and support mechanisms may contribute to people's ability to remain within their carbon budget. Table 4 summarises the channels of information, advice and support available, highlights those who will be best placed to deliver and draws attention to those groups who may need additional assistance.

[20] See: 'what about the kids?' http://uulmca.org/documents/UU_LCC/24_Engaging_Kids.pdf
[21] See: www.globalactionplan.com/node/109

Table 4: Forms of information, advice and support

	Channel	Providers	Vulnerable group
Information	Mass media; training programs; simulations; face to face; educational campaigns	Central and local government; working place; communities	Those without access to internet and other forms of mass media; the illiterate
Financial support	Money via allowances, loans, rebates, discounts	Local and central government; utilities; community groups	People who do not fall under any category of eligibility or unaware of their eligibility; do not know how to apply; cannot pay loans; need further help
Social support	Norms, feeling part of shared effort, tailored information, two way informal communication channel	Community, neighbourhoods, virtual communities, networks	People not belonging to communities (by choice or not); unaware of a relevant community

Summary:

- As with any new policy innovation, introducing PCA will require support and advice mechanisms about the practicalities of living with the scheme and also guidance on how to reduce individual households' emissions. This process should start now, to prepare people for a carbon-constrained world.
- Formal advice to individuals and institutions affected by PCA will be provided through mass media and information campaigns from government down to community level.
- Social support (both informal and organised community activities) will play a vital role in sharing experiences and changing social norms.
- Financial support is one mechanism that can be used to give extra support to targeted individuals within communities.

2.3.6 Carbon Trading

Carbon trading is a prerequisite for carbon budgeting and incentivising individuals to live with a PCA scheme because it gives freedom of choice over emissions and flexibility over budget limits. Under-emitters are also rewarded by trading, as it provides a mechanism for paying them to keep within their carbon budgets. However, in order for trading to function there are basic elements which will need to be addressed, such as making sure individuals understand the benefits and mechanisms relating to trading. Hence, knowing how to trade in the personal carbon market is important for those who wish to take an advantage of the economic benefits of reducing emissions. Obviously, many factors and variables – such as the number of carbon credits in the market, the number of traders, trading procedures, regulation, enforcement issues, and legislative constrains - would influence and shape the structure of the market. Understanding the interface between people and the market place, as well as how people might use the market and what would discourage them to participate in the trading scheme are further factors which deserve thought and further research.

Under a PCA instrument people will need to surrender carbon units when paying energy bills, buying petrol, or booking flights. If they exceed their carbon budget limits and have no units to surrender, they will need to pay the monetary value of the surplus carbon units. This amount will vary according to the fluctuating carbon price set by the market. This sort of trading (buying extra units) would be fairly simple and feel like a carbon tax (Starkey and Anderson, 2005; Roberts and Thumim, 2006). However, other aspects of the trading are less straightforward. For example: what if you run out of units and at the point of sale there are no units to sell? Who would people sell their extra allowances to? Would the carbon market be similar to eBay, where you bid for the best price? Who would run, govern, and regulate the market institutions – government or the private sector? Who would set the price for carbon? Would there be any ceiling for the carbon price? Would it be possible to speculate about the market, for example, with ‘futures’? Many questions related to the design of the carbon market have been raised, and partly considered by PCA scholars (see for examples: Starkey and Anderson, 2005; Roberts and Thumim, 2006; Fleming, 2006 ; RSA, 2006; RSA 2007 ; Starkey, 2007; Fawcett et al, 2007).

One challenge that makes the design of an effective personal carbon market complex and hinders the ability to forecast its behaviour is lack of experience, as no similar market exists. Under a PCA instrument individuals would receive allowances for free from the government and would then surrender them to different institutions when making transactions with related carbon emissions. So the allowances are awarded freely for people to use, but unlike food ration, it would be legal, legitimate and even encouraged to trade them. The market created by such scheme would be composed by tens of millions of individuals entitled to trade, each one given a relatively small number of credits to trade with. With time as allocated budgets become smaller, the

market and the trading activity would most probably also shrink because people have less to sell. However predicting how the personal carbon market and individuals would behave in this market is not possible.

Carbon is being traded today in the EU Emission Trading Scheme (EUETS) by a few thousands large energy consumers. Nonetheless the lessons that could be drawn from the EUETS to a personal carbon market are limited for few reasons: first, numerous studies in behavioural economics have demonstrated that individual economic behaviour is very different from businesses economic behaviour and follows a different logic; and second, businesses that fail to be profitable theoretically should be eliminated from the market[22], while people who exceed their budget and have no money to cover for the extra carbon credits would still to be consuming energy.

Obviously, some people – if not most of them - would find trading somewhat threatening, as they have no knowledge of markets behaviour and have never traded in such way. Hence, it makes sense to design the scheme in a way that provides a simple and familiar surrendering option, such as a card swipe, and a simple buying procedure, possibly like a tax payment (Starkey and Anderson, 2005; Roberts and Thumim, 2006; Seyfang, 2007). It is also important that the procedures will not consume too much time or effort (Starkey and Anderson, 2005). One suggestion is that people who do not wish to engage with their personal emissions, would be able to sell all their units once they receive the allowance, and then pay the 'tax like' carbon price at the point of sale (effectively, 'paying as you go'). This is one way to simplify individuals' experience of PCA procedures. However, it should be noted that this option makes carbon less visible and may consequently diminish the effect of PCA's social and psychological mechanisms, accordingly reducing the intrinsic and normative motivation for behavioural change.

For those who seek the advantages of the incentives encapsulated in the carbon market, it is important that the information on how to trade would be accessible and simple, as described in chapter 2.3.5. One concern is how to allow the correction of error and mistakes, which are the result of lack of experience. A simulation programmes for individuals, such as the RSA's *CarbonDAQ*[23] or similar would probably be very useful. Another concern relates to vulnerable groups. Supporting the various vulnerable groups goes beyond helping them to remain within their budgets. Some may need assistance to ensure that they do not sell their allowance for immediate cash and then lack the units to cover their future needs; others with no trading experience may require help with their first steps in the carbon market. These kinds of vulnerabilities can all be addressed through tailored information, advice and support schemes as discussed above.

[22] We state 'theoretically' as recent events have shown that governments around the world do support some struggling unprofitable businesses by bailing them out.

[23] See: http://www.rsacarbonlimited.org/default.aspa

The perceived fairness of the market is another important issue. As the aim of the carbon budget constraint is to achieve emission reduction in a fair way, it is important that trading is not perceived as an opportunity for government or business to make a profit on the back of individuals. It is also important that current energy consumers would not borrow from the future. Hence, market makers, which are intermediaries 'for profit' agents that buy and sell carbon units - an optional market structure described by Starkey (2007) – should be regulated in a way that will not allow them to take advantage of future generations, vulnerable groups, or to raise the carbon price to a level that makes it unaffordable to many. At the same time, it is vital that the economic penalty on exceeding the personal budget would not be negligible or lack any deterring effect, as this may consequently make the economic mechanism ineffective. It is believed, however, that the economic mechanism would be one of three mechanisms – the others being normative and intrinsic – to change behaviour (figure 1). Therefore, the economic penalty on exceeding the budget as well as the reward of using less than the budget, if combined with the other mechanisms, may not need to be very high to be effective.

Table 5: Design Issues relating to the trading aspect of PCA

Activity	When	To whom	Design questions
Surrender	Buying energy	Utilities/ transaction point	How (card? Pin?)
Buy	Shortage of unit	Transaction point / market makers?	Futures / speculators; What if there are no credits at the point of sale?
Sell	Extra units	Market makers? Individuals?	Bargaining?
Speculate	Future profits	Market makers? Individuals?	Allowed? Encouraged? Future generations interests

Summary

- Trading allows flexibility over budget limits: over-emitters can buy extra credits and under-emitters can sell their extra credits in the personal carbon market.
- Knowing how to trade is important for those who want to take advantage of the economic benefits from reducing emission.
- Trading procedures should be kept simple and well communicated, allowing people to learn how to trade as well as correcting errors.
- A 'pay as you go' option should be offered to those who do not wish to trade, although this option masks, to some extent, the effect of carbon visibility.
- Further thought should be dedicated to the effect of the following on perception of the market and the likelihood of people to participate in the trading: market setting, design and governance; trading options such as speculating with 'futures'; intermediate market makers.

3. Conclusion

PCA is a radical and untested instrument to deliver emissions reduction from the domestic sector. Living under a PCA scheme - with its linked personal carbon budget - will mean a step change in the way that we, as individuals, understand and interact with carbon in our daily lives. Managing a carbon budget will involve increasing the awareness of carbon associated with our activities and choices and therefore offers the potential to bring about a new era of carbon literacy among citizens.

This paper has looked at the carbon budgeting process and practicalities relating to the process through the viewpoint of the allowance holders. In doing so it highlights what could help allowance holders to be better aware of their carbon emissions and manage their carbon budgets. Viewing the policy in this way is useful for two reasons: first, it may help and provide the means to empower individuals to reduce their emissions and live a more low carbon lifestyle; and second, it draws attention to different aspects of policy design, that could support emissions reduction.

A few implications of the policy design, which may arise from individuals living under a PCA instrument, have been outlined. These implications relate to the practicalities which surround understanding a new currency, making informed low energy choices, having opportunities to choose from available alternatives and the infrastructure, support and advice that goes with such a scheme. We have suggested that implementing a PCA scheme will rely on many actors' involvement - from individuals up to central government - and have proposed a range of decisions that policy designers may need to consider before PCA could be introduced.

Sometimes the changes needed to support better carbon literacy and carbon budget management are simple and low cost, such as changes to the way we display emissions related data or schemes that encourage social innovations and networking between individuals and communities. Other support mechanisms however are costly, complex to implement and require long preparations, but will be important for the perception of PCA as a justified, fair and legitimate policy and therefore crucial to its success. Examples include setting acceptable budget limits, designing the trading elements and providing financial support for a variety of vulnerable groups.

We believe that some of these insights are relevant to any effort made to reduce emissions from the domestic sector, even if PCA is not the chosen instrument to deliver it. For example, recognising vulnerabilities other than low income; understanding what meaningful and timely information could be used to influence energy uses' decision making; and prompting low carbon alternatives as desirable norms are all needed in order to prepare individuals and society for a carbon-constrained world.

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