Regulation of energy suppliers to save energy – lessons from the UK debate

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Abstract

The UK has led the way in using energy efficiency obligations on energy suppliers to households in fully liberalised markets. This has increased deployment of cost effective energy efficiency technologies.

UK experience has influenced recent developments in other countries, but the approach has limitations. It has not generated a transparent market in energy efficiency, does not remove the volume sales driver for energy suppliers, does not address the growing demand for energy services nor provide incentives to consumers to change behaviour.

A number of bolder policy interventions in household energy supply have been suggested, including more liquid markets in energy efficiency certificates, capping supplier carbon emissions and tradable permits for individual consumers.

This paper sets out the theoretical and historical context of energy efficiency obligations. It describes the rationale for the suggested policy changes and considers the range of objectives against which they will be judged. It concludes that none of the suggested policy options is unproblematic. In particular, any form of cap and trade obligation that can incentivise behavioural change has higher risks of failure to deliver.

1. Introduction

Gas and electricity suppliers to household customers in Great Britain are subject to obligations to improve the efficiency with which their customers use energy. For suppliers in a competitive market, this is an unusual and counter-intuitive situation. Suppliers in other markets are not required to improve their customers' efficiency of use of their commodity and, in general, do not volunteer to do so as it tends to reduce sales and profits.

Despite the unusual character of the obligation, it has been a feature of GB retail energy markets since 1994, surviving changes of Government, regulator and market structure. A number of other countries have developed similar regimes based on the GB model. The approach has the political attraction of forcing the market to deliver energy efficiency improvement without detailed Government intervention or large public resources.

In a world increasingly concerned about energy bills and carbon emissions, it is likely that an approach of this broad type will be retained for the foreseeable future. Indeed the scale of obligation has been increased from 1st April 2008 (Defra, 2007a), requiring an estimated[1] supplier annual investment of £800 million. So, current debates focus on how to deliver more ambitious goals from this sort of mechanism.

This paper sets out the theoretical and historical background to using obligations on energy suppliers as a means to delivering energy efficiency improvement and energy demand reductions. It considers the options for future obligations and related instruments that are currently under debate for use in the UK. It describes the rationale for potential policy changes and how well they perform against the range of objectives on which such policies will be judged.

2. Theoretical Background

There is a well-established literature on barriers to energy efficiency (e.g. Sorrell et al, 2004). This has produced a taxonomy of barriers (see Table 1) that is now broadly accepted (e.g. Stern, 2006). To the extent that these barriers are market failures[2], there is under-investment in energy efficiency and cost effective opportunities for improved energy efficiency exist. There are many quantitative analyses of this for different sectors of the economy and in different countries. A recent example for the UK household sector (Pye and Fletcher, 2008) is shown in Figure 1. The implication for the energy system is that the potential energy efficiency improvement, if tapped, can supply additional energy services at a lower cost than new energy supply.

The concept of the "negawatt" (Lovins, 1989) has been used to popularise this idea. Provided that negawatt-hours from energy efficiency can be delivered more cheaply than new supply, investment in energy efficiency reduces the total cost of the electricity

[1] The legal obligation is to save carbon and therefore the scale of investment is, ex ante, necessarily an estimate.

[2] There remains debate about this, but the general conclusion is that at least some of the barriers are market failures.

system[3] and total consumer bills. The underpinning assumption is that customers want energy services not energy units, and therefore that investment in energy efficiency on the demand side is theoretically equivalent to new supply.

The barriers listed in Table 1 are **not** directly related to energy market structure. On the contrary, they are deeply embedded within a consumer economy. So the causes of under-investment in energy efficiency are largely independent of the energy supply system (Eyre, 1998).

3. Historical Background

Obligations on energy companies to improve end-use efficiency began in regulation of investor-owned, monopoly utilities that dominated much of the electricity sector in the USA until the 1990s. Utilities were subject to price controls with an acceptable rate of return allowed on capital employed. Following the oil prices rises of the 1970s, regulators sought to defer supply side investment through utility energy efficiency programmes "on the customer side of the meter", known as Demand Side Management (DSM). Whether DSM investments delivered such a result was for a time contested, although most subsequent evaluations were generally positive (e.g. Boyle, 1996).

DSM in GB developed at a later date, during market reform. The conjunction of price regulation with increased environmental concern led to a limited use of DSM in the years following privatisation. Household gas and electricity supplies were privatised as monopolies, not as competitive markets. The parallel with the USA was apparent, and energy efficiency advocates were able to argue that private monopoly suppliers should be expected to minimise consumer costs through energy efficiency.

Both the initial GB regulators accepted the need for energy efficiency programmes, in advance of full market liberalisation, although the initial programmes were limited in scale and abolished in the gas sector by its second regulator. The Labour Government, elected in 1997, saw attractions of achieving home energy efficiency without public funding. Responsibility for determining the scale of the obligations passed from the regulators to the Government under the Utilities Act 2000, avoiding the whims of individual regulators. Supplier obligations were re-imposed in gas and the scale of the obligations was increased from £25M per year in 1994 in successive regulatory rounds in 1998, 2000, 2002, 2005 and 2008. Estimated annual supplier investment is now over thirty times the scale of the initial programmes, with a commitment to retain at least this magnitude until 2020 (DTI, 2007)

The continuity of approach has been masked by periodic rebranding – from the Energy Efficiency Standards of Performance (EESoP), via the Energy Efficiency Commitment (EEC) to the Carbon Emissions Reduction Target (CERT). However, reviews have confirmed the approach as a policy success (e.g. Lees, 2006; NAO, 2008).

[3] In this context, the energy system includes the capital equipment that converts energy units to energy services on the customer side of the meter.

In summary, supplier obligations in liberalised markets have been successful in delivering low to medium cost energy efficiency measures. The UK has led the way in developing this policy option for liberalised retail markets and there are strong signs of a similar approach being followed in other countries (Vine, 2008).

4. The Case for Change

The Energy White Paper of 2003 (DTI, 2003) marked a key change in UK energy policy by adopting a long term carbon emissions reduction of 60%. Previous analyses had shown that this would imply major changes in the energy system and that to achieve this at reasonable cost would require increased energy efficiency (RCEP, 2000; PIU, 2002). Energy efficiency therefore became more central within energy policy (e.g., Eyre and Staniaszek, 2005).

The effectiveness of energy supplier obligations is now questioned, largely on the grounds of changing circumstances, in particular whether the existing approach can deliver ambitious carbon targets, which may need high cost measures, behavioural change, energy service demand reduction and new energy supplier business models – objectives for which existing policy was not designed.

The potential limitations relate, in particular, to the incentives for energy suppliers to reduce energy demand, especially where supply companies own related distribution networks and profitability is reduced by lower sales. The extent to which this actually influences supply company business strategy is not clear. However, mechanisms that allow removal of the volume sales driver for energy suppliers in regulated monopoly markets[4] are not replicable in markets without price controls.

Other concerns relate to energy supplier dominance over the energy efficiency industry that is created by the existence of large obligations. The obligation structure does not allow anyone other than energy suppliers to own CERT credits, and therefore has not generated a transparent market in energy efficiency. Whilst CERT and its predecessors have delivered large volumes of low cost energy efficiency measures, the 'least cost' driver faced by suppliers in competitive markets may not be able to drive higher cost approaches (e.g. "whole house" retrofits) needed to deliver long term policy goals.

This most fundamental question is whether energy suppliers can ever be effective agents of radical change. The track record of supplier obligations is proven for delivery of basic energy efficiency measures. But if the objective is recast to "energy demand reduction", then the situation is less clear cut.

Demand can be reduced by means other than installation of technical measures, notably by changes to consumer behaviour, see Figure 2 (Eyre, 2008). Supplier obligations are untried for behavioural measures. The potential reduction from 'good housekeeping' (Figure 2, bottom left quadrant) based on feedback of information to energy consumers is estimated to be in the range of 5% to 15% (Darby, 2006). The latest round of supplier obligations (CERT, 2008-2011) allows for savings from feedback devices, but the scale

[4] This is an approach increasingly being used in the USA.

of activity is expected to be small and the savings, and their persistence, in this context are uncertain.

The potential for energy suppliers to drive bigger lifestyle changes (Figure 2, bottom right quadrant) is even more dubious. These changes are not from improved resource efficiency or elimination of waste, but from more fundamental social change leading to a reduction in the demand for energy services. Research on lifestyle change (e.g. Jackson, 2004) indicates that friends, families and communities, not energy companies are the most likely drivers of such change.

In this context, new policies are being considered to address personal energy demand.

5. Household Energy Efficiency Trading Options

There is a strong commitment in UK energy policy to using market based instruments. In principle, a wide variety of tradable obligation on different actors is possible. However, only two categories of actor are closely involved with the use of energy at the household level - energy companies and consumers themselves. And there are only two broad categories of trading – 'cap and trade' and 'baseline and credit'. This leads to the four-fold taxonomy of options shown in Figure 3.

The current state of UK policy discussion on these options is considered below.

5.1 Supplier baseline and credit

The existing CERT system is a baseline and credit scheme. The extent of trading is limited because, under the current regulations, the only actors who can generate credits are the obligated suppliers themselves. Whilst suppliers contract out much of delivery to specialist companies (e.g. insulation installers and appliance retailers), there is no transparent market price and no active third party involvement in trading. Other countries who have adopted this broad option after GB – e.g. France, Italy and some states of the USA (Vine, 2008) – have chosen to use a 'white certificates' approach, in which anyone can generate energy efficiency certificates which can then be traded, with energy companies meeting their obligations through delivery of certificates.

The weakness of CERT with respect to price transparency has been recognised, with a proposal that it could be addressed by auctioning some credits (NERA, 2007). However, this would raise consumer costs without addressing the fundamental issue that the market for credits is an oligopoly. The option of opening up CERT into a tradable white certificate (TWC) scheme has been canvassed in Government commissioned work (NERA, 2006) but dismissed largely on the grounds that "*there are few additional cost-effective measures that would be generated by a TWC programme"*. This is a very controversial view. It neglects the insights of innovation theory that change is most likely to occur from outside the incumbents in the market: new entrants might find cheaper delivery routes. This seems likely in a market where energy suppliers face customer distrust about their motivations (EEIR, 2005). Suppliers themselves recognize this issue and have developed some successful schemes disguised as other forms of

financial incentives, notably the British Gas supported Council Tax rebate schemes (Waterson, 2005).

From 2008, CERT includes some changes to encourage new measures (Defra, 2007a), allowing credit for microgeneration, displays and meters that affect behaviour and unproven but promising demonstration technologies. The effectiveness of these approaches in a scheme originally designed to promote 'least cost, energy efficiency measures' remains to be seen.

5.2 Supplier cap and trade

A cap and trade approach may be used as an alternative to a baseline and credit scheme. The idea was first raised by the 2002 Energy Review (PIU, 2002), which undertook a preliminary assessment of the benefits and problems.

The benefits are potentially significant. Any action that reduces emissions, including consumer behavioural change, would assist delivery of the obligation. So suppliers would have an incentive not only to deliver effective programmes, but also to innovate in terms of tariff structures and business models.

The key problems identified included:

- a risk that suppliers will deliver targets through other means than energy saving, e.g. differential customer retention and capture.
- that long lifetime measures and programmes targeting customers of other suppliers become unattractive to suppliers, even though cost effective.
- greater uncertainty, as there is no *a priori* guarantee that any level of energy efficiency activity will deliver the obligation, and consequently a higher risk that companies will deliberately under-perform and accept the risk of penalty,
- greater risk to social objectives, as there would be no constraint on the type households[5] in which energy efficiency work could be undertaken,

Subsequent more detailed analysis (e.g. NERA, 2006; NERA, 2007: Climate Change Capital, 2007; CSE, 2007) has broadly confirmed this analysis.

Discussions about a supplier cap have neglected lessons from the EUETS about windfall gains. With either free allocation or auctioning, in a fully competitive market prices will rise to include the marginal costs to suppliers (NERA, 2006), precisely the effect that has been avoided in a measures based obligation, where only the carbon costs of the avoided emissions is passed through. A windfall could therefore result from free allocation and large Government revenues from auctioning. A quantitative analysis of this effect is outside the scope of this paper. However, the effect does not seem to have been considered in either the supplier obligation consultation (Defra, 2007b) or the analysis of its social impacts (CSE, 2007).

A claimed benefit for a cap and trade obligation is greater certainty of outcome for sectoral carbon emissions. This is self-evident if a cap is set and rigidly enforced, but it

[5] CERT and its predecessors have required a high proportion of activity in a "priority group" of homes with low income or vulnerable people

should not be confused with lower carbon emissions. Figure 4 shows what would have happened with a cap and trade system instead of EEC over the period 2004 to 2007. It is assumed that the cap would have been set using a projection for underlying growth in annual energy demand of 1.5% and with a cap set to achieve the same level of reduction as EEC2, i.e. 1.7% over 3 years (Defra, 2005). So, carbon emissions would have been capped at above the 2004 level, to account for projected baseline growth exceeding the impact of the intervention. In practice, emissions actually fell significantly, and would have done so even without EEC. So, in this case, the cap would have been set at a level that would have required no supplier activity at all.

If uncertainty in the baseline works in the opposite direction, i.e. it rises faster than projected (e.g. due to falling prices, colder weather or faster economic growth), the level of action required to meet the target could be very large. This implies a high carbon price and a major impact on consumer costs. It therefore seems likely that such a policy would only be adopted with a 'buy-out' mechanism, in the same way as the Renewables Obligation. In this case, the proposed benefit of 'certainty of outcome' of carbon emissions is lost.

The underlying problem is that uncertainties in drivers of energy demand that lie outside the control of suppliers, customers and Government are of at least the same order of magnitude as impacts of supplier activity. So the goal of supplier responsibility for 'carbon certainty' is illusory.

5.3 Consumer baseline and credit

In principle, it would be possible to put obligations to save energy on individual energy consumers rather than suppliers. Credits for individual measures could be set by the same sort of methodology as in CERT, but with the obligation distributed across energy users, presumably either to all households or individual adults.

A potential advantage is that it would incentivise energy users directly, rather than via suppliers, to invest in energy efficiency. It would need to be tradable, as, many customers will not opportunities for major energy efficiency investment, even over a 3 or 5 year period. And, with the exception of lighting, opportunity is effectively restricted to homeowners, so the mechanism could be seen as discriminating against tenants, as well as others with limited opportunities to make building investment – low income families, elderly and disabled people etc..

Enforcement would be a major issue. As a sizeable fraction of the population would take no relevant action, the only plausible enforcement would be an enforced buyout, effectively a fine or tax. So the likely outcome of the mechanism for many people would be broadly equivalent to a 'household climate levy' with proceeds used to finance energy efficiency measures by people who wish to undertake them. In this context, it is not surprising that this option has not been actively discussed.

A more plausible variant is to put obligations on specific groups of energy users who have good energy efficiency opportunities. Minimum requirements in building

regulations for boilers and glazing already fall into this category. There have been other proposals of this type, at the level of whole buildings, for example to require purchasers of inefficient homes to reach an improved mandatory standard before resale (Boardman, 2008). However, in all these cases, there seems unlikely to be any economic efficiency gain in making the obligation tradable.

5.4 Consumer cap and trade

A consumer cap and trade scheme has been actively promoted for a number of years, although much discussion has been disconnected from mainstream energy policy. Instead the idea comes from more fundamental application of environmental economics to climate change. There are several variants on the same broad concept, but basically two models:

- the original proposal (Fleming, 1997) for Tradable Energy Quotas (TEQs) in which the whole economy is carbon capped, with (in Fleming's proposal) allowances distributed free to individuals and auctioned to businesses, and
- variants restricted to energy use under the direct control of individuals, i.e. household energy and personal transport, known under the broad heading of Personal Carbon Trading (PCT) (e.g., Hillman and Fawcett (2004); Anderson and Starkey, 2005)).

TEQs have the property of only requiring enforcement at the top of the fossil fuel chain, i.e. the point of extraction or import. This would certainly ease administration considerably (Fleming, 2008), but potentially conflict with current disconnection rules. However, the proposed scope overlaps with the EUETS, which most analysts now take as a policy "given". The TEQs proposal therefore takes insufficient account of the policy landscape into which it would probably need to be introduced.

PCT has been designed to be complementary to the EUETS[6]. It would require downstream measurement and enforcement, but this may be necessary to engage energy users more actively in carbon emissions reduction. Indeed, none of the leading proponents of PCT has ever seen the scheme as a pure economic instrument, but on the contrary as a means of changing attitudes to and engagement with energy and carbon issues, (e.g. Fawcett et al, 2007).

PCT would have the attraction of addressing personal carbon emissions directly and transparently, and the advantage of avoiding any windfall to energy companies by granting property rights to final consumers. In principle, any allocation system could be used, although the only option considered in any detail has been equal per capita allowances, because of its apparent equity[7]. The usual proposed scope is wider than a household energy supplier obligation, covering personal transport.

This combination of broad scope and conceptual simplicity, combining environmental protection with equity, has attracted centre left political support. In particular, former

[6] PCT proposals include electricity use which is within the EUETS, but the carbon reduction measures the two approaches would incentivise are different – EUETS upstream and PCT downstream.

[7] "Apparent" because equity can be considered in many different ways and equal per capita allocations may not satisfy all of these (Starkey, 2007)

Secretary of State for the Environment, David Miliband, asked for investigation of the option, leading to a number of studies (Accenture, 2008; CSE, 2008; Defra, 2008; Enviros, 2008). The broad conclusions from these are that a PCT system would be technically feasible, if rather expensive to set up and maintain. Public acceptability is potentially problematic, but uncertain and, in the absence of a worked-up scheme and clear explanation of its impacts, likely to remain so. However, the distributional impacts are likely to be more progressive than a supplier cap and trade system.

The Defra review (Defra, 2008) found that the high implementation costs are unlikely to be justified by benefits that are additional to other approaches. This result has been contested as it depends upon assumptions about the effectiveness of PCT as a mechanism. If it operates solely through the price mechanism then upstream alternatives would be equally effective, whilst being simpler and cheaper to implement. However, other psychological and social factors may be at least as important as price elasticity, but, in the absence of trials or good simulation experiments, this uncertainty cannot be resolved. However, Defra's conclusion that the existing studies make the case for not continuing research on PCT has therefore been widely disputed, including by the Environmental Audit Committee (EAC, 2008).

There are three important differences between the 'supplier cap and trade' and 'consumer cap and trade' obligations:

- the consumer cap allocates the value of permits to customers, leading to greater market complexity and administrative costs, but potentially avoiding windfall profit concerns,
- widespread distribution of permits potentially creates new motivations for energy users not present in a more upstream version, although the implications for the scale of energy behaviour change are not known, and
- the scope of the scheme can easily be broadened to other energy uses, notably surface transport.

However, there is an important, but to date unrecognised, similarity arising from practical considerations. There is remarkably little literature about enforcement mechanisms for PCT, but researchers who have considered it (e.g., Anderson, 2007; Defra, 2008) assume that enforcement at the level of the individual citizen or household would be so expensive, difficult and unpopular, that actual enforcement would be via energy suppliers (household or transport fuel). In other words *it would be sale of energy without having sufficient carbon permits, not use of such energy, which would the activity subject to enforcement*. Permits would initially be allocated to customers, but would be bought and deliverede to the regulatory authority by energy suppliers. In other words, PCT would be another form of 'supplier obligation'.

The literature on both PCT and 'supplier obligations' fails to identify this commonality, probably because of the different traditions from which the approaches come. However, it is important, as it implies that much of the discussion in Section 5.2 above also applies to PCT. Whilst individuals could "carbon budget" and trade in carbon markets, the likelihood is that many would not and would instead "cash in" the initial allocation and

then adopt a "pay as you go for carbon" strategy to energy purchases. This would dilute some of the more extreme claims about its difficulties of PCT. But it would also diminish the potential benefits of securing greater individual engagement in reducing energy demand. The balance adopted between the two approaches would depend on customer 'carbon literacy' and 'carbon engagament'.

There seems no good reason why ongoing analyses of a supplier obligation cannot include a variant in which permit allocation is to customers, rather than the two being treated as fundamentally different.

6. Analysis

The criteria upon which different approaches might be judged by Government are set out in the consultation document on a supplier obligation (Defra, 2007b). The full list is:

1. Good fit with other policies and objectives
2. Good fit with the competitive energy market
3. Good fit with suppliers' businesses
4. Certainty for investors
5. Cost effectiveness
6. Engagement of consumers
7. Equity for consumers
8. Encourages innovation
9. Will continue to deliver savings effectively
10. Certainty of outcome
11. Able to be reliably monitored and verified
12. Simplicity
13. Minimizes risks of unintended consequences

In practice these may be split into a number of broader headings

- Political acceptability – notably consistency with the current determination to continue with a fully liberalised energy market (points 1 to 4)
- Cost effectiveness – through minimising transaction costs and securing customer contributions and engagement (5 and 6)
- Equity – particularly for disadvantaged customers (7)
- Innovation – new measures and approaches (8 and 9), and
- Risk – of non-delivery (10 to 13).

Political acceptability

All of the options described above are compatible with a liberalised market, as well as other market structures. The idea of providing credits for energy efficiency action is well established in a number of countries and has long been successful in the UK. Both of the 'cap and trade' options potentially imply higher prices, as well as the perception of policy constraints on energy using behaviour – of which politicians, unsurprisingly, are wary. It seems very likely that such an option would only be politically acceptable if adopted with a 'buyout' option to cap carbon prices at politically acceptable levels.

Cost effectiveness
The baseline and credit system is a proven cost effective approach - targeting the lowest cost energy efficiency measures through a mechanism with low transaction costs. Cost effectiveness is only likely to be improved by including 'behavioural' measures that have zero (or low) costs. Cap and trade options may be able to do this better than a baseline and credit system, but this is unproven. It seems very likely that a PCT system will have more effect on behaviour than a 'supplier obligation'. However, the effect would be reduced by a 'pay as you go' strategy to individual carbon budgeting, and therefore greater 'carbon engagement' is probably a necessary precursor to an effective PCT policy.

Equity
The existing CERT system is progressive, because it is cost effective, has a small impact on prices and is required to deliver a high share of benefits to low income customers. Cap and trade schemes will raise prices substantially and could only replicate a low income priority by having more than one market with separate caps. The scope for supplier windfalls also exists in a supplier cap and trade. The initial allocation in a consumer cap and trade would have substantial redistributional impacts, making this option also broadly progressive.

Innovation
A baseline and credit system has proven ability to deliver low cost measures and current developments in CERT may allow more innovation in technology designed to change behaviour and higher cost technologies. Moves to a more tradable 'white certificate' approach would encourage new entrants and delivery innovation. However, the lack of direct involvement of end users that is inherent in the approach seems unlikely to produce fundamental market change or major impacts on final user behaviour.

Either cap and trade option seems more likely to stimulate changes to tariffs and new business models, although they risk of 'throwing out the baby with the bathwater' by disincentivising investment in energy efficiency measures, notably those with long lifetimes. Supplier cap and trade is less likely to produce behaviour change than PCT, as current supplier business models have limited capability to affect user behaviour. PCT can also extend more easily to other personal uses of energy, notably transport.

Risk
A baseline and credit system has minimal risk. It is well-established in GB and the option of a more liquid market, through a white certificate scheme, is proven elsewhere. Any form a 'cap and trade' scheme would involve a two-fold increase in risk. First, it might fail to deliver the low cost energy savings that are proven from a baseline and credit system. Secondly, there are social and political risks in seeking to constrain energy use against an uncertain baseline, rather than simply improving efficiency. There is no experience anywhere else in the world of this type of approach, and currently no consideration of it.

Consumer cap and trade is frequently represented as presenting a higher risk than a supplier cap and trade. It has been argued here that this is exaggerated, because the 'small print' of PCT proposals implies that legal obligations for delivery will rest on suppliers, just as in supplier cap and trade. The additional risk over and above a supplier cap and trade therefore lies mainly in any extension of scope (to transport) and in the ICT infrastructure to deliver allowances to individuals.

7. Conclusions

Action to reduce energy demand represents a low cost option for reduction of carbon emissions and improved energy security. All of the options discussed above can, in principle, deliver on this goal. However, none of the options is unproblematic – to a greater or lesser extent all involve higher prices, new business models and increased consumer investment.

However there is a fundamental difference in objectives between 'baseline and credit' and 'cap and trade' options – the former seeks to improve energy efficiency, the latter reduce energy demand through either or both of improved efficiency and reduced demand for energy services. This is a political choice.

A baseline and credit approach is already well-established and successful. There seems little reason to abandon it, especially when much of the rest of the world is beginning to use it in a more tradable form. The potential advantages claimed for a 'cap and trade' scheme can be exaggerated. It might allow greater certainty in carbon emissions from household use, but emissions may well be higher than would result from baseline and credit approach.

The major potential benefit of 'cap and trade' lies in producing behavioural responses to reduce energy use. However, suppliers are not well-placed to do this, so this is a weakness of the supplier cap and trade option. A consumer based cap and trade option (PCT schemes) would be more likely to achieve this, through more direct influences at the personal and community level. However, high levels of 'carbon engagement' in the general population will be required for PCT to prove effective.

Either version of 'cap and trade' option represents a high risk, high reward policy option. The risk of failing to deliver energy savings is higher than in a baseline and credit system. And the social and political risks due to higher prices are significant.

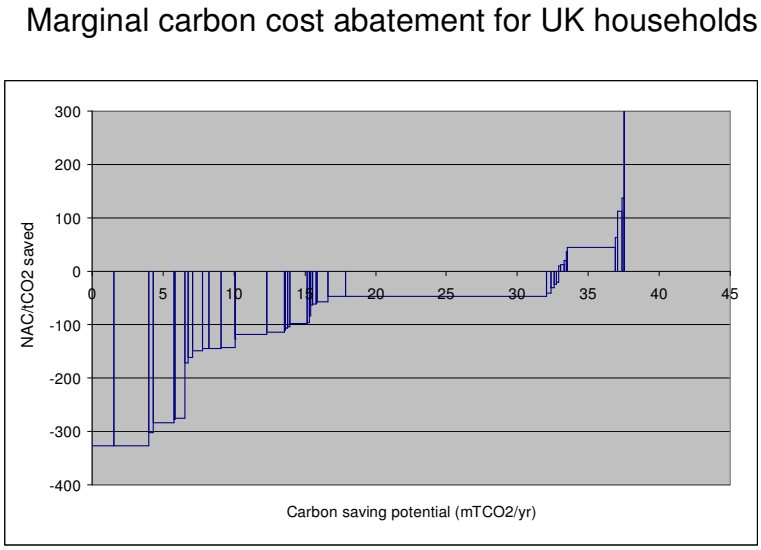
On balance there seems little to commend a 'supplier cap and trade' option in preference to an improved version of current policy. If greater emphasis on consumer behaviour is considered desirable, then policy will need to involve individuals more directly.

Table 1

Barriers to Energy Efficiency (adapted from Sorrell et al, 2004)

Risk	Perceived technical and financial uncertainties, including trust in delivery agents.
Deficient information	Incorrect or insufficient knowledge at the point of decision-making biases decisions against efficient products
Transaction or hidden costs	Perception or reality of costs of disruption, including value of time
Access to capital	Constraints on borrowing, including higher interest rates than justified by the risk of the project
Split incentives	Investors cannot appropriate the benefits of energy efficiency investments (e.g. landlords)
Bounded rationality	Energy consumers do not make the choice identified as optimal by economic analysis

Figure 1



Based on Pye and Fletcher, 2008 (for year 2022; 3.5% discount rate)

Figure 2

Behaviour change and carbon reduction

Technology Purchase	Choice of low carbon option	Discretionary low carbon investment
Routine behaviours	"Good housekeeping"	"Lifestyle change"
	Minor change	Major change

Figure 3

Options for household energy efficiency trading

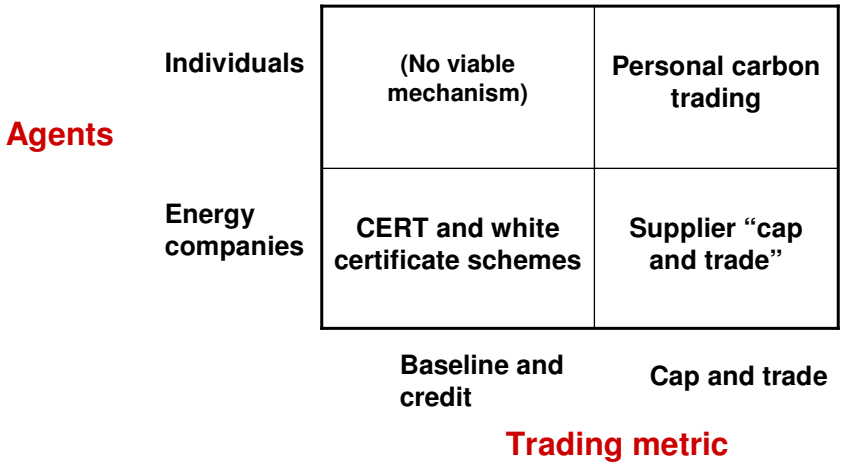
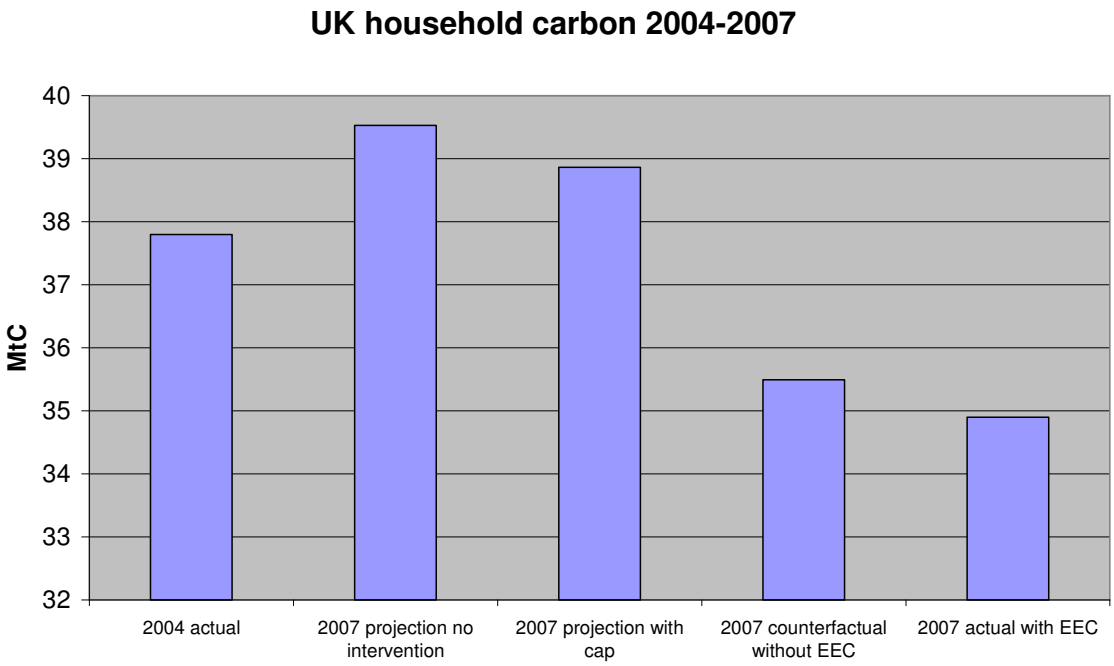


Figure 4



Based on official energy statistics, with an ex ante projection of a baseline of 1.5% annual growth (NERA, 2007), EEC savings of 1.7% in total over the 3 years 2005-2007 (approximately the EEC2 period) and a supplier cap with an equal ambition for reduction below the ex ante baseline.

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