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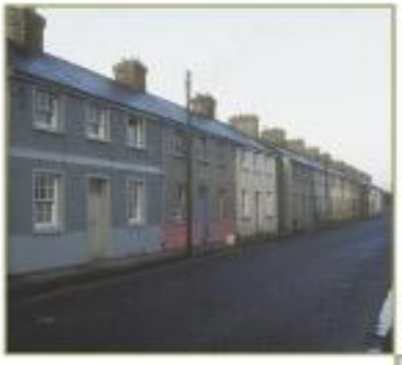
Can energy charges encourage **energy efficiency?**

A discussion paper to prompt debate

July 2009



Discussion paper on sustainable development

Ofgem has a duty to contribute to the achievement of sustainable development in the gas and electricity sectors. As industry regulator we can lead change where we have a remit to do so. In many other areas, however, the impact of our work is less direct. However, we see it as our duty to facilitate debate on important areas by drawing on our expertise and engaging on new policy issues as they emerge.

The goal of this discussion paper series is to undertake an exploratory review of the issues and encourage constructive debate on the actions that could contribute, as well as the roles and responsibilities of the relevant players. It is not a blueprint. The purpose is to encourage informed debate that brings together Government, energy suppliers, consumer and environmental groups, and other interested stakeholders. We might expect this to lead to identifying areas where further thinking is needed or new approaches in tackling the issues, improvements to policies, or the introduction of new initiatives.

Future publications of this type may cover other areas such as the deployment of smart metering and demand side participation. We welcome comments on the issues covered by this paper, or on the discussion paper format and ideas for future topics. Details on how to provide feedback are set out in Appendix 1.

Target Audience: Energy suppliers, consumers, consumer organisations and representatives, environmental interest groups, academics and other interested parties.

Overview:

The issue of how the retail market can further encourage household energy efficiency has become increasingly important. In order to inform this debate, and following a recommendation from Ofgem's Sustainable Development Committee, Ofgem committed in its 2009 Corporate Strategy to publish a discussion paper looking at these issues.

The paper looks at the potential effectiveness of various pricing structures to encourage an uptake in household energy efficiency. It sets out the context of the present debate and the Government's targets for reducing domestic energy consumption. The first part examines the issue of energy pricing and in particular how this influences domestic energy consumption in the context of persistent barriers to behaviour change and differences in the price sensitivity of higher and lower income households. We go on to examine the implications of various tariff structures for energy efficiency incentives, and the potential impacts on consumers, fuel poverty and competitive markets. In light of the potential unintended impacts, the final part of our report looks at some other options which Government could consider to contribute to sustainable social and environmental outcomes within the competitive energy market.

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Summary

The UK needs to reduce greenhouse gas emissions to achieve its climate change objectives. The UK Government has consulted on its ambition to reduce emissions from households by 30 percent by 2020.[1] To achieve this, households will need to change how they use energy and to improve the energy performance of homes. The challenge is to influence millions of individuals and households to change their behaviour and make more energy efficient choices and purchasing decisions.

One aspect that has come under consideration is the role retail energy tariffs can play in sending a message about the need to use energy wisely. Some have argued, for example, the current structure of retail supply tariffs does not provide the incentive to encourage energy efficiency because, typically, as more energy is consumed the average costs per unit of consumption fall.

The question of how different retail tariff structures might affect domestic energy consumption and household energy efficiency is an important issue for sustainable development. In a carbon constrained world with rising energy costs, retail tariffs not only interact with energy efficiency incentives but retail competition, funding of environmental programmes, affordability, fuel poverty and social tariffs.

The purpose of this discussion paper is to inform debate on the interactions between supply tariff structures and energy efficiency. It looks at supply tariffs such as two-tier rates, standing charges and rising block tariffs that can be found or could operate in the UK, prior to widespread deployment of smart meters, and considers how these might contribute to energy efficiency and the broader sustainability of markets. This paper does not present conclusions or make firm proposals for changing the current pricing structures in the retail supply market. The policy options we touch on relating to the funding of environmental programmes are, properly, matters for Government to decide not Ofgem. The purpose of this paper is to "add to the debate" around how tariff structures might encourage energy efficiency.

Domestic energy consumption and energy efficiency

In this paper we examine trends in aggregate consumption and household energy end-use to consider the potential demand response to prices and possible welfare effects. There is a large technical potential for households to substitute greater energy efficiency in place of higher energy usage. Different pricing structures can contribute to this. But price is just one of several economic, physical, social and demographic factors that affect domestic consumption patterns.

At the household level, improving energy efficiency involves changing behaviour and removing the barriers to behaviour change. The observed demand response to the price increases in recent years has been muted suggesting significant obstacles remain to these

[1] DECC (2009)

changes. Direct measures, including financial incentives, are needed to overcome high up-front costs, lack of information and advice, split incentives in the rented accommodation sector and the hassle factor. Price and tariffs are not an effective mechanism to address many of the barriers but they could play a supporting role to other measures. However, different pricing structures could, in some cases, lead to negative welfare effects as there are significant differences across income groups in price sensitivity and the affordability of substitutes, including energy efficiency measures.

Supplier incentives

We look at the residential tariffs suppliers offer and suppliers' incentives to encourage household energy efficiency. As the main interface between the customer and the energy industry, energy suppliers have a central and important role in encouraging improved domestic energy efficiency. For that reason, incentives on suppliers can be as important as incentives on households. Suppliers face a wide range of costs to deliver energy to customers, not just those related to the wholesale cost of energy. Many of these, such as the cost of environmental commitments and network charges, are borne by all suppliers and passed on to consumers' bills. A significant proportion of the costs to supply are fixed, which means the average unit cost of supplying energy declines as consumption increases. In a competitive market, we would expect suppliers to offer broadly cost-reflective prices, otherwise, a supplier risks their competitive position and overall profit. A supplier's incentives to encourage household energy efficiency depend, among other things, on the margin per unit of energy sold. Tariffs such as a mandatory rising block tariff could reduce the incentives for suppliers to help households with energy efficiency due to the marginal profitability increasing rapidly with volume. This impact on suppliers' incentives is not always sufficiently recognized.

Impact of alternative tariff structures

Some tariff structures such as rising block tariffs and time of use charging might enhance the price signal to consumers about the need to use energy resources more efficiently and increase consumers' engagement on their energy use. However, a mandatory rising block tariff could distort suppliers' incentives which may well outweigh the environmental benefits from households' incentives. Interfering with the competitive determination of prices could also impact the functioning of the market, product innovation, distorting supplier profitability, and the attractiveness of different customers groups to suppliers, discouraging demand management initiatives and investment in renewable and low carbon supply.

Competitive pricing of energy has driven down prices for all consumers, and it would be important to retain the benefits of this as far as possible, and minimise distortions. Using pricing structures to trigger behaviour change could also have serious welfare effects on consumers that do not have the resources or the opportunity to insulate their home, or replace appliances with more energy efficient versions – potentially hindering rather than helping the eradication of fuel poverty. Such approaches may require programmes to ensure vulnerable households are protected and do not suffer any unintended consequences in terms of disproportionate costs.

Different tariff structures also have varying impact on different types of customers. For example, contrary to the original intention, we find that two-tier tariffs disadvantage low use (and often low income) customers relative to the use of standing charges. In all, this only emphasizes the importance of improving the quality of information given to consumers on bills and through other channels, about the economic benefits to be gained, whatever the tariff structure, to help consumers make better decisions about tariff offers, suppliers and the opportunities for energy efficiency.

Options for sustainability

The range and scale of environmental programmes to tackle climate change are set to increase. At a time when numbers in fuel poverty are increasing, further thought is needed about the impact of these measures on household incentives to improve energy efficiency and the effects of these additional costs on low income households. Government is already thinking about some of the latter issues as part of its fuel poverty review.

Environmental externalities are best addressed directly by polluter pays measures and distributional concerns through the tax and benefits system. This approach can minimise distortions to the market and is the most equitable way to recover costs of programmes. However, Government policy is to use measures internal to the energy industry funded through energy bills. In general, this is implemented by placing obligations on suppliers. These are an increasingly large part of suppliers' costs. Government could, if it wanted, structure obligations to change suppliers costs to replicate some of the benefits of certain pricing structures in terms of energy efficiency incentives and assisting those in fuel poverty. In an effective market, suppliers are likely to alter their pricing structures to reflect changes in their costs given the competitive risks of not doing so.

Looking ahead there is likely to be significant potential for more innovation/customer engagement. Smart meters could be used to facilitate more demand side participation, leading to environmental benefits and savings to consumers through dynamic charges which reflect the real-time costs of supplying energy. This could appear complex for customers comparing available tariff options but it seems likely that a user-friendly interface and automatic controls could be developed to improve presentation and deliver benefits to consumers.

1. Introduction

Section Summary
This section sets out the context of the Government's targets for reducing domestic energy consumption and summarises the public debate about retail tariffs and household's incentives to improve energy efficiency. This section also defines the objective, scope and structure of this paper and the opportunities for stakeholders to engage on the issues covered by this paper.

The UK needs to reduce greenhouse gas emissions significantly in order to achieve its climate change objectives. The domestic sector consumes around a third of total national consumption of gas and electricity. The UK Government has estimated opportunities using established technologies for households to reduce their energy by around a quarter without any noticeable impacts on levels of service or comfort.[2] This represents a significant potential for energy savings, a reduction in CO2 emissions and would also contribute to meeting the UK's renewable energy target at least cost.

A number of measures are already in place to help achieve this such as regulation, economic incentives and energy efficiency programmes. However, these initiatives alone may not realise the full potential for energy savings. Reaching these targets will require households to make changes to how they use energy and to improve the energy performance of homes. The challenge is to influence millions of individuals and households to change their behaviour and make more energy efficient choices and purchasing decisions.

One aspect that has come under consideration is the role retail energy tariffs can play in sending a message about the need to use energy wisely. For example, a report by the Centre for Sustainable Energy for the National Consumer Council has argued that the structure of current retail tariffs does not provide the incentive to encourage energy efficiency.[3] Instead current tariffs could be seen as rewarding higher consumption, since on average, the more we use, the less we pay per unit of consumption with potentially negative environmental and social consequences, since:

- the average costs to consumers of increasing consumption, and the additional carbon emissions, reduces as consumption increases, even through the environmental impacts of that activity does not decline.

- those who can only afford to buy less pay more per unit of consumption, reinforcing the existing income disparities that underpin fuel poverty.

However, in terms of efficiency, suppliers set residential tariffs with a two part structure to recover both the fixed costs of supply, as well as the variable costs of the energy a household uses. The average unit price under a two-part charging scheme consequently falls as households' consumption increases.

[2] DEFRA (2007)
[3] CSE (2008)

A two part charging structure is the most efficient way to recover the fixed and variable costs of supply. This allows suppliers to generate sufficient revenues to meet customers' energy requirements on an ongoing basis. The cost-reflective pricing also ensures consumers make efficient consumption decisions according to their willingness to pay and the resource (and environmental) costs of supplying the energy they consume.

These different perspectives pose a number of interesting questions: what impacts would different tariff systems have on improving the energy efficiency of households? How could different tariff systems alter the incentives of households to become more energy efficient? Could different tariff structures address some of the barriers to the uptake of energy efficiency measures? How would different tariff structures fit in with a competitive retail energy market? Are tariffs that encourage households to improve their energy efficiency and ultimately reduce consumption compatible with suppliers' profit motives? What would the impact be on consumers, including some already struggling to cope with current energy costs?

Objectives and scope

This paper considers how different charging schemes used to calculate electricity and gas customer bills can influence and encourage households to become more energy efficient. The focus is on identifying the likely impacts of different tariff structures on suppliers' and customers' incentives to improve energy efficiency and/or address some of the barriers to the uptake of energy efficiency measures. However, retail tariffs not only influence the incentives for energy efficiency but also interact with retail market, funding of environmental programmes, fuel poverty and social tariffs. Therefore, we also consider the implications for effective competition and the interests of vulnerable consumers. The policy options we touch on relating to the funding of environmental programmes are, properly, matters for Government to decide not Ofgem. So, the purpose of this paper is to "add to the debate" around how tariff structures might support and encourage energy efficiency and a sustainable energy sector.

Many of the other activities and policies for improving the efficiency of domestic energy use such as subsidies for efficient products, building and product standards, energy efficiency programmes such as the Energy Efficiency Commitment are beyond the scope of this paper.

In developing this paper we have also discussed this work with Government officials and experts active in related areas when forming our initial findings. We are grateful to Dr Michael Pollitt, Prof Catherine Waddams, Gill Owen and Judith Ward for their comments and suggestions on an earlier version of this paper which have improved the final product. Any omissions or inaccuracies remain with the authors.

Following on from this introduction, Section two will consider what we know about domestic energy consumption. Section three will proceed to look at tariff setting in competitive energy markets, and describes the energy tariff structures that do or could exist in UK energy markets. The assessment of different tariffs is summarised in Section four. The final section concludes with some options to improve the sustainability of energy charges.

Next steps

The aim of this discussion paper is to encourage constructive debate on the issues with Government, energy suppliers, consumer and environmental groups, and other interested stakeholders. To facilitate this discussion we propose to hold a roundtable meeting in the autumn to bring together a select group of informed stakeholders that are experts in different aspects covered in this report. The objective of this event will be to take a 'joined-up' approach to the issues and identify the areas that require further thinking. For example, one area it would be useful to explore further is the behavioural economics of how people make decisions among options with uncertain payoffs, such as energy tariffs and energy efficiency opportunities. Some of the psychology literature suggests that better presentation of information that takes account of peoples' decision making heuristics can sometimes improve consumers' responses to the incentives. To add some consumer insight into these issues, we are also undertaking some research with our consumer panel on some of the consumer perceptions of different tariffs. We expect to be able to publish the findings from the panel in autumn.

2. What do we know about domestic energy consumption?

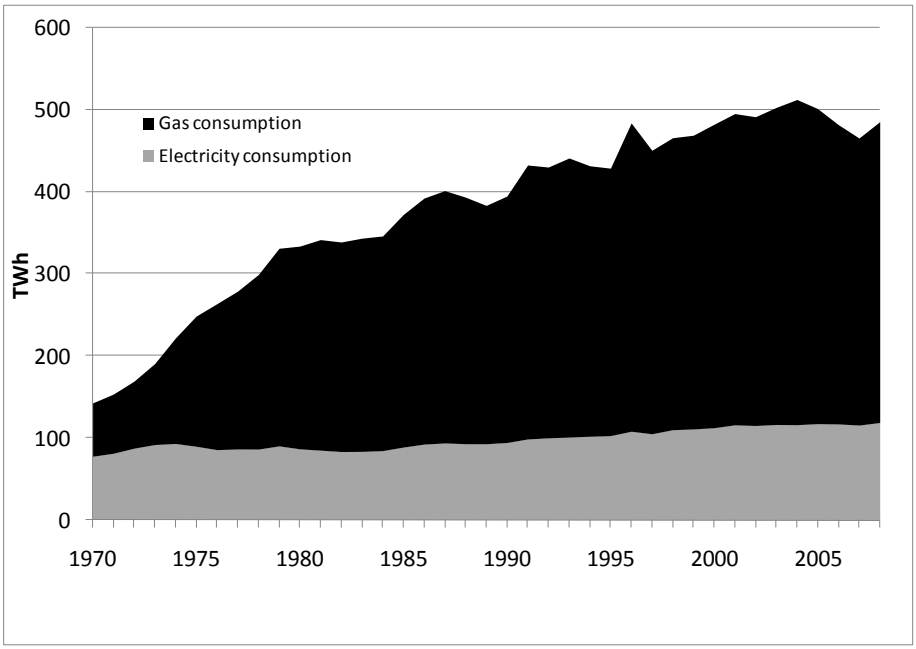
Section Summary

In this section, we look at some of the available data and research to understand domestic energy consumption. We are interested in the factors that influence household energy use and the potential demand response to changes in energy prices. We also look at some of the barriers to energy efficiency and behaviour change and households' consumption profiles as a function of income. These factors suggest the impact of energy prices in encouraging households to improve their energy efficiency is limited because of the obstacles that impede or reduce the benefits from households taking action. It may also adversely affect a significant minority of lower income households – potentially hindering rather than helping the eradication of fuel poverty.

Domestic energy consumption trends

Figure 1 shows domestic gas and electricity consumption since 1970 with consumption peaking at 512 TWh in 2004.

Figure 1: Domestic gas and electricity consumption

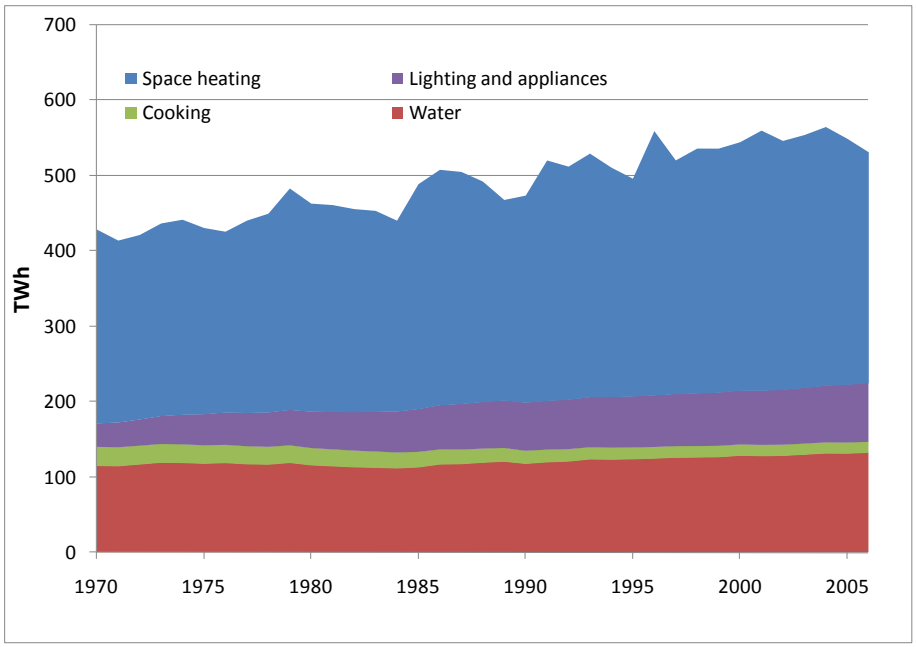


Source: BERR (2008) *UK Digest of Energy Statistics*

Figure 2 shows domestic energy consumption by end-use.[4] Around 80 percent of energy consumed in the domestic sector is for space and water heating.

[4] The level of domestic energy consumption is higher in figure 2 compared to figure 1 because other energy sources used by the domestic sector such as solid fuels are included.

Figure 2: Domestic energy end-use

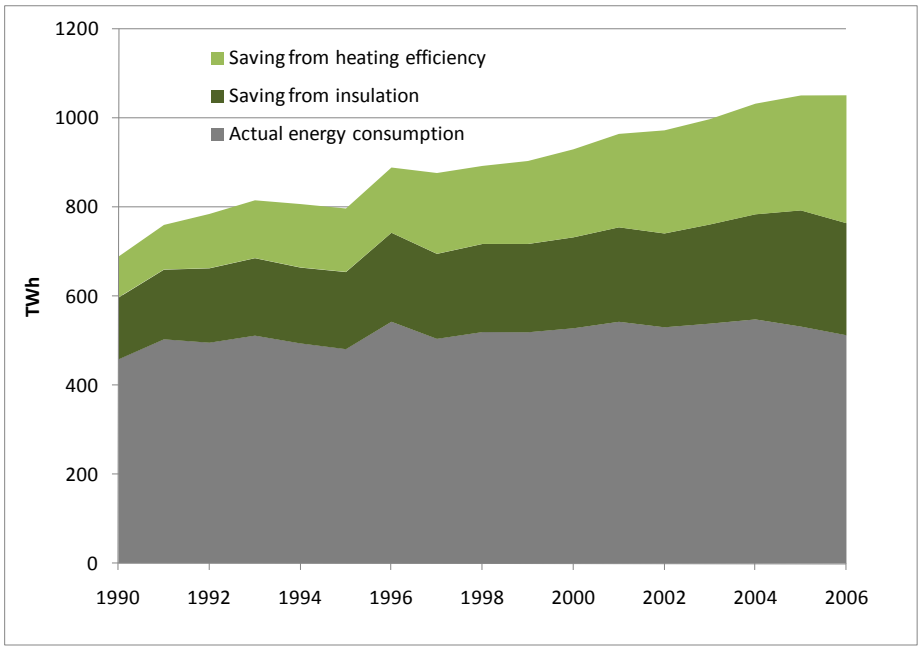


Source: BERR (2008) *Energy consumption in the UK*

Space heating in any year is largely dependent on outside temperatures, which explains the year-to-year fluctuations. The main factors that have contributed to the general upward trend over the period include a 40 percent increase in the number of households, a greater prevalence of gas central heating (average internal temperatures have risen from 12.1 to 17.8 degrees Celsius[5]), an aging population, and a 167 percent increase in household disposable income. On the other hand, an increase in insulation and improved heating efficiency has increasingly saved energy for space heating in the domestic sector. The Building Research Establishment (BRE) have estimated that without insulation and the installation of more fuel efficient gas boilers, gas consumption would have been around twice the current level (see figure 3).

[5] This is the average internal temperature of centrally-heated and non-centrally homes in Table 3.16 in Energy consumption in the UK: domestic tables, update for 2008.

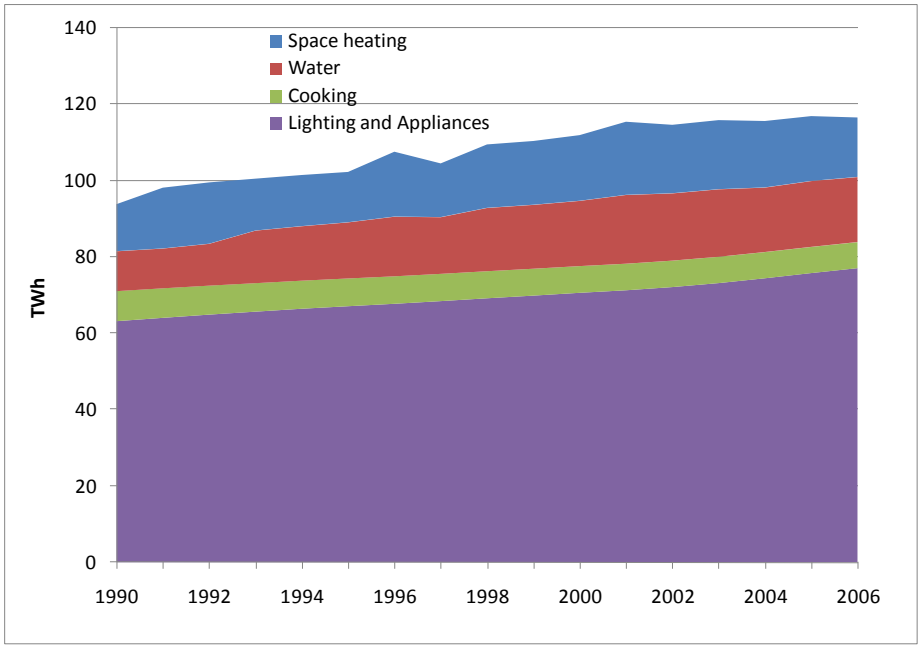
Figure 3: Estimated heat energy savings



Source: BERR (2008) *Energy consumption in the UK*

The other major uses of energy in the domestic sector are for heating water, lighting, cooking and appliances. Figure 3 shows that domestic electricity consumption since 1990 has increased predominantly due to higher consumption by domestic appliances.

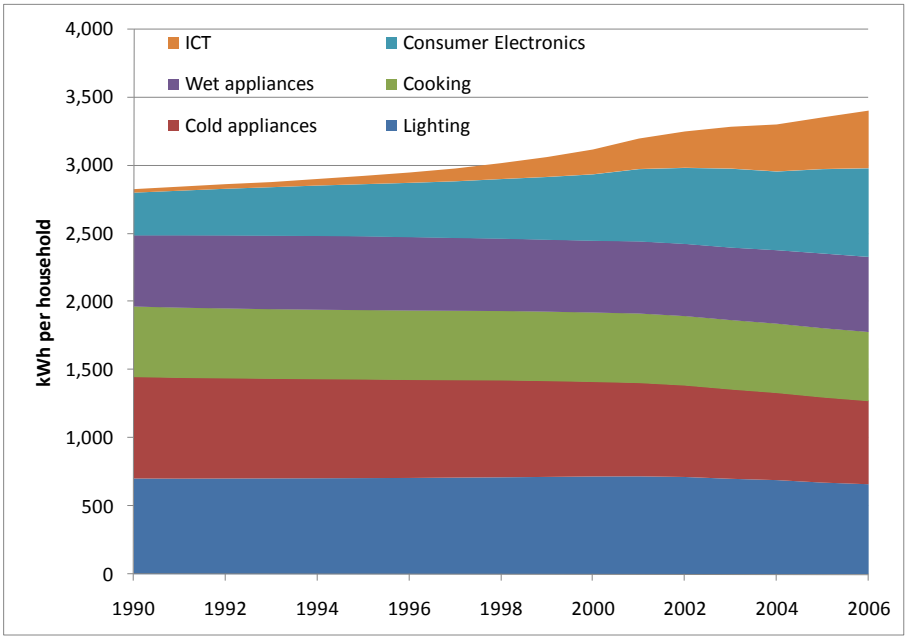
Figure 4: Domestic electricity consumption by end use



Source: BERR (2008) *Energy consumption in the UK*

In recent years, household electricity consumption for consumer electronics and information and communication technologies has been growing faster than the decline in consumption by cold (refrigerators, freezers), wet (washing, dryers) and cooking appliances (see figure 5). The fall in the latter is the result of improved energy performance of these appliances.

Figure 5: Appliance electricity use per household



Source: BERR (2008) *Energy consumption in the UK*

Potential for customer response to prices

In general terms, all else held constant, the higher the real price of energy, the more households will try to economise energy usage. Typically, demand for a good or service is more responsive (elastic) when there are substitutes for the product and when the item is a more significant portion of the consumer's budget. Also, demand tends to be more elastic longer term reflecting the fact that some adjustments take time.

Households' demand response to an increase in energy prices will depend on a combination of the substitution and income effects. Arguably there are few substitutes for powering household appliances and heating homes that are less expensive, in terms of money, cost and convenience, than electricity and mains gas. Although a price increase, all else held constant, will reduce consumers' purchasing power, energy costs as a proportion of household budget can vary widely across income groups. While low income households are relatively price sensitive, among many middle and higher income households, price responsiveness is lower. [6]

[6] Guertin, Kumbhakar and Duraiappah (2003) looked at interactions between energy prices and income in Canadian household data and found higher price elasticity in low income groups than in high income households.

However, increases in energy prices improve the relative prices of options to substitute away from higher energy usage. The options include:

1. the occupants reducing energy use, either as a result of modest behaviour changes or through significant lifestyle change;

2. reducing losses or energy requirements by installing energy efficiency measures such as loft or wall insulation or energy efficient appliances; and

3. installing or using alternative fuels for energy services they require such as solar thermal panels for water heating.

The technical potential of energy saving from demand reduction is significant. For example, the Energy Savings Trust have estimated modest behaviour changes such as turning thermostats down by 1°C, could save households up to 10 percent of energy used for space heating. However, it would take a significant change of lifestyle and social attitudes to reverse the rising trends in average level of appliance use and internal temperatures.

The Building Research Establishment (BRE) has estimated energy saving potentials that might result from installing individual energy efficiency measures in the home. Table 1 below gives estimates of the annual savings at the household level and for GB as a whole.

Table 1

Energy saving potentials of individual energy efficiency measures

	Annual energy savings	
	Household (kWh)	GB (TWh)
Space heating		
Cavity wall insulation*	3484	26
Solid wall insulation	12101	56
Loft insulation up to 270mm*	467	8
Floor insulation (raised timber)	1744	18
Glazing to C rated	2526	63
Insulated doors	464	12
Boiler to A-rated	4414	73
Improved heating controls	11094	19
Water heating		
Cylinder insulation to current regulations	254	4
Hot water heating controls	8276	14
Cooking		
A rated ovens	25	0.3
Induction hobs	25	0.3
Lights and appliances		
A++ rated cold appliances	259	6.5
A+ rated wet appliances	200	5.0
Efficient lighting	71	1.5
Integrated digital TVs	23	0.5
Reduced standby consumption	39	1.0

All measures are cost-effective over their lifetime

* Technical savings from measures have been reduced by 50% to account for improvement in U-values achieved in practice and a 'comfort factor'.

Source: BRE (2007) *Delivering cost effective carbon savings to existing homes, Report to DEFRA*

Not surprisingly, measures to reduce the amount of fuel needed for space and water heating offer some of the largest energy saving potentials (compared to total consumption of domestic customers circa 500 TWh). The next largest source of energy savings are from upgrading to more efficient versions of cold and wet appliances, and lighting. All measures are cost-effective for households as the energy bill savings over the lifetime of the measure pay back, and in some case, exceeds the installation costs.

BRE and the Committee of Climate Change have assessed the opportunities for households to invest in renewable heat and microgeneration technologies. These options can be significantly more expensive than energy efficiency measures and at current prices offer fewer cost effective opportunities for households to reduce their consumption of gas and electricity. The economics of some will improve if energy prices increase, but others need additional financial incentives such as the upcoming feed-in tariffs and renewable heat incentive to become a viable option.

Table 2

Energy saving potentials of microgeneration and domestic scale renewable heat

	Annual energy savings	
	Household (kWh)	GB (TWh)
Photovoltaic	2115	53
Small-scale wind	877	4
Ground source heat pump	8000	72
Solar thermal water panels	1230	22

Sources: BRE (2007) *Delivering cost effective carbon savings to existing homes, Report to DEFRA* and Committee for Climate Change (2008) *Building a low carbon economy – the UK's contribution to tackling climate change*

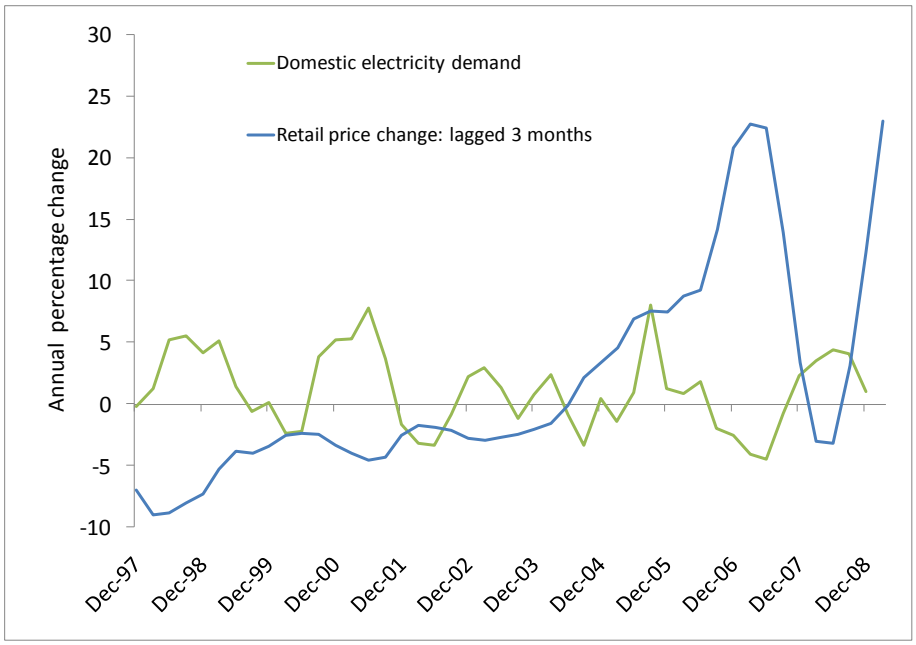
Price response

Given the cost-effective scope for households to reduce energy consumption and make bill savings we would expect consumers to exploit these opportunities, particularly in recent years when retail electricity and gas prices have increased significantly and become more volatile.

Figure 6 compares domestic electricity demand growth with annual changes in electricity prices.[7] Retail prices for all customers fell following the privatisation of the domestic electricity market in the late 1990s. Since 2004 retail prices have increased by around 50 percent. Domestic demand has been fairly volatile over the period but appears slightly less so in recent years. Demand fell by nearly five percent in 2007.

[7] Gas demand and electricity demand in figures 6 and 7 are not weather corrected.

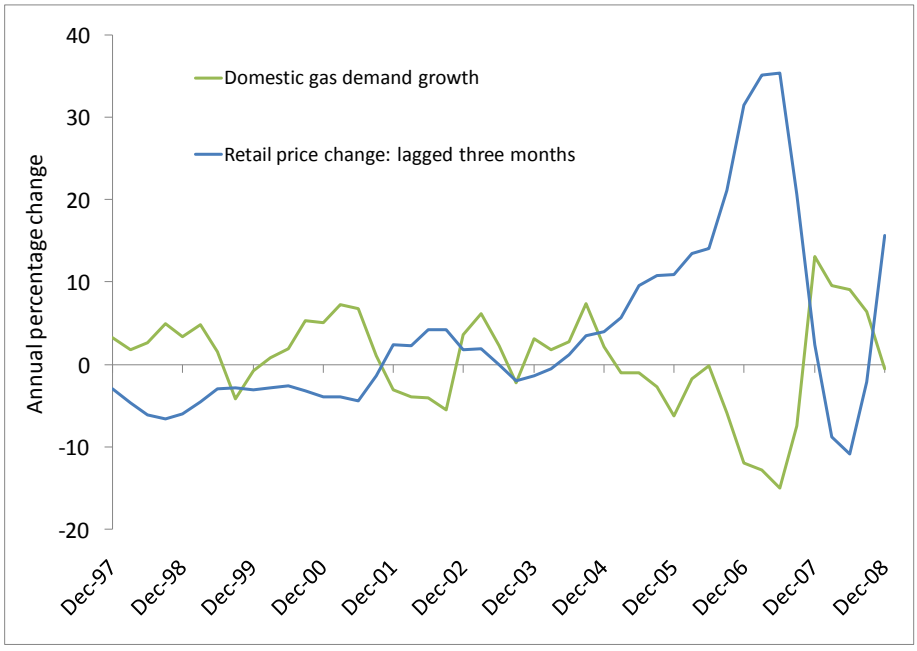
Figure 6: Domestic electricity demand and retail prices



Source: BERR (2008) *UK Digest of Energy Statistics*

Figure 7 plots annual changes in gas demand and price. The gas demand response to the 80 percent increase in prices over the past four years looks to have been relatively strong, at least initially. Domestic gas consumption is seven percent lower than it was in 2004 despite some demand growth over 2008.

Figure 7: Domestic gas demand and retail prices



Source: BERR (2008) *UK Digest of Energy Statistics*

It is not possible to determine the demand response directly attributable to increases in the retail price from observation alone. The size of consumers' demand response to changes in price is known as the price elasticity of demand.[8,9] Our analysis of household electricity and gas consumption in the UK between 1990 and 2007 on a quarterly basis found price to be a significant determinant of electricity consumption while gas demand is significantly influenced by price and income. However, deriving robust estimates of UK domestic energy demand is problematic. The dataset of explanatory variables are somewhat limited in terms of frequency and granularity. For example, using simple dummy variables to represent the commencement of energy efficiency programmes is not ideal, since it is the improvement in energy efficiency and the cumulative uptake that delivers energy savings rather than policy. Similarly, obtaining data on relevant household characteristics is also challenging.

Ideally future analysis would go beyond the aggregate demand level to examine various consumer groups and household types to get a better picture of the differences in customers' price sensitivity. For example, for low income customers, where fuel bills represent a sizeable part of their income, the price elasticity could be expected to be higher. Additional analysis could also consider the pricing ratios or differentials that trigger household investment in efficiency measures in the UK. Some further analysis may eventually be possible using smart meter trial information from the Energy Demand Reduction Project.[10]

Espey and Espey's (2004) review of 36 existing studies on residential demand found the median estimates for residential electricity price elasticities were -0.28 in the short run, and -0.81 in the long run.[11] For residential gas consumption, Bernstien and Griffin (2005) reported values of -0.2 in the short run and -0.3 in the long run. These estimates suggest that domestic energy demand is not very responsive to price changes in the short run. It does, however, increase over time. This is likely to be a result of consumers making some adjustments in usage such as the acquisition of new appliances.

Price can be an important influence on consumer behaviour and there are significant cost-effective opportunities for households to reduce energy consumption and make bill savings. But pricing levels and different pricing structures may only trigger modest investment by households in energy efficiency measures. For many households, energy costs are, in some cases, only a small part of household budgets. For others they are often unwilling to take action when saving energy involves relatively high costs in terms of money, effort or convenience. Others may not be able to respond, at least without reducing essential energy use.

[8] Price elasticity of demand is defined as the change in the quantity demanded for a commodity as a result of a change in the price of the same commodity.
[9] Price elasticity of demand is estimated by modelling energy demand as a dependent variable on own prices and other variables such as income; some measure of appliance stock; the price of substitute fuels or energy efficiency measures; outside temperature; and number of households.
[10] More information about the Energy Demand Reduction Project can be found here: http://www.ofgem.gov.uk/Markets/RetMkts/Metrng/Smart/Pages/SmartMeter.aspx
[11] The range of price elasticities for residential electricity demand reported in the studies went from 0.076 to -2.01 in the short run and -0.07 to -2.5 in the long run.

Barriers to energy efficiency and behaviour change

A number of market failures and barriers make it difficult for consumers to realise energy saving opportunities. The main barriers are:

- Financial barriers particularly around upfront costs;
- Hidden costs from the hassle factor such as redecorating post installation, search costs etc;
- Lack of consumer information about energy efficiency opportunities;
- Lack of consumer agency or empowerment to install measures and change behaviour; and
- Poorly aligned incentives particularly in the rental accommodation sector where tenant pays the energy bills.

The implication of these obstacles is the benefits of action to the household are not as achievable or as large as they first appear. This would help to explain the 'value-action' gap. Research into consumer attitudes on climate change and environmental issues and the specific steps people are taking to save energy showed 80 percent of people believe climate change will affect them and their family, but 40 percent of people were not doing anything to reduce their energy use. People commonly cite the barriers above constrain their ability to do anything.[12],[13] For example, people say they do not know what to do as there is a lack of information about which behaviours have the most impact, either in terms of cost or environmental impact.

Some people also find themselves 'locked in' to consumption patterns that they don't know how or don't feel they can change. For example, participants of the Ofgem's Consumer First panel criticised products that make it difficult for them to cut their energy usage such as TVs that don't allow you to turn them off standby. Lock-in also flows from cultural norms or sheer habit. Many are unwilling to make any further changes to their lifestyles and their energy consumption because they place high priority on home comforts. Others are put off by the hassle factor of having to make changes (for example, drying clothes naturally rather than using a tumble dryer).[14]

Historically domestic energy has been a low engagement issue for consumers. A survey taken in early 2008 showed that a large proportion of consumers did not know what energy tariff they are on.[15] Building an energy saving culture will require a fundamental shift in attitudes and behaviour. Part of this shift will come from an increasing awareness of energy.

The Consumer First panel cited rising energy costs over 2008 as a key factor for increased awareness of energy use around the home, with most people changing behaviour to contain

[12] Defra (2008)
[13] Ofgem (2009)
[14] Ibid.
[15] EST (2008)

or lower gas and electricity bills. The majority of participants say they have made changes to their energy consumption over the past year. Although most changes were small behavioural adjustments (for example, making more effort to turn off lights, turning appliances off standby or filling the dishwasher before running it). However, some are being more frugal in their energy use, making behaviour changes that would have slightly more impact on their lives than the examples above (for instance, putting on more layers of clothing rather than turning on the heating.) Only a small number of people had taken substantial steps that would sustain energy and cost savings if energy prices fall.

But there are risks that even if increases in prices prompt actions consumers could lose confidence that their efforts can make a difference if they do not see any positive evidence of these behaviour changes in estimated bills. The lack of a timely feedback mechanism makes it difficult to tell what kinds of savings are being made by implementing certain changes. The introduction of real time information could allow attitudes to become increasingly reflected in behaviour. The introduction of smart meters is supported by the majority of consumers.[16]

Energy efficiency at the household level fundamentally involves encouraging behaviour change by raising awareness and removing barriers that make it costly or difficult for people to take action. Direct measures, including financial incentives, are needed to overcome high up-front costs, lack of information and advice, split incentives in the rented accommodation sector and the hassle factor. Pricing and tariffs *per se*, are not an effective mechanism to address many of the obstacles but pricing could support other direct measures. For example, pricing structures that engage consumers on their energy use and improve the cost effectiveness could prompt some consumers to look for energy efficiency opportunities as well as reinforce behaviour change.

In recognition of the challenges, a number of programmes have been in place to influence household energy consumption. In addition to energy efficiency standards for new homes via Building Regulations, the key programmes to promote energy savings measures to households have been obligations on energy suppliers such as the Energy Efficiency Commitment (EEC) and Carbon Emissions Reduction Target (CERT). A recent evaluation of EEC 2005-08 estimated suppliers had delivered annual savings of 3.9 and 6.2 TWh of electricity and gas respectively.[17] There has also been an increase in the provision of information and advice to support behaviour change through organisations such as the Energy Savings Trust.

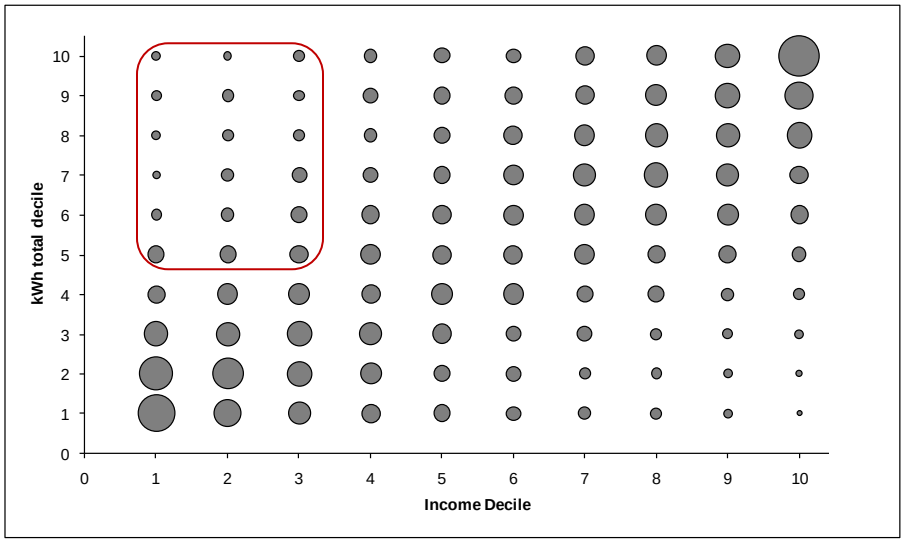
Energy consumption across income groups

The Centre for Sustainable Energy's dataset on the distribution of household consumption of electricity and gas across household income groups is plotted in figures 8 and 9 respectively.[18] The diameter of the bubbles indicates the number of households. Households

[16] Ibid.
[17] Eion Lees Energy (2008)
[18] CSE (2007a) have developed this data set from the 2004/05, 2005/06 and 2006/07 ONS Family Spending surveys, price data from the DTI and sample weightings to relate household weekly

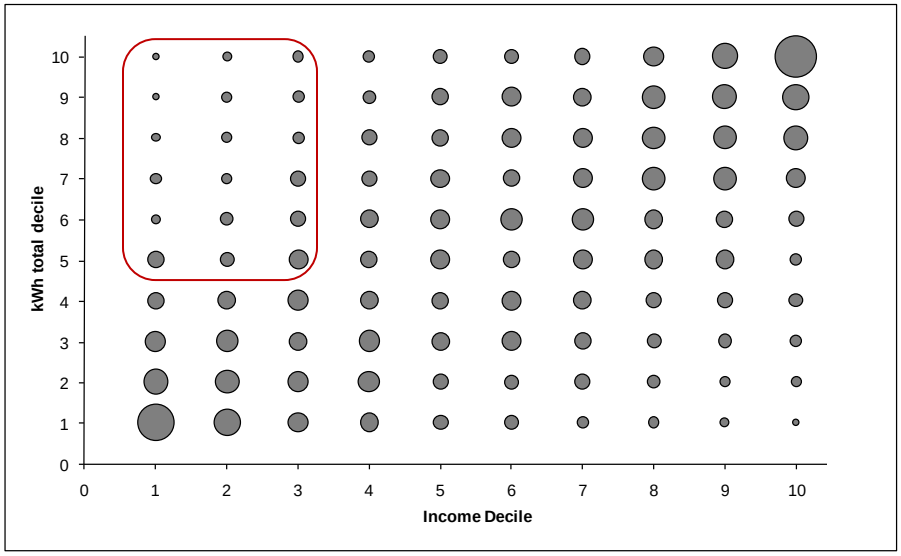
in the bubble in the left hand bottom corner of figure 8 are in the first income decile and lowest consumption profile and have a mean electricity consumption of approximately 940kWh per annum and a mean annual income of just under £5,000. Households in the bubble in the top right hand corner are in the highest income group and have a mean electricity consumption of 6,200kWh per annum and a mean annual income of around £70,000.

Figure 8: Electricity consumption across income groups



Source: Centre for Sustainable Energy (2008) *Assessing the social impacts of a supplier obligation: report to DEFRA*

Figure 9: Gas consumption across income groups



Source: Ibid

expenditure on energy to household energy consumption profiles.

In figures 8 and 9, the largest bubbles tend to be found on the diagonal running from the left hand bottom corner to the top right hand corner. This indicates a positive correlation between energy consumption and income which means higher income households, on average, consume more energy than lower income households.[19]

Nonetheless, in both figures there are some households with a low income / high energy consumption profile. The areas highlighted above represent approximately 18 percent and 17 percent respectively of the electricity and gas consumers in the sample who share such a profile. These households are most likely to be at risk of fuel poverty given the relatively high energy requirements and low income. As explained earlier, they are also likely to be some of the most price sensitive consumers because energy costs account for a greater proportion of the household budget.

Fuel poor households have higher energy costs because they are more likely to:

- Live in poorer quality housing that has, on average, have a lower thermal efficiency rating compared to non-fuel poor households;
- Use more expensive heating fuels such as electricity, oil, solid fuels;
- Occupy the dwelling during the day and not be in full-time employment; and
- Follow a non-standard heating regime[20].

The implication of this is that there could be serious welfare effects for a significant minority of consumers with a low income / high consumption profile. It is likely that these households would have less scope to respond to higher prices through improving energy efficiency (the substitution effect) owing to a lack of financial resources. There is also a concern that they will instead cut back on heating, maybe to a dangerous level, in response to higher prices (the income effect). Without additional measures to address the financial constraints, the income effect is likely to dominate the substitution effect. If the financial constraints were addressed many of these households could have significant scope for improving energy efficiency, reducing energy consumption and, in some cases, alleviating fuel poverty.

There could also be issues for households with high consumption profiles that are living in private rental accommodation, because of the low incentive for landlords to invest in energy efficiency when tenants pay the energy bills. Landlord's incentives could change in future if Energy Performance Certificates start to command a rental premium.

[19] The correlation between income and consumption was 0.22 for electricity and 0.28 for gas.
[20] A standard heating regime involves heating the full house, part of the day, reflecting someone at work with heating on in morning and evening only. A non-standard regime involves heating only part of the house all of the day.

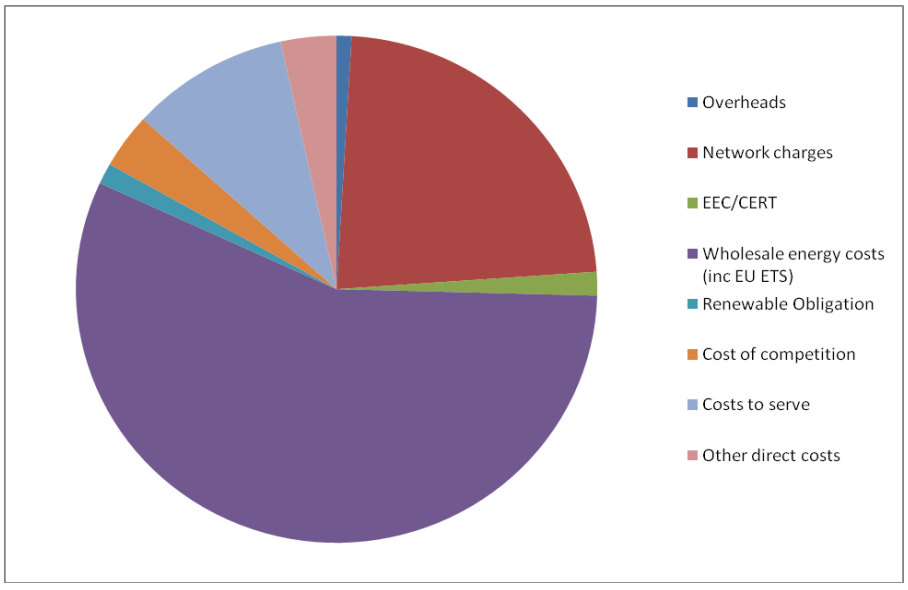
3. Tariff setting in competitive energy markets

Section Summary
In this section we look at suppliers' costs. We also consider suppliers incentives to encourage household energy efficiency. A supplier's incentives to encourage energy efficiency depend, among other things, on the margin per unit of energy sold. In an effective market, we would expect marginal profitability to be kept in check so as to not distort suppliers' incentives to encourage household energy efficiency. The relative importance of suppliers' incentives is not always recognised in the debate on tariff structures. The section also describes the structure of the main residential tariffs on offer in the UK and some other tariffs that can be found or could operate in the UK retail market ahead of the widespread deployment of smart meters.

Since the removal of regulated prices in the retail market in 2002, energy suppliers have been free to set tariffs as they choose. Suppliers operate in a competitive market, funded by private investors. They structure and set tariffs in order to recover costs and make a return to their shareholders. In doing so they must take account of various costs and the strategies of their competitors.

Suppliers face a broad range of costs in supplying energy (see figure 10). These range from being fixed in the short-to-medium term to being variable and dependant on their customers' consumption.

Figure 10: Combined electricity and gas supply costs for 2005-07



Source: Based on aggregate cost data received from five large suppliers, Ofgem.

The significant fixed and variable costs include:

- Wholesale energy costs;

- Network and use of system charges;
- Overheads;
- Costs to serve, including billing costs;
- Customer-related costs including acquisition costs, churn costs and costs to retain;
- Environmental obligations; and
- Social commitments.

Costs of supply

Approximately 60 percent of suppliers' costs are related to wholesale energy costs. Retail competition means that suppliers have a strong incentive to buy their wholesale energy as cheaply as possible. Suppliers generally buy in advance (hedge) on forward markets a significant proportion of their customers' energy requirement to avoid exposure to the volatility of day ahead or spot prices.

The next largest source of costs faced by suppliers in supplying customers is network charges (transmission and distribution). These costs are borne by all suppliers and are passed on to consumers' bills.

Suppliers also incur other (mostly fixed) costs in serving customers such as customer call centre, metering, billing systems, customer acquisition and retention, managing bad debt etc.

Environmental obligations

Energy suppliers are also subject to a number of environmental obligations. Electricity suppliers operating in the UK must meet obligations under the Renewable Obligation (RO) and the Carbon Emissions Reduction Target (CERT). Domestic gas suppliers are subject only to the CERT.

The costs of complying with the obligations of these schemes are incorporated into suppliers' overall cost structures and are recovered through consumers' energy bills. DECC estimates the cost to consumers of existing environmental programmes accounts for 14 percent of average electricity domestic bills and three percent of average gas domestic bills[21].

The structure of suppliers' obligations differs across schemes. The RO, the main support scheme for renewable electricity, obliges electricity suppliers to source an increasing proportion of their electricity from renewable sources, or pay an equivalent amount to those

[21] This is DECC's estimate of the cost of current environmental programmes on consumers' energy bills in the 2008 *UK Renewable Energy Strategy: Consultation Document*; p231. This includes the EU ETS which is incorporated into the wholesale cost of energy.

suppliers who have sourced renewable energy. The obligation is based upon the total megawatt hour (MWh) supplied, and suppliers can be expected to pass this cost into each MWh of electricity they supply to their customers.

In contrast, the CERT, an obligation on electricity and gas suppliers to install energy saving measures in domestic dwellings, is based on a suppliers' total domestic customer numbers. DEFRA estimate the cost to suppliers' of meeting their obligation to be £19 per customer per fuel.

Social commitments

Each of the "Big 6" energy suppliers also voluntarily undertakes a range of initiatives to assist vulnerable and fuel poor consumers[22]. This includes the provision of social and discounted tariffs, one-off rebates and discounts and trust-funds. Suppliers agreed with Government to increase their collective expenditure on these social initiatives over the 2008-11 period, based on their customer numbers. The cost of these initiatives is likely to be spread across a supplier's customers. By 2011 the cost of these social programmes is expected to account for approximately £6.30 of a customer's annual bill.

Supplier incentives

An energy supplier's business model will ultimately be driven by the level of return it can offer to shareholders. In the absence of effective competition, large differentials between suppliers' costs and retail prices could have an impact on suppliers' incentives. For example, a large positive difference between a supplier's costs and revenue from supplying energy to a household may increase suppliers' incentives to sell more kWh rather than promote energy efficiency. However, given the competitive nature of the energy supply market, suppliers need to ensure its tariffs and tariff structures are favourable against those of their competitors. Otherwise, a supplier departing from a competitive pricing approach risks losing market share and profit.

Although suppliers clearly do have an incentive to increase profits by selling more of their core product, this is not the only driver for their business. Factors such as increasing customer numbers, reducing the cost to serve and retaining customers, balancing the cost of purchased power and customer tariffs are all important to a suppliers' bottom line. A supplier selling less energy can be more profitable and produce higher shareholder value than another selling more, if it provides better service, balances energy sales and purchases, manages its cash flows, reduces cost-to-serve through its IT and customer management strategy and retains customers with a strong brand and competitive tariffs. Thus, in a competitive market, a number of factors can limit the relationship between volume and profit.

[22] For a comprehensive review of suppliers' social programmes, see *Monitoring suppliers' social programmes 2007-08*, available at: http://www.ofgem.gov.uk/Sustainability/SocAction/Suppliers/CSR/Documents1/Monitoring%20Suppliers%20Social%20Spend%20171.08.pdf

Tariff structures

A significant proportion of suppliers' costs described above are fixed. This means suppliers' average costs of supplying energy fall as households' consumption increases. Suppliers structure residential tariffs to recover both the fixed costs of supply, as well as the variable costs of the energy the household uses. A two-part tariff structure is the most efficient way to recover fixed and variable costs of supply.

The most common types of residential tariff structures available in Great Britain are based on a two-part charging structure. We describe these and some other tariffs that could operate in the GB retail market ahead of the widespread deployment of smart meters below.

Standing charge tariffs

Standing-charge tariffs incorporate a daily fixed charge and a single price per unit of energy consumed. For households with average consumption, the average standing charge is around 13 percent (£58.87) of the annual electricity bill and eight percent (£60.41) of the annual gas bill[23].

Two-tier tariffs

Two-tier tariffs include a higher unit price on the first tier or block of consumption. Consumption above the level of the first consumption block is charged at a lower per unit rate. The upper threshold for the first tier ranges up to 500kWh to 900kWh for electricity and 2680kWh and 6000kWh for gas[24].

Reduced consumption incentive tariff

SSE has introduced a specific tariff to promote energy efficiency in domestic customers. The tariff motivates customers to reduce their consumption by rewarding customers with a cash credit on their bills if they reduce their consumption year on year. The tariff also offers additional incentive in the form of further financial savings on other services provided by the company such as the installation of energy efficiency measures. The structure of these tariffs is based on a two part tariff structure similar to either a standing charge tariff or a two tier rate.

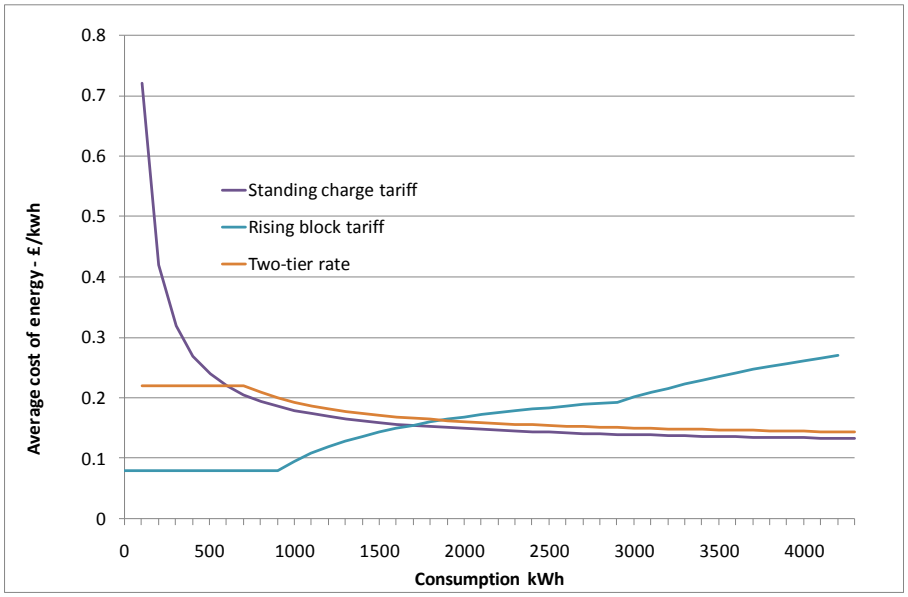
Rising block tariff

Rising, or increasing, block tariffs (RBTs) provide volume related pricing, where energy is priced at a low initial rate up to a specified volume of consumption, and then the unit price increases as consumption increases.

[23] Figures based on all available tariffs in the markets as at 01 January 2009 and from major suppliers. Average consumption relates to 3,300kWH for electricity and 20,500 for gas. Source: TheEnergyShop.
[24] Ibid.

A RBT would reverse the pricing structure of the current domestic tariffs such as the two-tier tariffs so the average unit price of energy would increase with consumption. This is illustrated in figure 11.

Figure 11: Average unit prices of energy under different tariffs



RBTs are not offered by any supplier in the UK at present. RBTs exist in a number of South-East European countries, such as Albania, Bulgaria, Moldova and Romania. In many of these countries, RBTs were introduced as a transitional measure to aid further liberalisation and independent regulation of prices, with the objective of providing an incentive for more efficient use of energy (especially to discourage the use of electricity for heating) and to make electricity affordable for the poorest consumers. In Romania, for example, the RBT is only open to those households whose income is below the national average.

In the US, five tier RBTs were adopted by regulated utilities following California's 2000-01 electricity crisis. In the Flanders region of Belgium, households receive a type of "lifeline" tariff, whereby they get an initial 100kWh for free, plus a further 100kWh per individual in the household. Thereafter, the pricing structure more closely resembles a standing charge tariff with a fixed daily charge and a per unit charge such that the average unit price falls as consumption increases.[25]

The proposed use of RBTs is also a topic of debate in other countries. For example, in Western Australia, where consumers can chose between a regulated or "market" standing charge tariff. The Office of Energy intends to progress work on considering the use of RBTs for domestic consumers and small businesses, once tariffs there approach cost reflectivity.

[25] Information received in personal communication from Belgium regulator.

Time-of-use tariff

Under time of use tariffs (TOUs) the price of energy is based on the time it is consumed. The multi-rate pricing schedule for different times of day are set ahead by suppliers. Economy-7 tariffs represent a simple form of the Time-of-use (TOU) tariff currently operating in the UK. Energy used during the night costs less, per unit, than energy used during the day. Consumers on Economy 7 are likely to optimise the use of the cheaper off-peak tariff for heating using electric storage radiators and heating water, but not for other uses such as washing machines[26]. Economy 7 tariffs are based on the two part tariff structure of a standing charge tariff or a two tier rate.

TOU pricing can take other forms such as critical peak pricing, dynamic and real-time pricing. Critical peak pricing tariffs have high per-unit rates for usage during designated 'critical peak periods'. Dynamic and Real-time tariffs reflect the wholesale price of electricity and therefore can vary continuously over time. Customers and their equipment are presented with dynamic prices, near to real time so that demand responses are required more or less immediately. These latter forms of TOU pricing require sophisticated metering and two-way communications technologies and are not considered further in this paper.

Outside of GB, a number of states offer time-of-use tariffs. Typical on- and off-peak tariffs are available in France, Greece, the Netherlands, Norway, Spain, New York and Maine (US). In Western Australia, all business customers can benefit from TOU tariffs, and some smaller suppliers also offer this to residential consumers. US electricity suppliers are required by law to offer each customer class upon request a "time-based rate schedule", which "shall enable the electric consumer to manage energy use and cost"[27].

Automated load control tariffs

An automated load control type tariff is designed to reduce peak demand on the network. These tariffs offer energy at a lower unit price in exchange for the household allowing the distribution network operator to control the amount of power the household uses for heating or hot water from time to time.

Approximately 10 percent of domestic consumers in Scotland are on a dynamic tele-switching tariff (DTS), a type of automated load control tariff. In addition, some suppliers in the UK are trialling devices that automatically turnoff certain appliances for a period of time (such as fridge) when the system is under particular constraint.

[26] Owen & Ward (2007)
[27] Association of Municipal Electricity Undertakings (2009)

4. Assessment of tariffs

Section Summary
This section sets out some high-level criteria for considering the potential impacts of different tariff structures on household energy efficiency, competition and customers, including vulnerable groups. A broad brush assessment of the various tariff structures immediately follows and is summarised in a table at the end of this section.

Criteria

The assessment criteria broadly cover the environmental, economic and social dimensions of sustainable development. This is a similar approach to that taken by the Centre for Sustainable Energy in its 2008 report for the National Consumers' Council, *Towards a sustainable energy tariffs*.

The assessment immediately follows and is by necessity, largely qualitative. As noted in section two, the available data and research into price elasticity of residential energy customers in the UK gives only limited qualitative insight into customers' price responsiveness. There is even less quantitative analysis looking at the pricing ratios or differentials that might trigger household investment in efficiency measures.

Energy efficiency

- **Signal about the value of energy conservation.** Tariffs that provide transparent signals about the value of energy conservation and the likely rewards and penalties of different energy use patterns could help improve consumers' awareness about their own energy use.
- **Impact on the financial payback.** Different tariffs structures could influence the uptake of energy efficiency measures by households by shortening the payback on the costs of measures.
- **Increase consumer engagement on their energy use.** Some tariffs could provide consumers with greater awareness of their energy use and a better sense of control on actions they take. This could help to re-materialise habitual energy use patterns.
- **Stimulate demand for and the provision of energy services.** Some tariffs could encourage a culture around energy efficiency and the development of a competitive energy services market. For example, tariffs could explicitly encourage consumers to become more proactive in identifying opportunities to improve energy efficiency. Similarly suppliers' could market tariffs alongside the provision of energy services to help their customers achieve energy savings.

Effective competition and economic efficiency

- **Impacts on competition, innovation and consumer choice.** In a competitive market, suppliers compete on price, innovation and service. Consumers benefit from economic efficiencies and better quality of service. Some tariffs could facilitate or impede the ability of suppliers to compete in these areas and restrict choice.
- **Impacts on efficient whole-of-system investment.** Competition provides incentives for suppliers to invest efficiently to meet their customers' requirements for security of supply, or risk losing business. Different tariff structures might have an impact on the efficacy of the price signal for additional capactity required in the future and for rationing demand.

Vulnerable consumers

- **Impact on fuel poverty**. There are a number of factors that contribute to fuel poverty, not all of which relate to fuel prices.[28] In terms of different tariff structures and fuel poverty some relevant considerations are the impact on fuel affordability, the ease by which different tariffs could be compared, and the accessibility or applicability to different consumer groups. Different tariffs might also assist in identifying vulnerable customer groups and targeting assistance to alleviate fuel poverty.

Standing charge tariffs and two tier tariffs

Impacts on energy efficiency

As noted earlier, the average unit price of these tariffs falls as consumption increases because of the two part tariff structure to recover fixed and variable costs of supply. Consumers are familiar with cheaper average unit costs from bulk buying marketing strategies used in other industries such as supermarkets. However, not many consumers think about their energy use in terms of units or average costs. The metric relevant for most residential customers is their total energy bill.[29]

Under these tariffs a given percentage of energy savings will not be translated into the same percentage of savings on a consumer's energy bill. This is because standing charges are payable regardless of usage and consumers on two tier rates are unlikely to reduce consumption to the extent they can avoid the higher per unit tariff on the first tier. This lengthens the payback on energy efficiency measures and provides less of an incentive for consumers with a strong weight on near-term benefits to invest. Consumer research shows that consumers generally have a relatively short payback horizon – approximately three years.[30]

A change in the average unit costs is unlikely to motivate non-fuel poor consumers to actively manage their energy use. Publicity about rising energy costs and increases in total

[28] These include household income and housing quality.
[29] Finding in forthcoming Ofgem Consumer First panel report.
[30] Element Energy (2008)

energy bills are likely to have been the main prompt for some consumers to start making an effort to reduce their energy consumption. In addition, some payment methods such as direct debit that smooth payments and estimated bills also reduce the feedback people receive on their actual patterns of energy use. Consumers on prepayment meters may be more aware about the cost of their actual energy use but, in many cases, have less financial resources or opportunity to undertake energy efficiency measures.

Impacts on customers and competition

Consumers willing and able to participate actively in the market seem to benefit from competitive offerings of the two main tariff structures.[31]

Some consumers have expressed a preference for standing charge tariffs over two-tier rate structures because the tariff structure makes it easier to compare different suppliers' offerings.[32] Consumers are sometimes perplexed by the range of tariffs on offer and find the variable unit prices and thresholds of two tier tariffs particularly difficult to grasp. This complexity is an issue if it makes it difficult for consumers to compare offers and find the best option for their circumstances.

Because these tariffs are time-invariant there can be a significant difference between the price households pay and the real-time cost of delivering the energy. This smoothing of real-time costs of supply, in combination with energy settlement for small customers using profiles, excludes the potential participation of demand side response from residential customers. This represents a missed opportunity to help balance system constraints that could save energy and money for customers as well as assist in the efficient investment of the future capacity, including network.

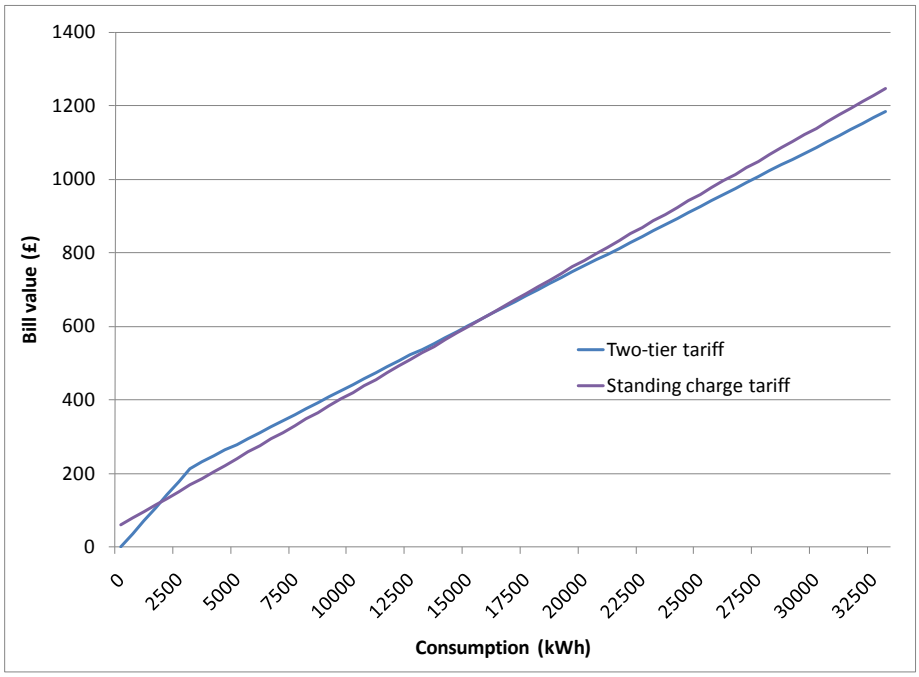
Impacts on vulnerable customers

On average, low income households are also low consumption households. CSE (2008) noted that the standing charge and more expensively priced first tier of these tariffs constitute a larger proportion of a low users' bill. This means low users typically pay more for each unit of energy compared with high consumption households.

CSE also noted the difference between the two tariffs for customers is largely presentational and that that consumers with low consumption should benefit from a two tier tariff. However, our analysis shows that while the bill values at average consumption levels are broadly the same, the annual bill of a low user of gas on a two tier rate is approximately five percent higher (circa £20) than the annual bill on a standing charge tariff (see figure 14). This result is at odds with the original political rationale for encouraging the removal of standing charges to assist low users. At high gas consumption levels, the two-tier tariff is around £45 (4%) cheaper than the standing charge tariff[33].

[31] Ofgem (2008)
[32] Ofgem (2009)
[33] Analysis based on the average of available tariffs in the market as of 1 January 2009 and from the main suppliers only. For gas, we define low consumption as 10,000kWh, average consumption levels is 20,500kWh and high consumption is 28,000kWh. Source: TheEnergyShop.

Figure 14: Gas bill values



Source: Ofgem's Domestic Price Database

Reduced consumption incentive tariffs

Impacts on energy efficiency

These tariffs provide an explicit signal to consumers about the value of energy conservation. Consumers are likely to understand the cash credit reward they will receive if they become more energy efficient and reduce their energy consumption. Positive incentives in the form of cash credits are generally viewed more favourably by consumers than a future stream of bill savings. People see this as a 'true reward' for doing their bit, despite the likelihood that lifetime bill savings could be greater than the one-off reward.[34] In combination with the bill savings, customers receive a double incentive to reduce consumption. This will shorten the payback on energy efficiency measures.

This tariff is most likely to appeal to a niche market of customers who want to be proactive in reducing their energy use. However, the modest level of reward might only encourage investment in less expensive energy efficient measures so that the level of energy savings achieved at the household level might not be very large. The tariff is not likely to appeal to the mass market and thus not very effective in achieving a significant volume of energy savings for the UK as a whole.

Impacts on customers and competition

The underlying rate structure is similar to the two part pricing of standard tariffs and two tier rates, thus efficiently recovers both the fixed and variable costs of supply.

[34] Ofgem (2009)

Consumers could benefit from improved levels of service and advice about their options for energy services, as part of the marketing package about the tariff.

This tariff could prompt consumers with the ability to pay to invest in energy efficiency. This may help to reduce the deadweight loss of supplier obligations for energy efficiency subsidised by consumers. Encouraging those that have the ability to pay to do so will be especially important given the likely costs of achieving the domestic energy savings set out in the Government's consultation[35].

Suppliers may also be attracted to this tariff because it allows self-selection of attractive/desirable customers. As noted above this tariff would appeal mostly to customers interested in reducing their consumption and this may also correlate to customer groups that are on good incomes, and are computer literate. Generally, customers with these characteristics are profitable from a supplier's viewpoint, despite the potential for them to reduce consumption, because they have lower costs to serve, and are a willing-to-pay market for energy efficiency measures. CSE (2008) also suggest suppliers could be attracted to incentive schemes if they are effective in retaining customers.

An increase in customer demand for these types of tariffs could help the development of a competitive energy services market. This could give consumers more information and choice about the measures that are appropriate for their circumstances, better service and also help to stimulate a competitive loan market to help households install measures through 'pay as you save' schemes.

Impacts on vulnerable customers

The reward is modest and one off so it is unlikely to address fuel affordability issues. In addition, low income households are unlikely to have the financial resources to install measures to achieve significant energy efficiency savings. CSE suggest that many low income households would not be able to access these types of tariffs because they are only available online.

If the tariff helps to foster the development of a competitive energy services market it could help mitigate deterioration in fuel affordability in the longer term.

Rising block tariffs

Impacts on energy efficiency

RBTs could sharpen the incentives for high users to reduce their energy usage if energy consumption above a certain level was priced very high. Consumers are likely to understand high users would be penalised under a RBT if they don't take action to reduce their consumption. RBTs would also shorten the pay-back on installing energy efficient measures for high users.

[35] DECC (2009)

If a RBT was set with a low price on the first block to improve fuel affordability it will also be fairly transparent that customers who are low users would benefit by paying less per unit. If consumers had a choice of a RBT then it is likely only those who stand to gain would opt to take it up and the energy efficiency incentive would be diminished as few high users would choose to take it up. To deliver improved energy efficiency it would be necessary for RBTs to be mandatory, but that raises a number of issues discussed below.

CSE (2007) estimated a mandatory RBT could result in a reduction in domestic consumption between 1 – 7.4 percent for electricity and 2.5 – 7.9 percent for gas depending on the relative weights between social and environmental objectives.

However, energy efficiency in households is likely to be more dependent on suppliers' incentives than the price impacts on customers' behaviour. A RBT would give suppliers a strong disincentive to encourage household energy efficiency as it increases the marginal profitability of additional sales. The adverse impact on suppliers' incentives may well outweigh the environmental benefits from households' incentives to become more energy efficient. It would at least discourage suppliers from assisting customers in reducing demand through proactive provision of information or services, which, as explained in section two, is essential (from suppliers or others) in addressing the barriers to energy efficiency.

Impacts on customers and competition

It is unlikely the market would voluntarily introduce or compete on RBTs given the current structure of costs. From a supplier's point of view, the tariff would appeal to low users and appeal less to high users. If a supplier did not attract enough high using households to sign up to the tariff it would find it difficult to recover costs of supplying energy under this tariff.

This suggests that the implementation of a RBT would have to be mandatory. A mandatory RBT could have a significant impact on the effective functioning of the competitive market and major implications for consumer choice, prices, retail competition and innovation. A mandatory RBT would mean that suppliers could no longer offer a full range of other tariffs and this would reduce consumer choice. The impact on price would also depend on the balance between social and environmental objectives. CSE's modelling showed an emphasis on environmental objectives would lead to price increases for all UK consumers. A larger weight on social objectives would reduce the price for low users but create correspondingly higher average prices for high consumption households.

Under a RBT-type tariff, the link between a household's consumption and a supplier's profit depends on the consumption block the household's energy usage falls into. Conceivably, a low-consumption household would represent a loss to a supplier while a high-consumption household would result in very high (or super-normal) profits for suppliers. RBTs have the potential to emphasise classes of desirable and less desirable customers from a suppliers' viewpoint. Given that high-consumption households would be more profitable for suppliers, there could be less competition for low-consumption consumers, resulting in worst customer service etc for certain categories of consumers.

Implementation of a RBT would involve significant changes to business systems and costs to implement, both in terms of up-front costs and on-going costs. For example, it would be necessary to reconfigure pre-payment meters and new billing systems to account for accumulative aspect of calculating RBT based bills. It would also require more frequent meter readings, so that consumers can adequately and regularly compare their consumption pattern with their bill value. There could also be significant issues about the administration costs of a RBT tariff which presumably would be akin to some form of price control. Other issues could include setting of the volume and prices of blocks, whether the blocks are adjusted for variation in household size, regional variation in heating requirements, incorporating seasonal variation in demand, compensating for extreme weather events etc.

Impacts on vulnerable customers

The introduction of an RBT-type tariff with a cheaper initial consumption block could help improve fuel affordability for low-consumption households. RBTs also have the advantage of not requiring the implementation of a means test and avoid stigmatising low-income households.

The scale of any such improvement would depend on the degree of cross-subsidisation from high consumers to low consumers. Bernstein (2008) looked at the RBT structure in California and found that the rate structure does redistribute income to lower-income groups, but that the effect was fairly modest, particularly compared to a means-tested program also in use.

CSE (2007) also showed that across households there are likely to be some big winners and losers under a RBT tariff structure. Estimates of reasonable energy requirements would vary across households according to various factors such as number of occupants, heating systems, thermal efficiency of the dwelling, average regional temperatures etc. Consequently, while some low income customers may be better off on average, a significant minority of households could be made worse off by a RBT. As discussed in section two, many fuel poor households in the UK have high usage not because they are profligate but as a result of higher energy requirements. For these households, a RBT could exacerbate financial hardship. While it might be possible to address this with further redistributional measures there is a risk that RBTs could hinder rather than help tackle fuel poverty.

Time of use tariffs

Impacts on energy efficiency

Most consumers would be familiar with time-based tariff systems from other industries, such as rail travel and mobile phones. The tariffs generally provide an incentive to households to avoid consumption in the higher priced periods and shift consumption to the lowest priced period to reduce energy bills. For example, EDF's trials in France of its "tempo" critical peak period tariff (two daily price periods and three types of days) found that daily consumption fell by 45 percent on high price days compared with lowest-price days.

Studies on consumers' likelihood to respond to TOU tariffs suggests a varied picture of consumers' responsiveness. Haney, Jamasb and Pollitt (2009) review of studies found own-price elasticities vary from -0.68 to -2.57.

Customers' responsiveness to time based prices will depend on several factors. The first of these is the extent to which end use is discretionary or is able to respond to TOUs. Owen and Ward (2007) estimate a potential discretionary load of around 20 -25 percent of all domestic electrical appliance use, equating to around 16 TWh per annum in the UK. Another aspect is the households' flexibility to modify their energy use. Some households may have less potential to respond to price signals and switch usage between time periods particularly if they are down to "essential" energy services already. The size of the pricing differentials will also be important for stimulating the customer engagement and response. If these are steep, customers would be more likely to actively seek opportunities to defer discretionary consumption to the lower priced periods.

The impact of TOUs on reducing a household's overall energy use is less clear. Non-discretionary usage at the times when peak energy is more expensive will provide an incentive at the margin for consumers to improve their energy efficiency. Many of these actions such as reducing standby consumption or better insulation could also apply in periods when the price is cheaper. Together these could result in overall reduction in energy consumption. On the other hand, households that can shift usage to off-peak periods and achieve bill savings will have less of an incentive to install energy efficiency measures. Trials have had mixed results. In Northern Ireland, TOU keypad meters in 2004 found that while customers reduced their consumption by 10 percent at evening peak, their overall consumption increased slightly. However, in a follow up survey in 2007 more than a third of respondents had reduced their consumption.

Although TOUs may not lead to a significant reduction in domestic consumption they may contribute to environmental objectives of lower CO2 emissions in other ways. If TOUs are successful in changing the domestic consumption profile it may require less carbon intensive generation to meet peak demand. Reducing the peaks in demand also helps to reduce transmission and distribution losses which also contribute to energy savings and reductions in CO2 emissions.

Impacts on customers and competition

Consumers can benefit from lower bills if they are able to adjust energy use to optimise use in the lower priced off-peak periods. Evidence from other markets suggests that some consumers find TOUs fairly easy to understand and have been positive about the savings they have made in terms of bills.

Suppliers set their TOU pricing schedule to shape households' consumption profile so that it matches their costs of supply. Suppliers are likely to provide information to households about the how they can maximise the benefits of being on this tariff in order to reduce the price risk if customers don't respond.

TOUs allow an extra dimension by which suppliers can compete and innovate. Incumbent suppliers have recently introduced some new TOU tariffs and new entrants, specialising in offering time-based tariffs, have started to appear. An increase in TOU structures could increase customer choice and options to suit lifestyle and usage patterns, potentially further reducing cross-subsidisation between different customer groups.

The introduction of more sophisticated TOUs such as real-time pricing would most likely require smart meters to record the time when energy is consumed, as well as the amount consumed. Until such a time there is a UK roll out of meters that can support these tariffs there is a risk the technology used to support the tariffs could make it costly for consumers to switch suppliers. In the long term, TOU-based tariffs, in conjunction with smart meters could provide much more scope for tariff innovation and customer engagement on their energy usage as well as the building blocks for active network management.

Impacts on vulnerable customers

TOUs could help improve fuel affordability for households with flexible energy use patterns. By necessity low income customers tend to be price sensitive therefore they may benefit from price differentials if they can reduce demand at peak times to reduce their energy bills.[36] The potential benefits of TOU for vulnerable and fuel poor customers will depend on the flexibility of their energy use patterns. Some vulnerable and fuel poor households may have a less flexible load profile than other households - for example, people with disabilities, and people caring for children. Some others may have higher dependence on energy during the daytime but greater flexibility around times of peak demand. This is an area that needs to be better understood.

It may be difficult for some vulnerable customers to understand how to make savings under a time-based framework. This could result in much higher costs for vulnerable customers such as those with literacy difficulties. Ideally information and advice would be given on the tariff to help consumers understand the time-based framework.

Automated load control tariffs

Impacts on energy efficiency

The tariff is unlikely to prompt customers to consider the costs and benefits of behavioural change or additional opportunities for energy efficiency (subsequent to the initial decision to relinquish control of some aspects of energy use in return for lower prices). The discounted unit prices lengthens the payback period of installing additional measures. CSE (2008) note that dynamic demand control is not designed to influence consumer behaviour since demand reduction takes place automatically.

The tariff provides a tool for suppliers or network operators to automatically manage smaller customers' use of energy. However, it is unlikely this approach would be effective for

[36] Reiss and White (2001) looked at the price elasticity of low-income customers in California and found these consumers have higher price elasticities than the average customer and may therefore be more likely to shift usage in response to higher prices.

making significant contributions to energy conservation since it would not be very attractive to consumers if they were being targeted, with noticeable loss of service, over-and-above consumers on other types of tariffs.

Nonetheless, the coordination and participation of smaller customers' demand could help achieve energy savings by reducing transmission and distribution losses. It may also contribute to broader environmental objectives by being used to help balance and integrate a higher percentage of renewable energy.

Impacts on customers and competition

Customers could face higher costs of switching to other suppliers due to the metering arrangements to enable the automatic control raising some concerns as to the competitiveness of this market. However, DTS customers on the third-party remote switching in Scotland pay around 10 percent less than those on regular tariffs.

The advantage of this type of tariff is that it allows the network operators to centrally manage smaller customers' load. This could be potentially valuable to network operators and suppliers because of the certain availability of the demand response. The automatic control of smaller customers' load at a large enough scale could provide significant economic efficiencies for suppliers and ultimately customers because it will help to reduce the costs of network constraints and potentially avoid or defer investment in additional capacity.

Impacts on vulnerable customers

Customers on the DTS tariff in Scotland are not on the gas-grid, and may include a significant proportion of fuel-poor consumers (due to higher costs of electricity to heat etc). This type of tariff provides savings to consumers in exchange for a loss of control on some aspects of energy end use, which may help alleviate some instances of fuel-poverty. However the tariff structure may not take account of individual requirements and may not meet the needs of consumers with specific energy requirements.

Summary

Table 3 summarises how the different tariff structures might be expected to perform across the criteria.

Table 3: Summary of tariff assessment	Energy efficiency	Customers & competition	Vulnerable customers
Standing change / two tier rates	• Total bill most relevant metric for customers • Bill savings less than energy savings • Low engagement & uncertain reward	• Efficient recovery of fixed and variable costs • Variable unit prices & thresholds make it difficult for consumers to compare offers • Time-invariant tariffs exclude demand side participation from smaller customers and possible benefits eg reduced costs	• Low users (and often low income) pay more per unit of energy compared with high consumption households • Typical low use customers worse off on two-tier tariffs relative to standing charges
Reduced consumption incentive	• Explicitly encourages consumer engagement • Presentation of positive incentive helps consumers to make better decisions • Could encourage greater demand for energy services market	• Efficient cost recovery • Prompts customers with ability to pay possibly reducing deadweight loss • Could improve consumer choice & service about energy services • Allows suppliers to innovate in energy service business model	• Modest reward for reducing consumption unlikely to address fuel affordability issues • Could be issues around accessibility for vulnerable customers is tariff only available online
Rising block tariff	• Could enhance price signal to high users • Could prompt high users to seek to reduce energy use • Reduced effectiveness if suppliers' incentives outweigh households' incentives	• Voluntarily RBTs loss-making for suppliers • Mandatory RBTs could result in reduction in consumer choice, innovation & increase in prices • Distort suppliers' incentives as profit rapidly increases with sales	• Could help improve fuel affordability for low consumption households • Likely to be negative welfare effects for significant minority of households with low income / high energy usage • Could induce lower quality of service for low users (typically low income)
Time of use	• Time-based pricing increases consumer engagement & sense of control • Mixed results on overall energy use • But can lead to environmental benefits through reducing peaks & managing constraints	• Some consumers could benefit from lower bills by switching usage to low priced periods • A new dimension for competition • Increase in customer choice • Reduce cross-subsidisation between different customer groups • Until smart meters are widespread could increase customer switching costs	• Welfare effects uncertain need more information about flexibility of energy use in low income and fuel poor households • Potentially difficult for some vulnerable customers to understand how to make bill savings under time-based tariffs
Automated load control	• Doesn't prompt consumers to actively reduce use • Effective tool for suppliers to manage some aspects of customers' energy use • Low consumer acceptance to deliver large savings but may contribute to environmental objectives	• Potentially higher switching costs for consumers ahead of widespread deployment of smart meters • Certain availability of smaller customers' demand side participation could contribute to economic efficiency	• Discounts on energy prices could help fuel affordability in some instances of fuel poverty

This broad brush assessment does not suggest that a single price structure can equally advance all the objectives simultaneously. The various tariffs have different strengths and weaknesses in relation to the impacts on energy efficiency, competition and across different customer groups. However, the possible welfare effects across different consumers groups are a particularly important consideration. Competitive pricing has driven down prices for all consumers, including the fuel poor, and it would be important to retain the benefits of this as far as possible, and minimise distortions to competition and suppliers' incentives.

An important point this assessment highlights is that better information about tariffs and the economic incentives to be gained from energy efficiency improvements, might help consumers make better decisions. In Ofgem's 2008 Energy Supply Markets Probe, there was clear evidence that many consumers experience significant confusion in making decisions about tariffs and suppliers. It is likely that this difficulty also extends to consumers' decision making about the choices and options they have around improving energy efficiency. Prior to the widespread implementation of smart meters, much more could be done to improve the presentation of information about different tariffs provided on the bill and through other channels to help consumers make significantly better choices. The framing of prices is a well recognised tool in marketing and could have a significant effect on how customers perceive the risks and rewards of particular actions under different tariffs.

Looking ahead there is a likely to be significant potential for more innovation/customer engagement. Smart meters could be used to facilitate more demand side participation, leading to environmental benefits and savings to consumers through dynamic charges which reflect the real-time costs of supplying energy. This could appear complex but it seems likely that a user-friendly interface could be developed to improve presentation for consumers.

5. Options for improving sustainability

The challenge

A sustained reduction in energy demand could help the UK achieve its climate change and renewable energy targets as well as reduce the investment needed in the supply chain. There is a significant cost-effective potential at the household level to do so through energy efficiency measures and modest behaviour change. The challenge is in realising this potential.

Charging structures to reinforce price signals

Increasing environmental costs and investment required to meet future energy requirements are contributing to higher energy prices. If this causes energy costs to increase as a proportion of consumers' budgets this is likely to intensify consumer awareness about their energy use. At any given price level, different tariff structures also interact with the incentives for more efficient energy use. In this paper we have looked at how some charging structures might provide sharper economic incentives for consumers to take action than others. We also consider the impacts different charging structures could have on competition, suppliers' incentives for energy efficiency and welfare effects across different income groups. On balance, it appears there could be some concerns around using pricing restraints to sharpen incentives in view of the possible distortions on competition, and suppliers' incentives. The complex distribution of winners and losers from different charging structures also suggest that there is no quick win for the issues of identifying and targeting protection and assistance to vulnerable customers and those that can least afford to pay.

This leads to the question of whether it is possible to have charging structures that can sharpen the existing price signals and encourage consumers to become more energy efficient without compromising the benefits of competition for all consumers, including vulnerable customers. To add to the debate, we conclude with some ideas about how Government might contribute in this area. These are, properly, matters for Government to decide.

Influencing charging structures through suppliers' costs

One option Government has at its disposal to influence prices is to consider the way it structures supplier obligations. These are an increasingly large part of suppliers' costs, and Government could, if it wanted, structure obligations to replicate some of the benefits of certain pricing structures. In an effective market, suppliers are likely to alter their pricing structures to reflect changes in their costs given the competitive risks of not doing so. It may be possible to structure obligations to explicitly sharpen energy efficiency incentives

and also to consider the issue of 'who pays' when setting supplier obligations. There are options which have different welfare effects and could assist those in fuel poverty.

The structures of existing supplier obligations do little to incentivise households to improve their energy efficiency. Currently, all consumers pay the same proportion of their energy bill to fund the RO. To fund the CERT consumers are likely to pay the same absolute amount per fuel, regardless of their consumption level (assuming suppliers pass on the CERT cost in this way).

This means that, even at modest consumption levels, where consumers have little scope to be energy efficient or are already being energy efficient, they contribute the same proportion of their energy bill, or in the case of the CERT, the same amount as customers with high consumption. This does not explicitly encourage consumers to be energy efficient since they cannot reduce the absolute or relative amount they pay by reducing their energy use. This is at odds with the purpose of the programme to encourage energy efficiency. It is also regressive since energy bills represent a higher proportion of expenditure for low income than better off households.

Advancing sustainability

Environmental externalities are best addressed directly by polluter pays measures and distributional concerns through the tax and benefits system. This approach can minimise distortions to the market and is the most equitable way to recover costs of programmes since low income households pay less tax than higher income households. The tax and benefits system is inevitably more flexible and able to accommodate tapering (to avoid the poverty trap problem) and rapid changes in a household's circumstances from week to week.

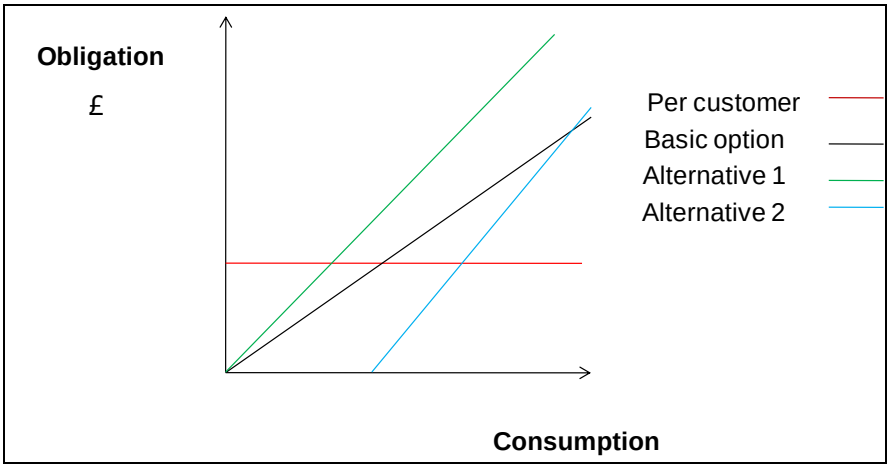
Government could also look at the options of structuring obligations to explicitly provide incentives for improving household energy efficiency. One approach could be to base obligations on a proportion of annual sales less a basic block of consumption (kWh) per customer.

Owen (2008) discusses the regressive nature of climate change policies paid for by gas and electricity customers, both in terms of who pays and who benefits. Owen highlights the need to consider the equity implications in the design and development of policy to avoid conflict between environmental and social goals and recommends prioritising a greater proportion of programme benefits such as energy efficiency measures to 'climate and fuel proof' low income and vulnerable households. In the absence of more public financing for energy efficiency support schemes, Owen also recommends minimising the regressivity of funds raised through customer charges.

To address growing equity concerns about the regressive aspect of funding programmes, the Government could consider structuring suppliers' obligations to be more progressive, effectively changing 'who pays' and 'by how much'.

Figure 15 below illustrates the impact that structuring suppliers' obligations in different ways might have on consumers bills. We compare this to how we expect the current CERT obligation is feed through to customers' bills (red line in figure 8). The basic option (black line) is the obligations based on volume supplied (kWh), which is similar to the RO. Alternative 1 (green line) is an obligation based on volume supplied to 'non-vulnerable' customers (kWh). Alternative 2 (blue line) is an obligation structured on the volume supplied to all customers above 2000 kWh/year for electricity.

Figure 15



Basing environmental obligations on energy supplied to 'non-vulnerable' customers (green line) would reduce suppliers' costs of serving vulnerable customers and might help to mitigate the impact of rising costs for those already struggling to pay their bill. The higher unit costs of consuming above the basic block (the blue line) could also be expected to provide a stronger price signal to consumers about the value of using energy wisely. These examples illustrate how such an approach could contribute to sustainability as well as work within the competitive market. Of course, there are other costs, such as VAT, distribution and transmission charges, that are borne by suppliers and passed on to consumers' bills that could also be sculpted to replicate sharper incentives to reduce consumption or exemptions for certain customer groups.

Appendices

Appendix 1 – Stakeholder feedback

1.1. Ofgem would like to hear the views of interested parties in relation to any of the issues set out in this document (in particular, we would like to hear from suppliers, consumers, environmental groups).

1.2. Responses should be sent to:

European Strategy and Environment

Ofgem

9 Millbank

London

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0207 901 7390

Anna.Kulhavy@ofgem.gov.uk

1.3. Unless marked confidential, all responses will be published by placing them on Ofgem's website www.ofgem.gov.uk. Respondents may request that their response is kept confidential. Ofgem shall respect this request, subject to any obligation to disclose information, for example, under the Freedom of Information Act 2000 or the Environmental Information Regulations 2004.

1.4. Respondents who wish to have their responses remain confidential should clearly mark document/s to that effect and included the reason for confidentiality. It would be helpful if responses could be submitted both electronically and in writing. Respondents are asked to put any confidential material in the appendices to their response.

1.5. If you have any further queries, please contact the above named person.

Appendix 2 – The Authority's powers and duties

1.1. Ofgem is the Office of Gas and Electricity Markets which supports the Gas and Electricity Markets Authority ("the Authority"), the regulator of the gas and electricity industries in Great Britain. This Appendix summarises the primary powers and duties of the Authority. It is not comprehensive and is not a substitute to reference to the relevant legal instruments (including, but not limited to, those referred to below).

1.2. The Authority's powers and duties are largely provided for in statute, principally the Gas Act 1986, the Electricity Act 1989, the Utilities Act 2000, the Competition Act 1998, the Enterprise Act 2002 and the Energy Act 2004 , as well as arising from directly effective European Community legislation. References to the Gas Act and the Electricity Act in this Appendix are to Part 1 of each of those Acts.[37]

1.3. Duties and functions relating to gas are set out in the Gas Act and those relating to electricity are set out in the Electricity Act. This Appendix must be read accordingly[38].

1.4. The Authority's principal objective when carrying out certain of its functions under each of the Gas Act and the Electricity Act is to protect the interests of existing and future consumers, wherever appropriate by promoting effective competition between persons engaged in, or in commercial activities connected with, the shipping, transportation or supply of gas conveyed through pipes, and the generation, transmission, distribution or supply of electricity or the provision or use of electricity interconnectors.

1.5. The Authority must when carrying out those functions have regard to:

- the need to secure that, so far as it is economical to meet them, all reasonable demands in Great Britain for gas conveyed through pipes are met;
- the need to secure that all reasonable demands for electricity are met;
- the need to secure that licence holders are able to finance the activities which are the subject of obligations on them[39];
- the need to contribute to the achievement of sustainable development; and
- the interests of individuals who are disabled or chronically sick, of pensionable age, with low incomes, or residing in rural areas.[40]

1.6. Subject to the above, the Authority is required to carry out the functions referred to in the manner which it considers is best calculated to:

- promote efficiency and economy on the part of those licensed[41] under the relevant Act and the efficient use of gas conveyed through pipes and electricity conveyed by distribution systems or transmission systems;

[37] entitled "Gas Supply" and "Electricity Supply" respectively.
[38] However, in exercising a function under the Electricity Act the Authority may have regard to the interests of consumers in relation to gas conveyed through pipes and vice versa in the case of it exercising a function under the Gas Act.
[39] under the Gas Act and the Utilities Act, in the case of Gas Act functions, or the Electricity Act, the Utilities Act and certain parts of the Energy Act in the case of Electricity Act functions.
[40] The Authority may have regard to other descriptions of consumers.
[41] or persons authorised by exemptions to carry on any activity.

- protect the public from dangers arising from the conveyance of gas through pipes or the use of gas conveyed through pipes and from the generation, transmission, distribution or supply of electricity; and
- secure a diverse and viable long-term energy supply.

1.7. In carrying out the functions referred to, the Authority must also have regard, to:

- the effect on the environment of activities connected with the conveyance of gas through pipes or with the generation, transmission, distribution or supply of electricity;
- the principles under which regulatory activities should be transparent, accountable, proportionate, consistent and targeted only at cases in which action is needed and any other principles that appear to it to represent the best regulatory practice; and
- certain statutory guidance on social and environmental matters issued by the Secretary of State.

1.8. The Authority has powers under the Competition Act to investigate suspected anti-competitive activity and take action for breaches of the prohibitions in the legislation in respect of the gas and electricity sectors in Great Britain and is a designated National Competition Authority under the EC Modernisation Regulation[42] and therefore part of the European Competition Network. The Authority also has concurrent powers with the Office of Fair Trading in respect of market investigation references to the Competition Commission.

[42] Council Regulation (EC) 1/2003

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