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Energy Tariffs for Sustainability

A report by the Centre for Sustainable Energy for WWF-UK

CENTRE FOR SUSTAINABLE ENERGY

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Energy Tariffs for Sustainability

Report to WWF-UK

By Joshua Thumim, with Vicki White, Zoe Redgrove and Simon Roberts

Written in collaboration with Paul Herrington, author of 'Water Tariffs for Sustainability', also for WWF-UK.

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Context

It is now widely accepted that a 2 degree rise in average global temperature is a critical threshold, beyond which dangerous climate change will become inevitable. The avoidance of this requires global emissions reductions far beyond those codified in the international agreements to which the UK is currently a party. Even so, while the UK is on course to meet its binding Kyoto 2010 target of a 12.5% greenhouse gas emissions reductions relative to 1990, it is unlikely to meet the domestic target for a 20% reduction in CO_2 emissions over the same period. Much more radical action is therefore needed to curb UK emissions from all sectors, including those resulting from household demand for electricity and gas, on which this report focuses.

As the figures below illustrate, household demand for electricity and gas has grown consistently over the past three decades in the UK, and although emissions from household electricity demand fell during the 1990s as a result of changes to the generating fuel mix, these reductions are now being lost as those changes in the mix are reversed, and demand increases.

Figure A: Household gas use and CO_2 emissions

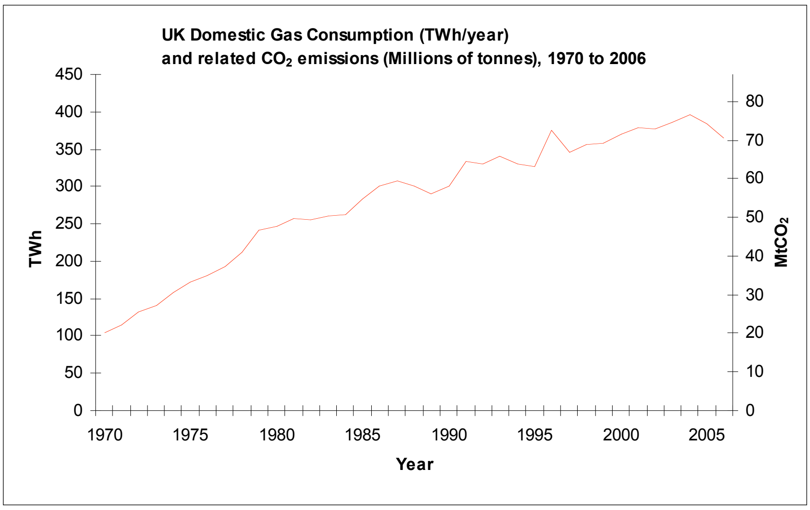
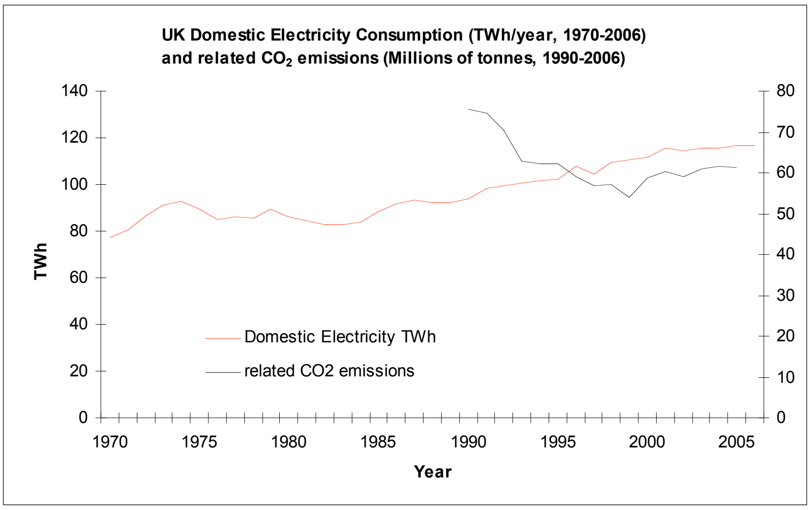


Figure B: Household electricity use and CO_2 emissions



These trends are simply unsustainable in the context of the obvious and urgent need for substantial reductions to UK greenhouse gas emissions. Two possible responses arise: (1) reducing household demand for energy by changing behaviour and improving the thermal efficiency of our homes, and the electrical efficiency of our lights and appliances; (2) developing lower carbon sources of heat and power to meet household demands. While it is inevitable that a combination of these approaches will be required to achieve the necessary long-term, deep emissions reductions, demand management offers more cost effective and rapid solutions in the shorter term, since eliminating wasteful household use of energy has lower up-front investment costs, and immediate paybacks in the form of cost reductions.

However, the price signals that result from the current structure of the UK's household gas and electricity tariffs do nothing to encourage demand reductions – in fact they embody rewards for consuming more, since on average, the more we use, the less we pay per unit of consumption. This has negative environmental and social consequences, since (1) the marginal cost of producing more carbon emissions reduces as consumption increases, even though the environmental cost of that activity does not reduce, and (2) those who can only afford to buy less end up paying more per unit of consumption, which augments the existing income disparities underpinning fuel poverty.

This is the context in which this report was commissioned, as part of WWF-UK's work to reduce the negative environmental impacts of the energy and water industries, and its campaign to reduce the impacts of UK homes and lifestyles.

Aims

The report looks at the implications of sustainability for UK household electricity and gas (and in a parallel report by Paul Herrington, water) tariff structures, and reviews the theoretical basis upon which tariff changes affect household demand, along with the evidence suggesting that the provision of improved feedback of information on consumption (such as that enabled by the use of smart meters) can itself facilitate better household energy demand management. The report then considers existing examples of social and sustainability tariffs in several countries, evidence on the way that household incomes and the demand for gas and electricity are distributed across UK households, and the current regulatory and market frameworks for household electricity and gas supply. Finally it examines, using a detailed model created for the purpose, whether 'Increasing Block' household electricity and gas tariffs (IBTs) have the potential to both create price signals that encourage demand reductions, and protect access to affordable essential energy supplies for low income households.

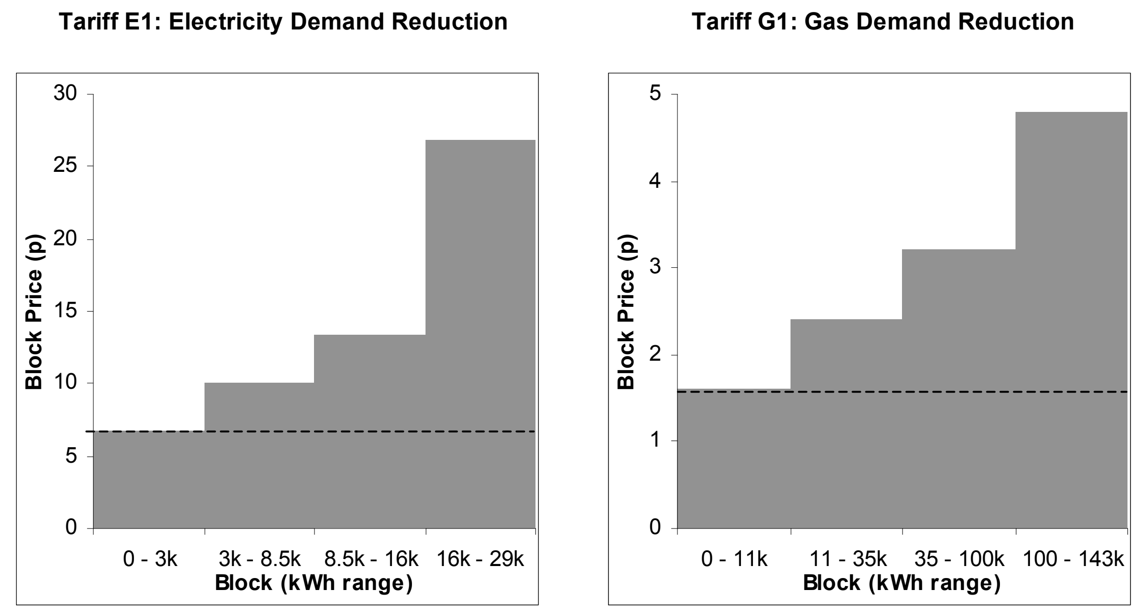
Results

CSE's UK household electricity and gas tariff model was used to test the environmental, economic, and social effects of a set of three increasing block gas and electricity tariffs. Each of the three pairs of tariffs was designed iteratively, to prioritise a specific outcome along environmental, economic, and social lines respectively:

1. achievement of electricity and gas demand reductions (environmental)
2. balancing overall supplier revenues (economic)
3. reducing the burden of energy costs to low-income households (social)

Figure C illustrates the structure of the two 'Demand Reduction' tariffs. The results of the modelling and analysis show that these aggressively structured increasing block tariffs could deliver reductions in electricity and gas demand of 7-8%, leading to CO_2 reductions of almost 10 million tonnes annually across the housing sector. This would make a significant contribution to meeting the UK's CO_2 reduction targets.

Figure C: The Demand Reduction Tariffs



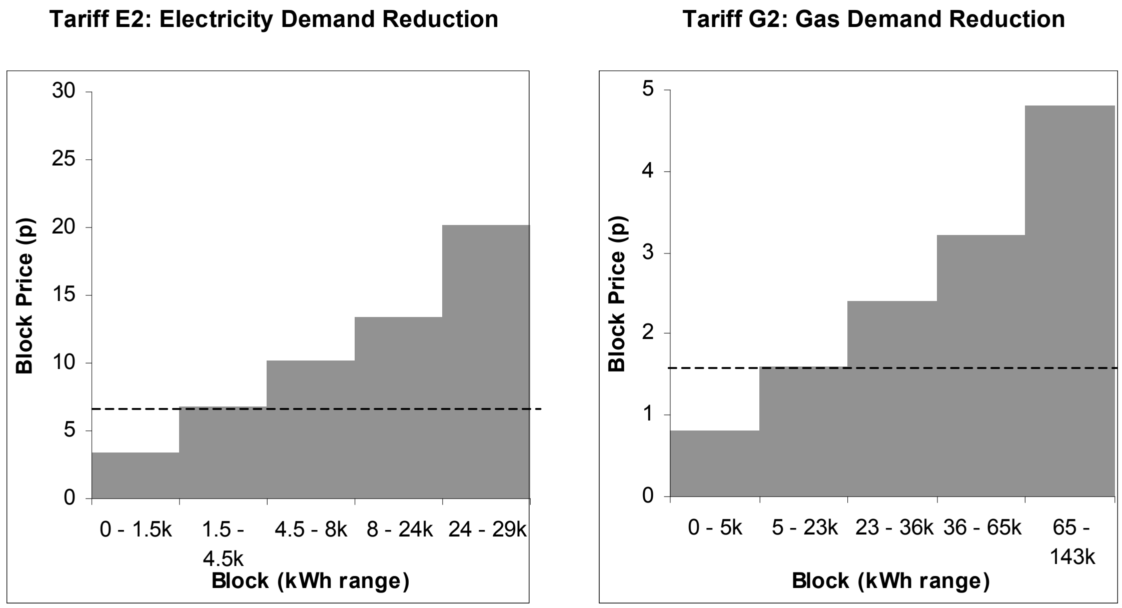
Note: dashed lines indicate 2004 actual average unit prices

Summary of Impacts: E1			**Summary of Impacts: G1**		
Demand Reduction (TWh)	7.29	(7.4%)	Demand Reduction (TWh)	28.66	(7.9%)
CO_2 reduction (Mt)	3.84		CO_2 reduction (Mt)	5.56	
Revenue Change (£ Bn)	+0.92	(13.8%)	Revenue Change (£ Bn)	+1.02	(+17.6%)

However, these tariffs would also lead to cost increases for nearly all UK households, including those already struggling to cope with the burden of energy costs. They would therefore exacerbate fuel poverty unless targeting of assistance for fuel poor households was improved (beyond recognition) in parallel. Finally, by increasing the UK-wide average price paid for a unit of electricity or gas, the more aggressive increasing block tariffs would also increase revenue to electricity and gas suppliers. Such 'windfall profits' could be used to significantly increase investment in household energy efficiency improvements. If this was carefully targeted at low income and vulnerable households it might be possible to ensure that the more aggressive increasing block tariffs did not exacerbate fuel poverty, but instead accelerated the rate of improvement to the energy efficiency in the UK housing stock.

Figure D illustrates the structure of the two 'Revenue Neutral' tariffs. These more subtly structured tariffs, which were designed to achieve constant overall supplier revenues, achieve modest demand reductions of just over 1% while saving 1.6 million tonnes CO_2. They also reduce average energy costs for most low-income households, although there are still a number of low income households made worse off (and high-income households made better-off) because although on average, higher incomes lead to higher energy consumption, there are many low-income households with high energy consumption (and vice versa).

Figure D: The Revenue Neutral Tariffs



Note: dashed lines indicate 2004 actual average unit prices

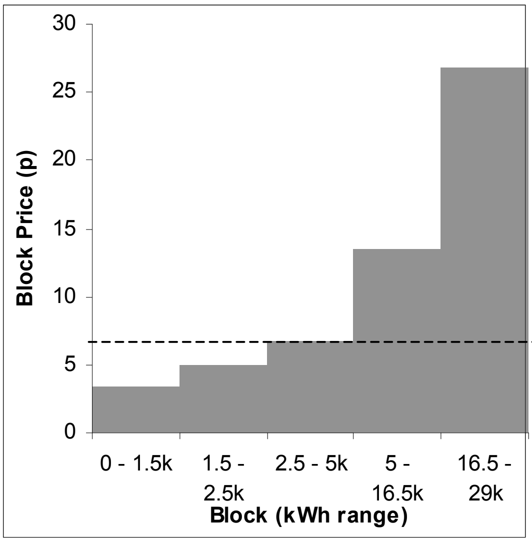
Summary of Impacts: E2		
Demand Reduction (TWh)	1.19	(1.20%)
CO_2 reduction (Mt)	0.63	
Revenue Change (£ Bn)	-0.02	(-0.30%)

Summary of Impacts: G2		
Demand Reduction (TWh)	4.97	(1.40%)
CO_2 reduction (Mt)	0.96	
Revenue Change (£ Bn)	+0.01	(+0.20%)

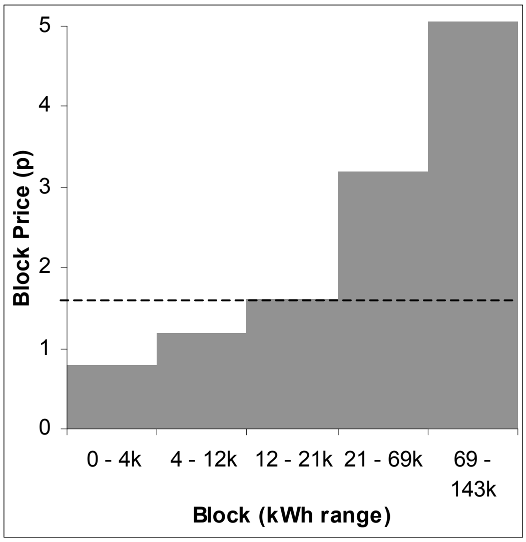
Finally, the tariffs shown in Figure E below were designed to minimise energy costs to low income households. The modelling results suggest that these would reduce electricity and gas demand by demand by 1.6% and 2.5%, respectively, while successfully reducing the average cost of electricity and gas for low-income households, by creating correspondingly higher average prices for higher income households. However, because of the wide variation in electricity and gas use within income bands, these latter tariffs still create low-income losers, and they tend to lose more under these tariffs than under the revenue balancing tariffs.

Figure E: The Redistribution Tariffs

Tariff E3: Electricity Redistribution



Tariff G3: Gas Redistribution



Note: dashed lines indicate 2004 actual average unit prices

Summary of Impacts: E3			**Summary of Impacts: G3**		
Demand Reduction (TWh)	1.58	(1.60%)	Demand Reduction (TWh)	9.05	(2.50%)
CO_2 reduction (Mt)	0.83		CO_2 reduction (Mt)	1.76	
Revenue Change (£ Bn)	-0.11	(-1.70%)	Revenue Change (£ Bn)	+0.06	(+1.10%)

Conclusions

These results suggest that Increasing Block Tariffs (IBTs) have the potential to play a significant role in delivering reductions in UK household demand for electricity and gas, and related reductions in CO_2 emissions. This report has also outlined possible approaches to resolving the tension between the environmental objective of demand and CO_2 emissions reductions, and the social objective of ensuring that all UK households have access to affordable essential energy supplies.

This could, for example, be achieved through the introduction of more subtle IBT structures, which could still achieve demand reductions of over 1%, along with progressive social impacts. More significant demand reductions could be achieved via more steeply increasing block prices, and this would require parallel investment in a vastly improved and expanded programme of support for households at risk of fuel poverty. Such a programme would have to include a combination of special tariff arrangements (eg for households relying on electricity for space and water heating), and household energy efficiency improvements, and could be funded at least in part by the additional revenues suppliers would be likely to receive under the more aggressive IBT structures.

A further issue to consider is that IBTs could create uncertainty around the actual average unit revenue received by energy suppliers, since this is determined by a combination of the tariff structures (which would be known), and the public response to them (which would discovered only after the tariffs were in place).

In the current market context, energy suppliers are unlikely to offer IBTs unilaterally, since one can assume that only those customers who stood to benefit from such tariffs would sign up for them. This would lead to price increases for other customers, who would then switch away to companies offering flat tariffs – a competitive nightmare that suppliers would avoid.

Hence for IBTs to become a reality in the current UK context, they would need to be made mandatory across all customers, and all suppliers. Although there are examples of IBTs in operation in other countries (eg Flanders, California and Bulgaria) this would clearly go against the grain of the liberalisation of UK energy markets over the last 20 years. However this period also saw large increases in household demand for gas and electricity, and these trends simply cannot be allowed to continue – promising solutions should not be dismissed without proper analysis of the costs and benefits they would entail. In any case one could stipulate the structure of an IBT (in terms of the positions and widths of the blocks, and the price ratios between them), without specifying the prices themselves. This would not resemble price control in the classical sense, and it would leave suppliers free to compete on price.

Alternatively, under an upstream (ie supplier-based) capped carbon-trading system such as the Supplier Obligation currently under consideration by the Government, gas and electricity suppliers would be incentivised to assist and/or stimulate their customers to reduce their emissions. The most cost-efficient way to achieve this would be through demand reduction, achieved via energy efficiency improvements and behaviour change (the more expensive alternative being the development of lower-carbon sources of heat and power). In this scenario suppliers could see Increasing Block Tariffs as a cost-effective option for ensuring compliance with their targets under a Supplier Obligation. This would remove the need for IBTs to be made mandatory, and energy suppliers would be free to use them as one of several tools for influencing the behaviour of their customers. Whether or not they chose to would depend on several factors, not least the tightness of the overall cap on carbon emissions.

1 Project Background

1.1 WWF-UK

WWF, one of the world's leading conservation organisations, was founded in 1961 and its main mission today is to stop the degradation of the planet's natural environment, and to build a future in which humans live in harmony with nature, by:

- conserving the world's biological diversity;
- ensuring that the use of renewable natural resources is sustainable;
- reducing pollution and wasteful consumption.

WWF, as part of the Environment and Development community, sees the next 10 years as crucial as providing a critical window of opportunity to address the causes of human-induced climate change – emissions of carbon dioxide (CO_2) and other greenhouse gases. To avoid the most serious impacts of climate change, the rise in the global average temperature must be kept to less than 2°C above pre-industrial levels – the critical 'tipping point' for people, wildlife and habitats.

We are over-consuming the planet's resources at an ever-increasing rate. Indeed, if everyone lived the way we do in the UK, we would need three planets to support us. In the UK, WWF works to ensure Government and the business community show leadership in order to change the way we produce and use energy in industry and in our homes, so that we live within the Earth's ecological and natural resource limits. This philosophy is known as *One Planet Living*(R)[1].

This report follows on from previous work by WWF-UK, aimed at Government and industry on important policy agendas, such as climate change mitigation and adaptation, sustainable homes and livelihoods, sustainable water management and social equity issues. It also provides a firm basis for WWF-UK's ongoing engagement with the energy supply industry, and provides a powerful complement to WWF's One Planet Living campaign.

See www.wwf.org.uk/oneplanet/ophome for further details.

1.2 Project Team and Acknowledgements

Centre For Sustainable Energy

Joshua Thumim (lead author and analyst), Vicki White (statistical analysis), Zoe Redgrove (modelling support), and Simon Roberts (strategic input).

The project team is also indebted to Angela Druckman, Research Fellow on the RESOLVE programme at the University of Surrey (see www.surrey.ac.uk/ces) for the initial analysis and data extraction of the Expenditure and Food Survey which underpins this study.

CSE is an independent charity which advances sustainable energy policy and practice through direct advice to the public, education and training initiatives, technical consultancy and policy analysis. CSE seeks energy solutions that engage people and communities to

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[1] *One Planet Living*(R) is a joint initiative of BioRegional and WWF based on 10 guiding principles of sustainability. The vision of *One Planet Living* is a world in which people everywhere can lead happy, healthy lives within their fair share of the Earth's resources.

meet real needs for both environmentally sound and affordable energy services. For more details see www.cse.org.uk.

Paul Herrington

Paul Herrington, author of the parallel WWF-UK report on water tariffs for sustainability, has been an independent environmental economist since 1997, specialising in the water sector. From 1964 he worked as an academic economist at Lancaster and Leicester Universities. He has written books, reports and papers about all aspects of water economics, especially demand analysis and forecasting, climate change, water conservation and tariff structure and design.

He was a Tribunal Assessor at the Yorkshire Water Inquiry in 1996 and has advised House of Commons Select Committees on Water Conservation (1996) and the 1999 Ofwat Price Review (2000). Recently he has worked for UKWIR, the Department of the Environment, the Environment Agency and the OECD. He is a member of the Watersave network. Before this he worked extensively for environmental organisations in challenging the naïve extrapolation of water demands, ignorance about consumption and leakage, and thus the need for additional reservoirs in England.

1.3 Structure of this report

This structure of this report mirrors that adopted in 'Water Tariffs for Sustainability', which was produced by Paul Herrington in parallel with CSE's work.

Section 2 of this report looks at the implications of sustainability for household electricity and gas (and in the parallel report by Paul Herrington, water) tariff structures.

Section 3 reviews the theoretical basis for considering how tariff changes affect household demand for electricity and gas, along with the evidence suggesting that the provision of improved feedback of information on consumption (such as that enabled by the use of smart meters) can itself facilitate better household energy demand management.

Section 4 then considers existing examples of social and sustainability tariffs for household energy supply, and Section 5 briefly presents evidence on the way that household incomes and the demand for gas and electricity are distributed across UK households. Section 6 describes the current regulatory and market frameworks for household electricity and gas supply.

Section 7 presents the methodology and results of the modelling and analysis of new Increasing Block Tariffs for household electricity and gas supply, and Section 8 presents CSE's conclusions.

Appendix 1 gives more detailed data on the distributional effects of the tariffs modelled in Section 7. Appendix 2 presents a detailed analysis of the socioeconomic characteristics of low income households (that is, households in the lowest three income deciles), losing financially under the tariffs modelled in Section 7. Appendix 3 summarises a brief review of literature on price elasticity of energy demand, carried out as part of the tariff model development process.

2 The Key Issues

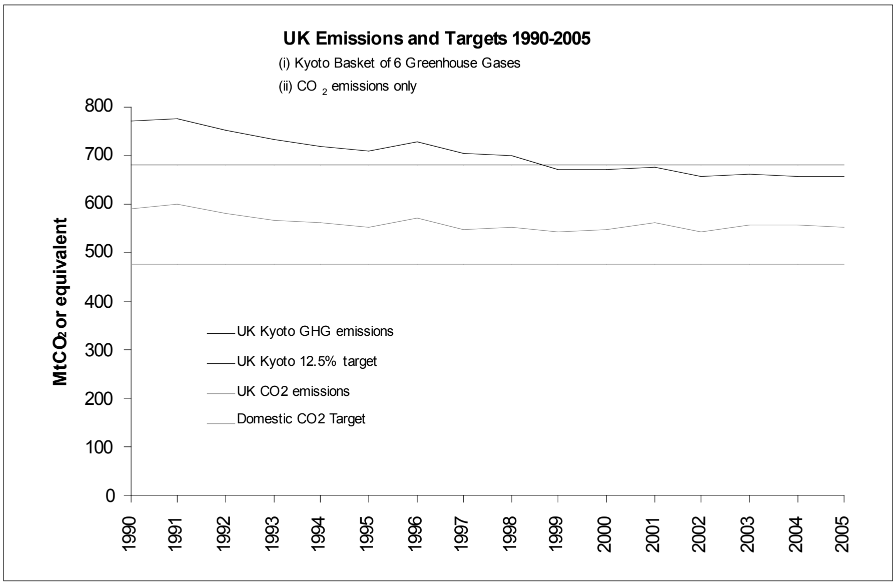
2.1 The Present Situation

It is widely accepted that a 2 degree Celsius global average temperature rise is a critical threshold, above which dangerous climate change will become inevitable. As the EU heads of member states have agreed, we therefore need to stabilise atmospheric greenhouse gas concentrations at levels close to those we have today. This requires dramatic reductions in annual global emissions of CO_2 and other greenhouse gases.

As a party to the Kyoto Agreement, the Government has committed the UK to reductions in all greenhouse gas emissions of 12.5% by 2010 relative to 1990. It has also made a non-binding commitment to a 20% reduction in CO_2 emissions for the same period. These targets, while an important step forward, are nowhere near the level of reduction that will be required to avoid a 2 degree global average temperature rise: even the Government's long-term commitment to a 60% reduction on 1990 levels by 2050 is almost certainly insufficient.

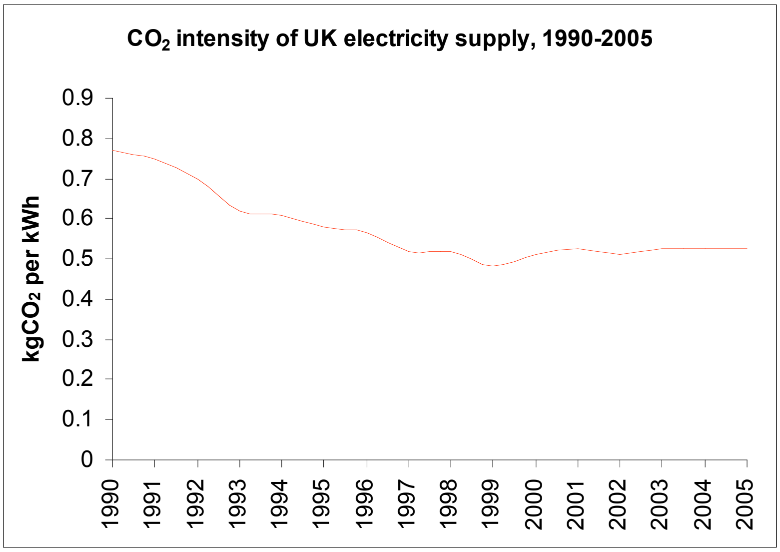
Figure 1 below shows that the UK is on course to meet its binding 12.5% greenhouse gas emissions reduction target, if overall greenhouse gas emissions remain at or below their current levels to 2010. However it also shows that the 20% non-binding target is unlikely to be met, despite emissions falling by about 7% during the period 1990-2000 largely as a result of (1) a decline in industrial activity, and (2) a switch from coal to gas as the primary fuel used in electricity generation.

Figure 1: UK Emissions and Targets



As Figure 1 below shows, between 1999 and 2005 there was a reversal of this 'dash for gas', which increased the carbon intensity of UK electricity by 10% from 0.483 to 0.527 $kgCO_2$ per delivered kWh.

Figure 1: CO_2 intensity of electricity



In parallel with these changes, as Figures 3 and 4 below show, household demand for electricity and gas has been rising since the 1970s, and the reduction in CO_2 emissions from household electricity use that resulted from the 'dash for gas' went into reverse after 1999.

Figure 1: Domestic gas use and emissions

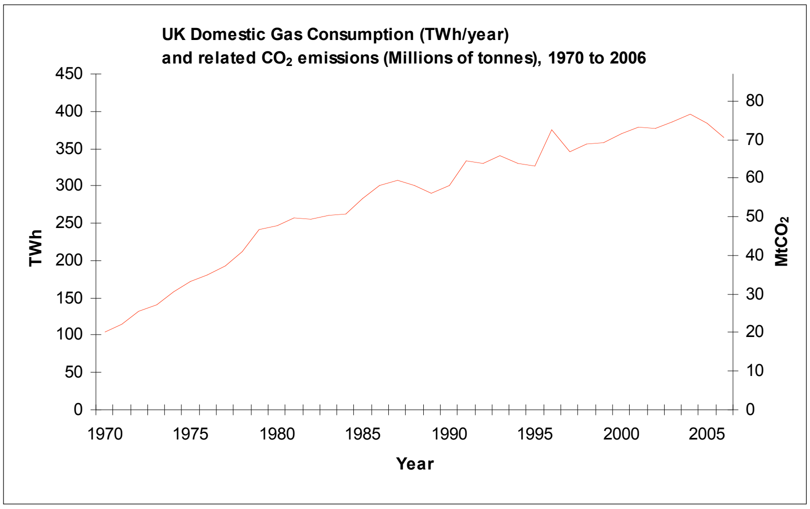
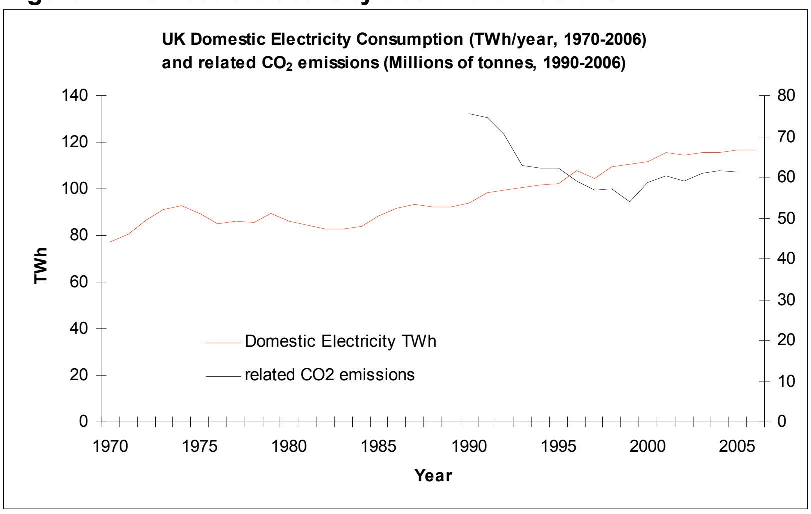


Figure 2: Domestic electricity use and emissions



These long-term growth trends in household demand for gas and electricity result from a combination of factors, including: reductions in average household size (and consequent losses of economies of scale); population growth; the rapid expansion in demand for cheap consumer electronics; and low energy prices when compared with incomes. These trends appear likely to continue for the foreseeable future in the absence of action to curtail them.

As touched upon earlier, the UK is not on track to meet its CO_2 emissions reduction target, a target which is in any case far from the level required to avoid dangerous climate change. Immediate action is therefore needed to reduce UK emissions, and this must include household energy and gas use, which as we have seen, look set to rise indefinitely unless the UK acts now.

In this context the current structure of domestic gas and electricity tariffs embodies arguably perverse[2] rewards for consuming more. On average, the more we use, the less we pay per unit of consumption. This has negative environmental and social consequences. It means:

- the marginal cost of producing more carbon emissions reduces as consumption increases - even though the environmental cost of that activity does not reduce
- those who can only afford to buy less, pay more per unit of consumption: this augments the existing income disparities underpinning fuel poverty.

Thus, current household gas and electricity tariffs send price signals to consumers that are directly opposed to their own basic needs for affordable warmth or to the wider need to stimulate lower energy consumption.

However, there are commercial reasons why energy supply companies currently structure their tariffs in this way:

- the average cost of supply of energy does reduce as consumption increases since there are many fixed costs of supply (such as billing, meter reading, delivery infrastructure)
- regulatory approaches favour ‘cost-reflective’ pricing and act against cross-subsidies between groups of customers
- the current regulatory structures for the delivery infrastructure (pipes and wires) tend to be volume driven (providing incentives for maximising their use)
- the costs of environmental damage are not carried by those who cause them.

This report is aimed at examining how these commercial interests and realities can be better aligned with environmental and social imperatives so that UK household energy tariffs emerge which explicitly stimulate more sustainable patterns and levels of household energy demand.

[2] A non-tariff example of a perverse incentive from an energy supplier would be Southern Electric’s current offer of Air Miles to new dual fuel customers: see http://www.southern-electric.co.uk/ForYourHome/EnergyProducts/Airmiles.aspx

2.2 Moving Towards Sustainability

2.2.1 What do we mean by sustainability?

For the first 75 years of the twentieth century the 'predict and provide' approach to the provision of basic utility services held sway in developed countries and thus, through knowledge and technology transfer, infiltrated into most continents. By the late 1970s, however, recognition of the growing economic and environmental costs of this ethos – and thus its clear *unsustainability* – was filtering through to governments and international organisations. In 1987 the UN's World Commission on Environment and Development produced the influential Brundtland Report, concluding that it was possible to create the conditions for, and to actually realise, sustainable development – defined as meeting the needs of the present generation without compromising the ability of future generations to meet their own needs.

Sustainability applied to national energy supplies and electricity generation requires that stocks of capital involved in their provision should be non-declining and non-environmentally damaging in the long-term. The types of capital involved are the *manufactured* capital base (power stations, distribution networks, etc.) and *natural* (or environmental) capital.

The natural capital involved in the provision of energy supplies includes wind, wave, tidal, hydrological and solar energy, and stocks of fossil fuels and uranium. Importantly, it also includes the atmosphere, which has, since the industrial revolution, functioned as a sink for CO_2 emissions from fossil fuel use.

The human-induced climate change we are now experiencing is a direct result of this accumulation of CO_2 and other greenhouse gases in the atmosphere, and requires sustainability to incorporate standards of atmospheric integrity[3] (ie greenhouse gas concentrations). These lead directly to acceptable CO_2 emission levels, and from there to optimal future mixes of renewables and fossil fuel use. These concerns have been adopted internationally through the 1992 United Nations Framework Convention on Climate Change, and the 1997 Kyoto Protocol (now Kyoto Agreement).

2.2.2 From Supply-fix to Demand-management

If *supply-fix* had characterised much energy and water planning in the pre-Brundtland decades, Brundtland and the consequent 1992 Rio Earth Summit (the UN Conference on Environment and Development) heralded a questioning of unlimited demand and thus began to popularise *demand-management* as a way of partially resolving future supply-demand imbalances or conflicts[4].

In principle, demand-management may be pursued through:

- changes in energy/water tariff structures and levels
- other economic instruments (taxes, subsidies and tradable permits)
- standards and regulations

[3] These would normally be set by Government, in an international context

[4] The intellectual origins of the incorporation of demand-management into decision-taking are to be found in Least Cost Planning, itself originating in the Office of Conservation at the United States Department of Energy in the mid-1980s. There it was recognised that consumers demand energy services and not energy *per se*, which gave a powerful new perspective on how to resolve what hitherto had been viewed as supply-demand imbalances in energy itself.

- education and information; and
- moral suasion.

Because tariffs are required anyway, to raise the revenues necessary for full cost recovery, charges will have to be in place in some form or other.[8] Additionally, certain tariff structures are capable of helping to manage complex demand patterns. Within the second category (listed above) environmental taxes may have a similar role to tariff levels as regards their effects on demand, but subsidies will always be competing with other government priorities (as well as often giving consumers misleading messages about the value of a service) and tradable permits may be unsuitable for dealing with basic utility service demands. Standards and regulations are appropriate for appliance-specific energy use, but increasingly are difficult to apply effectively to the more heterogeneous luxury demands associated with rising real incomes. Education and information provision are best regarded as complements to the other demand-management means, while 'serious' moral suasion is best reserved for crisis or pre-crisis periods.

2.3 Tariffs for sustainability

In section 2.2.1 two categories of capital were highlighted as particularly relevant to energy (and water) utilities' activities: the fabricated asset base (manufactured capital) and the environmental asset base (natural capital). Maintaining these capital stocks at their desired sustainable levels over time (both quantitatively and qualitatively) uses economic resources, which can be represented in monetary terms. In this way the annual costs that arise in keeping a utility's stocks of manufactured and natural capital on track may be estimated[5].

To these annual capital costs should be added all the 'operating' costs borne when a utility service is being provided. These include, eg raw materials, labour, bought-in services, plus any other social costs incurred in the utility's 'production' activities, whether or not they are compensated for by the utility. The result is a stream, into the future, of the annual long-run total social costs (LRTSC[6]; economic, environmental and other) generated by the particular demand (and therefore supply) profile. By undertaking the same exercise for another demand profile, that is different enough from the first one to be noticeable, while small enough to be marginal, it is possible to calculate the long-run *marginal* social cost (LRMSC) of, e.g., a kWh of electricity or gas, or a cubic metre of water[7]. This is the ideal benchmark basis for the price of energy or water *at the margin,* if metered consumers are to be relied upon to make decisions about consumption which accord with the social interest.

Other approaches to estimating tariffs for sustainability concentrate on, in turn: (i) assembling the LRMSC estimate in a building block approach; (ii) estimating peak-demand price bases in the manner just described above for average demands; and (iii) reversing the process above, by setting the desired level of supply (of energy or water) at the outset and then fixing the price at an estimated level required to produce this outcome. In the first of these approaches,

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[5] The expenditures incurred in maintaining (and adding) to a utility's manufactured capital stock are lumpy, so appropriately annuitised costs will have to be calculated with the aid of discounting, thus smoothing the flow. If some environmental costs (e.g. those arising from groundwater damage or depletion) cannot be valued, relevant environmental standards will have to be agreed in advance, and thus the economic costs of meeting those standards can be identified. An indirect valuation is thereby generated. Any other social costs arising from capital maintenance (and expansion), even if not resulting in any cash flows, should also be included.

[6] LRTSC is a *long-run* concept because it includes all the costs involved, including those that vary only in the long run.

[7] The well-established techniques to deal with lumpiness of manufactured capital and the derivation of a marginal cost measure from two total cost measures are dealt with for water in OECD (1987) and Ofwat (2001).

the utility calculates its own LRMC, concentrating on manufactured capital and operating costs, and then adds in – perhaps on the advice of the relevant environment protection agency department – the relevant long-run marginal environmental costs of its actions; social costs are also researched and accounted for separately. Approach (ii) above is relevant if it is believed that peak demand reductions are crucial for sustainability; while approach (iii) is appropriate if a one-stage-at-a-time approach to sustainability has been adopted (a quantitative prediction of consumers' demand responses to marginal price increases is of course essential in this situation).

Electricity and Gas

Electricity is an energy carrier converted from a range of primary energy sources, including coal, natural gas and oil, all of which are finite fossil fuels and which produce CO_2 when burnt; uranium, which brings with it fundamental and unresolved short- and long-term human health, environmental, and security risks; and cleaner, low-carbon renewables such as wind, wave, tidal and solar power, all of which are (currently) limited in availability, and expensive per unit output. (In the UK, natural gas is also used directly as a heating source, leading to further emissions of carbon dioxide, and additional pressure on this finite resource).

It is sometimes argued that the existing global markets in various energy sources can be relied upon to balance supply and demand through price signals. This may or may not be an optimal approach to managing dwindling natural resources. In either case there is as yet no reliable mechanism for pricing the 'environmental externality' of CO_2 emissions from energy use and their negative impacts on the environment (ie climate change). The combination of finite and expensive energy resources, wasteful energy use, and negative impacts on the environment, means that we need to introduce some form of demand management over and above international energy price signals, if we are to achieve sustainable levels of energy consumption and associated CO_2 emissions.

As touched upon earlier, the two obvious candidates for managing UK household demand for gas and electricity energy are: (a) tariff structures and price levels which discourage excessive and wasteful consumption, and (b) tradable quotas. A system of Tradable Energy Quotas (TEQs) has been proposed by David Fleming[8], as a way of simultaneously managing finite fossil fuel resources, and limiting the carbon dioxide emissions from their consumption. An alternative but related approach to this - where it is the CO_2, rather than the energy that is rationed - is a system of tradable personal carbon allowances, the feasibility of which is currently being examined by the UK Government and others (including CSE[9]).

There are problems associated with assessing the long run total and marginal social costs of electricity and gas use. This is because, firstly, the primary energy resources for electricity generation, including natural gas, are imported from many different parts of the world, and secondly, the effect of marginal emissions of CO_2 on the global climate is difficult to quantify, varies over time, and is non-linear. Indeed, this uncertainty (allied with the precautionary principle) is one of the arguments in favour of capped carbon markets, within which the response to the overall cap defines the market price of carbon. In other words, uncertainty over price is accepted in return for certainty over the level of emissions.

[8] Energy and the Common Purpose, David Fleming, 2007 (available at www.teqs.net)

[9] A Rough Guide to Individual Carbon Trading. CSE 2006, commissioned by Defra. (Available at www.cse.org.uk/pdf/pub1067.pdf)

However, in the absence of an appropriately capped carbon market, UK energy tariff structures may represent the best and quickest available approach to managing household energy use and resulting CO_2 emissions. Given the difficulty of assessing the long run costs of energy production and use discussed above, it is likely that such energy tariffs will have to be designed as per approach (iii) above – that is, with a specific demand/emissions reduction as the starting point. The challenge is to design a tariff with a structure which effectively discourages excessive energy use, while eliminating as far as practicable regressive economic impacts on low income households. This is a not straightforward, because as we show in Section 1, although household energy (electricity and gas) consumption and income are correlated at the level of means between deciles, there is wide variation in energy use within income deciles, and very little correlation between energy use and income overall. This means that there are many low-income households with greater energy consumption than many high-income households, and vice versa.

Under current electricity and gas tariff structures for UK households, and with large numbers of poor quality and thermally inefficient homes, there are serious problems with the affordability of basic energy requirements for the large number of UK households who find themselves in fuel poverty. This is defined as the need to spend 10% or more of household income maintaining an acceptable heating regime (at the same time as providing cooking, lighting and electrical appliance services). In response to this problem, specific tariffs have been designed in the UK and abroad, with the objective of providing affordable energy to low income households. These are known collectively as 'Social Tariffs' and are considered in more detail below.

2.4 Social tariffs

In the context of basic utility services for UK households (such as those using energy or water), what precisely is meant by a 'social tariff'? In the limited literature available covering this issue, two distinct strands of thinking can be discerned.

Passport tariffs

One strand would include any payment scheme – or amendment or rebate to, or discount on, an existing scheme – which is specially designed for, and restricted to, carefully defined low-income and perhaps other vulnerable households, the aim being to reduce significantly the bills actually paid by such groups for a given utility service.[10] Because eligibility to partake in the scheme would have to be established, the term 'passport tariffs' is used to describe this type of social tariff.

For example, in recent research undertaken for Unison (CSE & NRtFC, 2006), the majority of a group of 24 fuel poverty and energy policy stakeholders who were questioned defined a social tariff as:

> *"…a tariff only available to certain vulnerable or low income households and designed to help them pay for their fuel." (p. 25)*

[10] If a given utility charging burden for a household is defined as the proportion of its annual disposable income accounted for by its annual expenditure on that service, the payment scheme might be designed to reduce the burdens to (say) no more than 10% for fuel and 3% for water services.

NEA (National Energy Action) echoes this view, recently stating in a policy paper that:

> *"[what constitutes a social tariff]…is uncertain, but…….is taken to mean any special payment arrangement, over and above those specified by the Supplier's Licence Conditions, devised with a view to benefiting disadvantaged energy consumers."*[11]

Following recent CSE/NRtFC research, the inadequacies of these definitions has been clarified, for both quotations are seen to be referring to *intentions* rather than *outcomes*. A passport tariff that fails in its core social aim should arguably not be classed as a 'social tariff'.

One-Size-Fits-All (OSFA)Tariffs
In a quite different approach, this concept considers that no *special* charging arrangements are needed. Rather the term 'social tariff' could be (and has been) used, especially in World Bank and OECD literature[12] and discussions about the water sector and water poverty, to describe any general tariff for households which, through its structure (normally referred to as an *increasing block tariff or IBT*) and through the actual tariff rates levied, has the effect of resolving, to a significant degree, affordability issues (again its success would be measured by reductions in the charging burdens of low-income and other vulnerable households). The advantage of this approach is that it does not require the implementation of means tests (which carry expensive administration charges), it does not stigmatise low income households and there are no problems relating to non take-up from eligible households.

Note that the difference between *social tariffs,* as defined in UK energy literature and as reflected in the OSFA tradition, mirrors the debate in the UK within social security policy over means-testing versus universal provision (see, for example, Deacon & Bradshaw, 1983; Dean, 1994; Barnes, 1999). Thus, social tariffs in the UK energy tradition almost inevitably involve means-testing, while 'one size fits all' tariffs provide a universal approach.

There are numerous examples in continental European as well as central and south American countries of increasing block tariffs (IBTs) for residential energy and water consumers, incorporating one or more 'early' low- or zero-priced blocks which are designed to cover basic/essential use, and higher prices for 'later' blocks, which have often been referred to as social tariffs. These tariff structures therefore mean that, through a stepped relationship, the more energy or water a household uses, the higher will be the price paid for the next block or tranche of consumption (see Figure 3 below, which illustrates the relationship between price and quantity embodied in Increasing Block Tariffs). Under certain conditions – to be explored in this report – the effect of such tariffs is to keep the utility bills down for low-income customers while still ensuring full cost recovery overall. Because in such cases each household is on the same tariff, these will be referred to as one-size-fits-all (OSFA) tariffs.

Note also the attractive possibility that the higher unit rates that will need to be charged on the higher blocks of consumption, to ensure recovery of all capital and operating costs, would be expected to contribute to the achievement of sustainability objectives by stimulating demand (and hence emissions) reductions.

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[11] www.nea.org.uk/Policy_&_Research/Policy_Position_Papers/Social_Tariffs, updated 24.4.07.
[12] e.g., in OECD (1999) and OECD (2003).

Figure 3: Generalised example of an Increasing Block Tariff

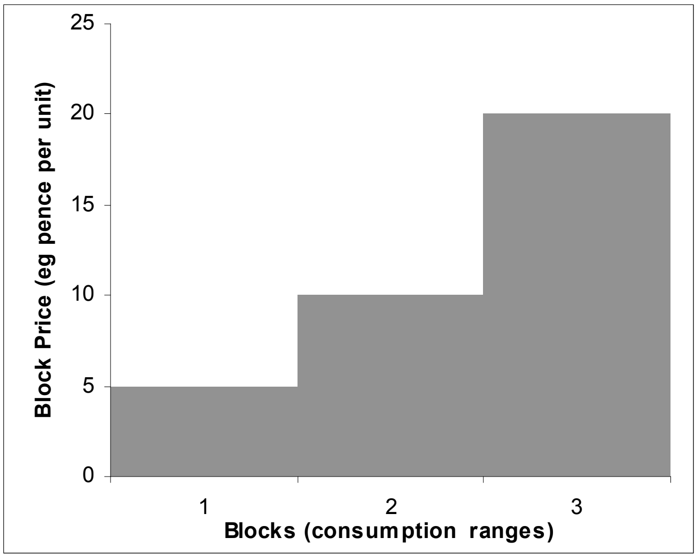

Figure 5 above illustrates how price varies with consumption under an IBT arrangement. The x-axis shows the price blocks, which represent ranges of consumption of either electricity or gas (in kWh) or water (in litres). Each unit falling into block 1 is charged at the price for that block, which is shown on the y-axis. Units falling into subsequent blocks are then charged at increasing prices. The effect of this is to make annual costs rise more steeply with consumption than they would with a flat rate tariff – in fact the steepness itself increases each time a household's consumption enters a new block.

2.5 The Options

As shown in Section 2.1 of this report, energy consumption by UK households has increased steadily over the last three decades. In the future, without a radically different approach to household energy demand-management, we may expect further demand increases for three reasons: (i) a rise in average real incomes will lead to the acquisition of more energy-using appliances; (ii) unparalleled reductions in average household occupancy (with the loss of the economies of scale in resource use that are achieved in larger households); and (iii) substantial forecast increases in population.

Section 2.3 discussed briefly the principles behind four approaches for estimating the prices of energy (and water) supplies which are necessary to help any move towards sustainable production and consumption in these sectors of the economy. It is possible to design tariffs which target marginal, inefficient, wasteful or unnecessary consumption, and which encourage households to reconsider energy- and water-using habits, which have been around for a long time. Prices at the margin are capable of reaching household behaviour which cannot be touched by bureaucratic regulations and supplier persuasion.

However, new issues arise which must be resolved. If such prices – and they would be much higher than at present are being paid – were to be charged on all of a household's electricity and gas consumption, they would pose intolerable burdens on the budgets of lower-income and other vulnerable households. They would also generate large financial surpluses for the (privatised) suppliers.

Indeed, under current tariff arrangements for electricity and gas, millions of households are already either unable to heat their homes adequately, or are forced to spend a disproportionate amount of their income doing so.

The traditional response of some politicians and too many economists to this issue has been directed at the tax and social security system. Thus energy and water suppliers themselves have started recently to consider more seriously what can be done via their own tariff structures. Sometimes their efforts have been half-hearted (energy) and one major utility company has had its ambitious proposals dismissed by the regulator (water). This report builds on that interest and concern, and uses both domestic and overseas experience to show how tariffs can be structured to secure sustainability while simultaneously addressing affordability.

It has been seen in section 2.4 that two sorts of tariff structures may allow progress: *targeted passport tariffs* and the more inclusive one-size-fits-all *increasing block tariffs*. At this stage we do not attempt to rank these tariffs or state any preferences. Instead in the following sections of this report we examine the evidence on the existence, effects (demand and distributional) and regulatory context of sustainability and social tariffs for household electricity and gas.

3 Impacts of tariffs on demand: theory and evidence

3.1 Theory of demand reduction

In general terms, higher real unit prices for household energy supplies may induce lower levels of demand by users for a number of reasons. These behavioural effects would also result from the first-time impact on a household of metering a utility service, as price rises from zero to a positive level, and additionally from any real increases in seasonal or other temporal charges. The distinct effects of higher real unit prices are:

1. All or part of some energy-using activities with relatively low values to the household are now not worthwhile, since it is ‘rational’ for users to forego the benefits of those activities, but save on the energy charges avoided.
2. Reducing energy losses in the home (e.g. switching off appliances on standby, improving leaky homes) generally requires effort and/or expense by a household, but more action is now justified since the savings from avoided charges are greater than the costs.
3. Users may find it economic to substitute labour-intensive for energy-intensive methods of undertaking household tasks or to change to low(er) energy using technologies (e.g. low energy lightbulbs and the most energy efficient appliances on the market).
4. Households may find it cost-effective to substitute their own or an alternative supply technology to that provided by the utility service (e.g. micro-renewables).
5. There may be re-arrangement over time of activities using energy (e.g. use of Economy 7 tariffs and certain appliance usage). In the case of electricity, peak load-shifting could in itself lead to CO_2 emission reductions, because (carbon intense) coal-fired generation is currently used to meet electricity demand peaks. Additionally, a long-term reduction in the peak demand to base load ratio would reduce the total electricity generating capacity required in the UK.
6. Users may also step up their search for new technologies (to achieve given results with lower energy inputs) in which any extra cost to, or effort by, members of the household is valued at less than the savings realised by lower energy charges; profit-seeking firms, responding to or anticipating such searching by consumers, then increase research and development activity because of the potential larger financial rewards.

As a result of all these factors, some operating in the short-term and others mainly in the longer-term, energy conservation is encouraged at the household level and human impacts on the natural environment are reduced.

3.2 The impact of price changes: price elasticities of demand

The ‘Price Elasticity of Demand’ (PED) is a number that describes the way demand for a good or service is influenced by a change in its price. Typically, the more expensive an item is, the lower the demand for that item (although there are exceptions), and the PED is simply the ratio of the percentage change in demand to the percentage change in price that caused it.

For example, a PED of -1 means that for every 10% *increase* in the price of an item, there is a corresponding 10% *decrease* in demand (and the ratio of the % change in demand to the %

change in price is -1). A PED of -2 means that a 10% price increase causes a 20% demand decrease, and a PED of -0.5 means that a 10% price increase leads to a 5% price decrease.

By definition, a larger magnitude price elasticity of demand leads to a bigger demand response to a given price change. The value assumed for price elasticity therefore strongly influences the results of modelling demand responses to price changes.

In identifying an appropriate modelling value for the price elasticity of demand for electricity and gas for this research, CSE reviewed a number of academic papers on the subject (see Appendix 3 for details), and found a wide range of values identified, covering both short- and long-term elasticities. The criteria we applied to selecting a value to use in the modelling process were that the values should be:

1. conservative in terms of demand and emissions reduction effects (to avoid overestimation of these effects in the context of the project); but
2. within the range identified in the literature.

The papers reviewed revealed a very wide range of values for both short and long-term price elasticities of household demand for electricity and gas. We therefore decided that the most appropriate basis for using the numbers from the literature review was to take the median values as representative of the central tendency of the set of numbers, since the mean of a distribution is more likely to be influenced by outliers.

Short-Run	Median	Mean
Electricity	-0.175	-0.35
Gas	-0.2	-0.27
Both	-0.16	-0.30

Long-Run	Median	Mean
Electricity	-0.355	-0.66
Gas	-0.36	-0.53
Both	-0.325	-0.55

Combined	Median	Mean
Electricity	-0.21	-0.53
Gas	-0.33	-0.40
Both	-0.22	-0.44

Finally, to avoid giving an impression of spurious accuracy, we selected the nearest 'round number' above (in magnitude) the actual median value across all papers, of -0.22. This led to the selection of -0.25 as the value to be used in the modelling for both electricity and gas.

More details of the literature review are included in Appendix 3.

3.3 Evidence of tariff impacts on energy demand

3.3.1 How might new tariff structures affect demand?

This section reviews the likely impact of different tariff structures on energy demand. In particular it assesses the effects of time-related, volume-related or seasonal tariffs for gas and electricity that have already been, or are currently, in use. The review draws on recently published research by Sustainability First (Owen & Ward, 2007). This considers in particular the potential smart meters provide for introducing more innovative tariffs.

Owen & Ward argue that there is very little quantitative evidence of the impact of different tariff structures on energy demand in Britain. They highlight Ofgem's Energy Demand Reduction trials (2007-2008) and the substantial evidence base this will provide, for the first time in Britain, about consumer behaviour and energy-use in response to a range of improved feedback and information.[13]

Gas

In the UK gas provides 70% of household energy and represents about 55% of household carbon emissions. Four times more gas than electricity is used in the home (kWh equivalent). Gas-use is extremely seasonal with a winter summer ratio of around 5:1. Gas-use is also highly temperature dependant. Most price-related response in domestic gas is likely to result in an overall reduction in gas demand, rather than simple load-shifting. This is because most domestic gas-use is for space-heating, hot water and some limited cooking. There is no commercial driver for suppliers to offer time-of-use gas tariffs, since pricing for gas-market balancing is daily, rather than half-hourly pricing for electricity.

However, there are other potential tariff structures that may help improve peak-demand management for gas in UK households. They include:

i. ***Block or volume tariffs –*** these could prove very effective in cold snaps when the gas system is under pressure. However, they would prove controversial, especially in winter, with respect to the fuel poor and vulnerable groups.

ii. ***Seasonal tariffs –*** these would need to be extremely high in winter to influence consumer behaviour and again could prove controversial.

iii. ***Third-party remote switching of gas boiler or hot-water thermostats –*** favourable tariffs offered to customers agreeing to this could help reduce peak demand. However, there is likely to be considerable consumer resistance to the loss of control associated with the tariff.

Electricity

Unlike gas, carbon emissions associated with electricity demand depends upon the carbon intensity of the electricity generated, which varies over time. It is therefore difficult to attribute a given level of carbon saving to a particular level of electricity-saving. Around 70% of household electricity consumption in Britain is accounted for by electrical appliances, including lighting, and around 30% by space-heating and cooking (Market Transformation

[13] CSE has been appointed to lead the evaluation of these energy-saving trials in more than 40,000 homes; see http://www.cse.org.uk/cgi-bin/news.cgi?full&live&&1294 for more details.

Programme, 2006). Together, lights and appliances comprise over 20% of all household carbon emissions.

The half-hourly pricing regime that operates in the wholesale electricity market offers considerable potential to secure electricity demand reduction through the use of innovative tariffs. A report for the US Environmental Protection Agency offers three definitions of time-varying tariffs (Energy & Environmental Economics, 2006):

Time-of-use tariffs – in which different per-unit prices are offered for different blocks of time. The time-of-use periods will differ dependent upon the timing of peak system electricity demands over the day, week or year and may be year-round or seasonal. This is the most likely tariff to be offered to consumers in Britain.

Critical peak pricing tariffs – have high per-unit rates for usage during designated 'critical peak periods'. The days in which critical peaks occur are not designated in the tariff but notified, sometimes at short notice, for a limited number of days.

Real-time pricing tariffs – reflect the wholesale price of electricity and therefore not a fixed tariff; these will vary continuously over time.

Owen & Ward (2007) provide a useful overview of the potential for time-of-use tariffs to influence different electricity usages in Britain. They consider space and water heating, showers, cooking, wet appliances, cold appliances, lighting, electronic & brown goods, computers and stand-by. They conclude that most price-response is likely to occur in wet appliances (including tumbler driers), electric showers and a modest amount of lighting. Together these account for about 20-25% of all household electrical appliance use. However, around 70-80% of household electricity-use (fridges, freezers, lighting, brown goods) was considered non-discretionary and therefore non-price responsive. Virtually all electric space and water heating is already off-peak and therefore does not offer additional potential for load reduction.

3.3.2 Case studies of the effects of new tariff structures on demand[14]

Northern Ireland key pad meters

Northern Ireland Electricity (NIE) has installed 190,000 key pad meters in Northern Ireland – about 25% of the customer base. In conjunction with the 'smarter meter' facilities offered by key pads, NIE is trialling a time-of-use tariff known as 'Keypad Powershift'. This uses a price message to encourage customers to avoid consumption at peak times. A trial was conducted with 200 Powershift consumers to establish the impact of the tariff on household electricity consumption (NIE, 2004). 100 consumers were offered the time-of-use tariff and 100 a flat rate tariff, i.e. these represented a control group.

The trial found that time-of-use consumers reduced consumption by 10% at evening peak, resulting in a 1.5% cash saving due to the demand-shift. However, the trial found that time-of-use tariff consumers showed slightly increased overall consumption. The research concluded that time-of-use tariffs have some impact on reducing peak demand, leading to lower bills, but little impact on overall energy consumption.

[14] Material largely drawn from Owen & Ward, 2007.

NIE currently offers the Powershift tariff to 1000 consumers. It intends to carry out additional research to assess whether the price response is sustained before further roll-out of the tariff. NIE has also recently started a research project with the University of Ulster to look at the impact of real time and historical consumption feedback linked with energy advice on overall energy consumption. The report of the research is due in 2009.

California smart metering trials

The key driver for smart metering in California is the need to reduce peak electricity demand, particularly after the power cuts of 2001. Peak demand is largely driven by air conditioning use during the summer – a quarter of the capacity is used for less than 100 hours a year.

In 2003-4, the California Public Utilities Commission (CPUC) authorised a state-wide pilot of 2500 residential and small commercial consumers to assess demand response to 'critical peak pricing' with smart meters. Demand response marketing and customer education programmes were run alongside the trials. Some in the trial had automated response (the meter was linked to appliances and could change thermostat settings or switch them off), while others were given information about periods of high prices. The effects ranged from 27% reductions in demand for automated response customers, to 5-10% reductions without automated response. One group of households was just given information about peak periods without a price signal. No discernable response was found in these cases – the price signal therefore appeared to be important.

The trial found that there was no impact on overall demand – it was merely shifted to off-peak periods. However, an analysis of 16 other time-of-use tariffs found an average reduction effect of 4% (Charles Rivers Associates, 2005).

As a result of the trials, the CPUC authorised state-wide installation of smart meters for all residential and small commercial consumers by 2011. The trial also established that despite the cost of smart meters, the overall cost-benefit was positive due to the value of the reduction in peak demand. The trial also found that costs exceeded benefits if the demand response benefits were not taken into effect.

3.3.3 Ofgem review of consumer feedback mechanisms

CSE carried out a review of consumer feedback mechanisms for Ofgem in 2003 (Roberts & Baker, 2003). While the review did not address tariffs per se, it did stress the importance of providing good quality information about tariffs and consumption to consumers. The review highlighted the fact that domestic metering and billing systems in Britain routinely provided inaccessible, infrequent and/or estimated or inaccurate information about consumption.

The review identified a wide range of techniques and technologies for improving domestic customer feedback on energy consumption – from shorter billing cycles and better on-bill presentation of consumption data to 'smart' meters displaying energy use and identifying load-reducing opportunities. Through a 'meta-analysis' of studies of a wide variety of feedback mechanisms, the review concluded that the introduction of even a limited number of feedback improvements would bring about a sustained reduction in household electricity consumption of 5–10% for many customers.

The review also found that:

- Consumer feedback is most effective when it is immediate, prominent, accessible and specific to the consumer.
- Consumers are able to respond appropriately to historical comparison information on their bills and in-the-home meter displays.
- How feedback information is presented to consumers is a key consideration.
- Prepayment meter customers (who would not benefit from improved billing feedback) would benefit from improved meter displays giving them options to review consumption against historical data.
- Enhanced feedback programmes are most successful where supported by energy advice and other educational activities by suppliers, Government or other agencies.
- While historical information might provide some such motivation, this will only be the case if household consumption is increasing.
- Concern that, as a result of improved feedback, low income households may ration essential energy use so that they become slightly less poor but colder.

4 Social and Sustainability Household Energy Tariffs in practice

In Section 1 we survey household energy tariffs which have been implemented or proposed in the UK or other developed countries to further the (i) sustainability and (ii) social objectives discussed in sections 2.3 and 2.4 respectively.

4.1 Tariffs for Sustainability

There is growing interest in designing energy tariffs that encourage reducing excessive and/or wasteful household energy consumption. This comes from a number of directions:

- Government proposals for introducing a 'supplier obligation' (the replacement for CERT after 2011)
- Government consideration of social tariffs to tackle fuel poverty
- Supply company energy efficiency initiatives proposed for households

Supplier obligation

With respect to the UK supplier obligation, the Government recently issued a call for evidence in which it outlined its vision for an energy market in which consumer demand creates 'a robust, self-sustaining market for low carbon measures and services' (Defra, 2007). It presents two options for achieving this – a further evolution of the measures-based approach (i.e. EEC and CERT), or a more radical shift to an outcome-based scheme that would set overall targets on suppliers to reduce carbon emissions or delivered energy. The more radical option – referred to as 'cap and trade' – is likely to result in suppliers deploying a range of activities to deliver household carbon savings.

The Defra report suggests that suppliers might introduce increasing block tariffs (IBTs) whereby households are 'rewarded' for low consumption. Thus, suppliers determine a basic quota? of energy at a fixed low baseline rate, while charging increasing rates to reflect the cost of non-compliance with the Supplier Obligation. This would incentivise energy efficiency investment and discourage 'profligate' use. The report raises a number of issues with this model:

- Consumers, in general, have not proved to be very sensitive to energy prices (although the report notes that this may change with the introduction of smart meters and real time displays);
- Price is the main driver behind customers switching suppliers, so the first company to introduce such a charging structure may lose customers;
- It refers to DTI research on social tariffs (see footnote 13), in which it suggests increasing block tariffs can have a negative impact on the fuel poor.

'Social tariffs'

The Government has shown an interest in increasing block tariffs as part of its work on social tariffs for the Energy Review and Energy White Paper (DTI, 2006 and 2007). A DTI commissioned report explored the potential for introducing increasing block tariffs as one of four possible options for social tariff design[15]. The report noted that an increasing block structure would benefit low user consumers and would be effective in targeting the fuel poor if there was a strong correlation between income and fuel consumption. It also noted that

[15] The evaluation, which has not been published, was commissioned as part of the Government's commitment to evaluate options for social tariffs, as called for by the CSE/NRFC research described earlier.

increasing block tariffs would avoid administrative costs and the stigma associated with means-tested targeting.

However, the report went on to reject increasing block tariffs on the grounds that while only 5% of the non fuel poor in England had *required* annual energy spend greater than £1200, around 20% of the fuel poor did. It is notable that the report accepts that there is a good correlation between income and *actual* fuel consumption; however, it argues that the tariff structure would not work for the large number of fuel poor households whose consumption is disproportionately high.

Supplier initiatives

EDF Energy 'Read, Reduce, Reward' scheme – under this scheme EDF Energy provides 250 Nectar points per fuel for each valid quarterly meter reading submitted online. It also allows customers to monitor their energy use. If consumers use less energy from one year to the next, they receive 1,000 bonus Nectar points per fuel.

SSE energy efficiency credits scheme – under this scheme SSE customers earn 'energy efficiency credits' by: reducing their consumption of electricity and gas over time; investing in energy efficiency measures such as loft insulation or the replacement of inefficient appliances with A-rated ones; and taking steps to minimise other environmental impacts by, for example, opting for electronic billing. The credits can then be used towards their SSE energy bills or further energy efficiency measures.

In the first year a customer with average energy use could secure credits worth around £100 by actions including: reducing their consumption of electricity and gas by around 10%; buying one new low-energy appliance at about £250; and installing loft insulation with a net cost of around £200. These credits would be in addition to the direct energy bill savings achieved as a result of cutting consumption and savings on the underlying cost of appliances themselves. There will be no premium on the price of the electricity and gas supplied in the programme compared with standard tariffs offered by SSE.

Note that these schemes are not EEC-accredited, and are probably best viewed as the beginning of a process whereby UK energy suppliers attempt to reposition themselves in anticipation of more significant changes, such as the introduction of a Supplier Obligation.

4.2 Social Tariffs

United Kingdom

Social tariffs in energy are a relatively recent development in the UK. In its report on international social tariffs for energywatch, CSE commented that social tariffs[16] in Britain are unique in that they have emerged in post liberalised markets (energywatch, 2006). Social tariffs in other countries were either developed under monopoly conditions or were introduced as part of the liberalisation legislation (e.g. Belgium). Social tariffs have largely emerged in Britain as a supplier response to the effect of fuel price rises on vulnerable households, particularly with respect to the impact on the Government's Fuel Poverty Strategy targets (price rises between 2003 and 2006 are considered to have doubled fuel poverty over this period, DTI, 2007).

[16] The report adopted a broad definition of social tariffs.

Because energy social tariffs in the UK represent voluntary initiatives from suppliers, albeit in response to Government and stakeholder pressure, the products on offer vary considerably in design, coverage and eligibility. Research carried out by CSE and the National Right to Fuel Campaign highlighted a number of inconsistencies with certain 'so-called' social tariffs (CSE/NRFC, 2006). It found that many beneficiaries still paid more than Direct Debit consumers of the same company. Further, many would be better off by switching to the standard tariff provided by other companies, although the research noted that there were few good deals on offer for prepayment meter consumers. The research went on to ask the question:

"*To what extent can a tariff be termed 'social' if beneficiaries still pay more than consumers who tend to be more affluent?"* (ibid)

Largely as a consequence of the CSE/NRFC research, there have been moves to adopt a more precise definition of the term 'social tariff' in energy. There is now a general consensus:

> *"that for an offering to be classed as a social tariff it would need to display certain features, such as being equal to or lower than a supplier's lowest available standard offering"* (Ofgem, 2007)

Energywatch, while accepting that this represents a minimum standard for a social tariff, goes on to argue that it merely provides parity with the 'fuel rich', i.e. it offers only what is already available in the open market and stops short of the additional degree of assistance that vulnerable groups require (energywatch, 2007). Energywatch therefore advocates two possible options for a meaningful social tariff:

- Alignment of the social tariff with a supplier's direct debit rate regardless of payment method, plus a further percentage discount.
- A percentage discount against the existing tariff for each payment method (i.e. payment method differentials are maintained), meaning that the discount would need to be set at a sufficient level to ensure that all the prepayment meter social tariff customers would pay a rate below the supplier's lowest cost option in the open market.

A number of organisations argue for a third option, namely a national, uniform tariff for certain categories of vulnerable consumers. All beneficiaries would pay the same tariff, regardless of payment method and fuel supplier, with the tariff pegged to offer a lower rate than the lowest tariff offered in the open market (CSE/NRFC, 2006).

The advantage of this approach is that all beneficiaries of the social tariff are treated equally, that is:

- the rate charged under the social tariff is the same regardless of payment method
- the same tariff is charged regardless of fuel supplier
- the tariff is guaranteed to be lower than the best tariff available in the open market.

However, the tariff would entail a considerable cross subsidy to beneficiaries (unless the eligibility criteria are very restrictive) and would represent a considerable additional cost. For this reason, proponents of the option generally argue for Government subsidy of the tariff on the grounds that subsidy by tax-payers is more progressive than subsidy by fuel consumers.

There is therefore a considerable groundswell of opinion advocating the widespread introduction of social tariffs in energy, albeit with differences on what these should look like. The CSE/NRFC report argued that meaningful social tariffs would almost certainly require Government legislation because of the likely cross subsidies their introduction would involve. However, the report also argued for a full evaluation, including a consideration of alternative policy options, before the Government adopted this course. Energywatch has come down firmly in favour of legislation (energywatch, 2007)[17]. It advocates two possible models that would allow social tariffs to be introduced without causing undue distortion to the energy market, as described above (ibid). Both models involve suppliers offering 'energy assistance packages' in which suppliers also provide energy efficiency assistance and benefit entitlement checks to social tariff beneficiaries.

The Government's Energy White Paper highlighted the current variability of suppliers' social tariffs and called upon suppliers to "put in place a proportional programme of assistance (for low income groups)" (DTI, 2007). The White Paper goes on to state:

> "*we hope this will encourage suppliers to do more in this area. If it does not, we will look to give the Secretary of State powers to require companies to have an adequate programme of support for their most vulnerable customers. We will also be looking at whether there are ways to encourage best practice in protecting the most vulnerable consumers from the large differences in bills because of the payment methods they use."* (DTI, 2007)

The key point of contention relating to energy social tariffs is whether or not the Government should mandate them. The Government is giving the energy industry a final opportunity to bring about meaningful social tariffs across the industry through self regulation. It expects certain suppliers to either introduce meaningful offers or to improve the number of consumers helped if already offering a product. However, it is debatable whether reliance on self regulation will lead to suppliers addressing a number of fundamental issues pertinent to social tariffs, including:

- Which groups should be eligible and to what extent do they correspond to the 'fuel poor'?
- How can suppliers make sure that all the defined eligible group receive the social tariff?
- Will the social tariff address price differentials between different payment methods?
- Will the social tariff offer a rate at least as good as anything else the company is offering?
- Will the social tariff offer a rate at least as good, or preferably better, than anything else on offer in the open market?

Other countries[18]

Social tariffs exist in many countries, including countries with liberalised energy markets. They include many US states, European countries and New Zealand. However, there is considerable variation in the design of such tariffs. The following gives some examples of this variation:

US States

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[17] The report also gives details of current social tariffs on offer, including numbers helped and nature of help offered. Ofgem is currently carrying out an audit of suppliers' offers which will update the energywatch information.

[18] This overview draws upon CSE's research for energywatch on international experience of social tariffs (Baker & Andrews, 2006).

Examples include the Ohio Percentage of Income Payment Plan (PIPP), the Pensylvania CAP discount tariffs, the Nicor Gas sharing programme (Illinois) and the Indiana Universal Service Programme.

The PIPP tariff pegs consumers' payments to their incomes such that beneficiaries do not have to pay more than 15% of their income on fuel bills. The CAP tariffs offer seven discounted rates to beneficiaries, dependent on income; discounts range from 20-80% of energy costs. The Nicor scheme involves 'able to pay' consumers making a voluntary donation to a fund which is matched by the company. Beneficiaries are given a grant under the scheme. All the US schemes are notable for integrating social tariffs with State provision in terms of common eligibility criteria and cross referral between the schemes.

France – Basic necessity tariff
1.6m households in France are offered a discount tariff of around 20%. Beneficiaries are people on certain means-tested benefits.

Flanders – social tariff
All households in Flanders receive a certain amount of free energy based on the number of household members. The tariff is effectively a two-block tariff with the first universal block being free.

Belgium – 'special social tariff'
All older and disabled households in Belgium are offered a 'special social tariff' which includes no standing charge and a free allocation of gas, electricity and oil.

New Zealand – low user tariff
All companies must offer a low fixed charge tariff to low use consumers. Bills must be lower than any corresponding tariff option. The tariff is considered to benefit low income users in that they tend to have low consumption. About 31% (1.58m) of residential consumers in New Zealand are on the tariff.

South East Europe
South East Europe is of particular interest because a number of countries offer a form of 'Increasing block tariffs'. Two-block tariffs are offered in Albania, Bulgaria, Moldova and Romania and three-block tariffs in Serbia (European Bank, 2003). The tariffs are compulsory in Albania, Bulgaria and Serbia, whereas consumers have to actively 'opt in' for the tariffs in Moldova and Romania. The Serbian tariff is explicitly designed to encourage energy efficient behaviour by consumers. All the tariffs offer an initial block of energy at low cost, often referred to as a 'lifeline' tariff.

A European Bank for Reconstruction and Development (EBRD) study of the various social tariffs in South East Europe argued that 'lifeline' tariffs scored well on transparency, predictability, ease of administration and high (universal) coverage but poorly on targeting vulnerable customers, expense and tendency to distort prices (EBRD, 2003). Energy discounts and privileges were not considered to distort prices directly but were considered to have unintended side-effects, such as encouraging inefficient use of energy.

Policy impetus for social tariffs

Most social tariffs in other countries came about as a result of Government or regulatory intervention. They therefore differ from social tariffs in Britain which are generally supplier-led (although the Government and regulator 'encourage' British suppliers to offer them). The only supplier-led social tariff overseas identified by CSE's research was the Nicor Gas sharing scheme in Illinois, USA. Only a small number (3,000) of consumers were helped under this scheme.

Social tariffs in European countries were generally either introduced before liberalisation, e.g. France and Italy, or introduced as part of the liberalisation legislation, e.g. Flanders. Social tariffs in the USA are generally negotiated between suppliers and regulators as part of the licensing process (new or renewed).

Australia represents an interesting case study in that considerable debate is currently taking place over the design of tariff structures and their impact on affordability. Consumers can currently chose between regulated tariffs or 'market' offers, with the former representing a form of social tariff, although not recognised as such. A number of consumer representatives advocate the introduction of rising block tariffs on the grounds that they provide a mechanism for addressing both affordability and demand management (Nance, 2004).

Eligibility criteria

Eligibility criteria for social tariffs included means-tested and universal criteria, criteria based on levels of usage and flexible 'hardship' criteria. Means-tested criteria could be further divided into 'direct' measures of income and 'indirect' measures, in which the latter were based on 'receipt of passport benefits'. Only two social tariffs (Ireland and Belgium) were based on household type ('people over 70' and 'disabled people', respectively).

Not surprisingly, social tariffs based on universal criteria had the highest take-up rates (Flanders, Ireland, Serbia, Albania and Bulgaria). Some social tariffs appear very effective (in terms of level of help offered); for example, some consumers in Pensylvania receive 80% of their fuel costs, while 1.6m consumers in France receive 20% discounts on their fuel costs.

Social tariffs and social policy

The CSE study (CSE/NRFC, 2006) argued that a full comparison of take-up rates, levels of coverage and effectiveness of the different social tariffs it reviewed would require placing the social tariffs within a wider social policy context.

The importance of wider social policy considerations was illustrated by the widespread practice in many European countries of including heating costs within tenants' rents. If social security policy also covers rent, energy affordability is much less likely to be an issue (given that space heating generally represents the largest single element of fuel costs).

5 Distributional data

For this project, WWF-UK commissioned CSE to undertake research into different household gas and electricity tariff structure options for the UK. The Increasing Block Tariffs (IBTs) introduced in Section 6 were modelled by CSE using data adapted from the Expenditure and Food Survey 2004[19]. This data comprises an approximately 7,000 strong representative sample of UK households, harmonised with the national distribution of household incomes. Expenditure on electricity and gas was converted into consumption using a combination of payment method, and Sunderland Table data on regional gas and electricity prices in 2004[20].

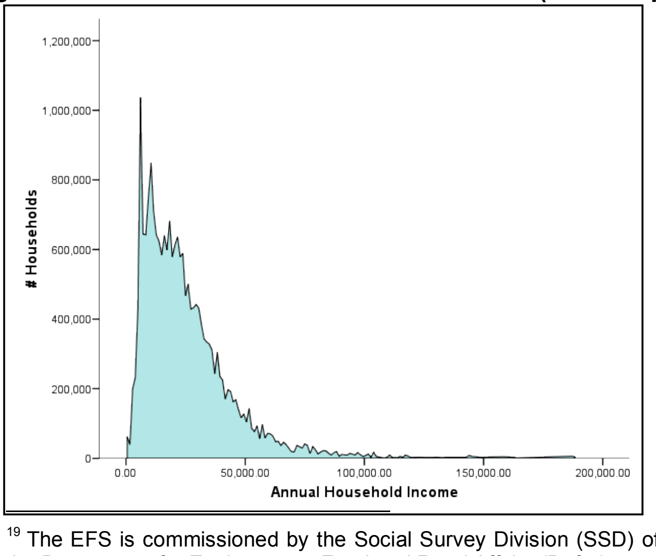
5.1 Distribution of Incomes

Table 1 and Figure 4 below show the distribution of incomes in the UK based on the data from the 2004 Expenditure and Food Survey. The histogram shows how the distribution is skewed, indicating that a higher proportion of the population is concentrated in the lower income bands, with fewer households at the top end of the higher income bands (resulting in a long tail-off in the distribution). However, the figures in Table 1 show there is wide variation in income within deciles. This is even more prominent at the highest income decile, where a few very high incomes skew the mean upwards.

Table 1: Income distribution by deciles

		Annual Income (£)				
		Mean	Minimum	Median	Maximum	Standard Deviation
Annual Income Deciles	1 (low)	4,995	-16,943	5,649	6,778	1,815
	2	8,549	6,782	8,614	10,177	991
	3	11,669	10,177	11,621	13,417	939
	4	15,234	13,422	15,220	17,129	1,090
	5	19,015	17,147	18,942	20,883	1,079
	6	22,803	20,887	22,757	24,904	1,143
	7	27,358	24,912	27,273	29,990	1,473
	8	33,035	29,992	32,908	36,513	1,911
	9	41,474	36,535	41,013	47,857	3,225
	10 (high)	70,170	47,862	60,268	1,209,235	41,544

Figure 4: UK Household Income Distribution (data cropped to show range £0 - £200k per year)



[19] The EFS is commissioned by the Social Survey Division (SSD) of the Office for National Statistics (ONS) and by the Department for Environment, Food and Rural Affairs (Defra).

[20] This aspect of the work was undertaken by Angela Druckman at the University of Surrey, in association with the Centre for Sustainable Energy

5.2 Electricity and Gas consumption (2004)

Tables 2 and 3 below show how electricity and gas consumption are distributed among UK households by income decile. The tables show that for both electricity and gas there is: (1) a strong between-income-deciles correlation between mean income and mean energy consumption; and (2) wide within-income-decile variation in both income (see Table 1), and energy consumption.

The implication of (1) is that, overall, energy consumption is proportional to income, so on average increasing energy unit prices in line with consumption will be socially progressive. However, the variation described in (2) above means that there are exceptions to this rule, in terms of both high energy-using low-income households, and vice versa. This means that increasing energy unit prices in line with consumption would, despite being progressive overall, also have regressive outcomes by creating low-income 'losers', and high-income 'winners'.

Table 2: Electricity Consumption Distribution by Income Deciles

Annual Income (£)		Annual Electricity Consumption (kWh)				
Decile	Mean	Mean	Minimum	Median	Maximum	Standard Deviation
1	4,995	4,114	89	3,423	20,443	2,811
2	8,549	4,357	754	3,750	18,765	2,532
3	11,669	4,268	580	3,590	23,384	2,864
4	15,234	4,711	146	4,001	25,790	2,901
5	19,015	5,129	114	4,377	22,164	2,899
6	22,803	4,989	302	4,456	27,499	2,738
7	27,358	5,530	197	4,842	23,085	2,969
8	33,035	5,819	197	5,122	28,856	3,252
9	41,474	5,903	508	5,245	22,930	3,160
10	70,170	6,710	202	6,014	26,658	3,490

Source: Adapted from Angela Druckman & CSE, 2007

Table 3: Gas Consumption Distribution by Income Deciles

Annual Income (£)		Annual Gas Consumption (kWh)				
Decile	Mean	Mean	Minimum	Median	Maximum	Standard Deviation
1	4,995	12,441	0	11,324	90,349	12,915
2	8,549	14,290	0	13,894	85,492	12,791
3	11,669	15,317	0	15,360	78,368	12,821
4	15,234	16,687	0	16,596	100,624	12,616
5	19,015	18,525	0	18,803	98,106	14,568
6	22,803	18,681	0	18,419	85,492	13,945
7	27,358	18,667	0	18,803	87,577	14,285
8	33,035	21,422	0	21,237	142,278	15,328
9	41,474	22,681	0	22,224	88,155	15,490
10	70,170	25,054	0	24,434	136,590	18,702

Source: Adapted from Angela Druckman & CSE, 2007

5.3 Distribution of Energy Need

The data presented in Table 4 below was produced for CSE by Dr. Richard Moore using background modelling data from 'How Much? The Cost of Alleviating Fuel Poverty' [21] - as yet unpublished research for EAGA Partnership Charitable Trust, undertaken by CSE, ACE, and Dr. Richard Moore.

The 'How Much?' model is based on detailed data on fuel prices, domestic energy efficiency, household incomes and fuel poverty used in or derived from the core sample of 15,874 households in the 2004 English House Condition Survey (EHCS). The EHCS sample provides a SAP rating for each dwelling which is based on energy use in kWhs per m^2 for a property occupied under a standard heating regime. The 'How Much?' model unpicks this, and allows for use of lights and electrical appliances (as defined by the ACE Fuel Prophet tool).

The data in Table 4 below are presented here to illustrate that, as with energy *consumption*, modelled energy *requirement* shows (1) a strong between-income-decile correlation between mean income and mean energy requirement, and (2) wide within-income-decile variation in energy requirement.

Table 4: Distribution of Required Energy Consumption by Income Deciles

		Total Energy Requirement (kWh)				
		Mean	Minimum	Median	Maximum	Standard Deviation
Annual Income Decile	1	24,173	5,425	23,204	100,276	10,303
	2	24,582	5,637	23,238	94,275	10,621
	3	26,480	6,366	25,257	122,681	11,247
	4	27,516	4,643	26,523	92,256	11,022
	5	28,462	5,354	26,840	140,035	11,870
	6	29,550	6,067	28,019	116,639	12,476
	7	30,852	6,529	28,866	101,497	12,874
	8	31,596	4,973	29,674	98,083	12,571
	9	33,760	6,529	31,106	113,092	14,203
	10	37,835	8,539	34,708	184,729	16,249

[21] 'How Much? The Cost of Alleviating Fuel Poverty': unpublished research for EAGA Partnership Charitable Trust, by CSE, ACE and Dr. Richard Moore.

6 Regulatory context

The historic and current legislation relating to the charging powers and duties of the Secretary of State and of the regulatory bodies for the UK power sector is outlined in the Gas Act 1986, Electricity Act 1989, Gas Act 1995 and Utilities Act 2000

The Utilities Act 2000 amalgamated the two previous regulatory bodies into the Gas and Electricity Markets Authority and this branded itself the Office of Gas and Electricity Markets, or Ofgem. The Act introduced a significant re-casting of the regulator's duties. In effect, the protection of consumer interest became Ofgem's primary duty, although the Act went on to state that this would be best met 'by promoting competition', wherever appropriate, between suppliers.

The Act also harmonised the particular groups the Secretary of State and regulator should have regard to within the gas and electricity sectors, namely disabled, chronically sick, low income and rural households. Another significant development, particularly with respect to sustainability, was the definition of consumers to include both existing and future consumers. The Act also gave powers to the Secretary of State to issue guidance to the regulator on attainment of social and environmental policies. In practice, the guidance just reiterated already published Government social and environmental policy objectives which the Government considered relevant to gas and electricity supply.

The Act introduced 'reserve' powers for the Secretary of State whereby if he/she considered disadvantaged customers were treated less favourably than other customers in respect of charges, "he may make an order containing a scheme for the adjustment of charges for electricity (gas) with a view to eliminating or reducing the less favourable treatment." This power has yet to be invoked.

A key regulatory activity was the setting of price controls for the UK household supply market. These were set for the three main payment methods used in the domestic gas and electricity market: Direct Debit, Standard Credit and prepayment meter. From the outset of liberalisation, Direct Debit tariffs attracted the lowest charges and prepayment meters the highest. Ofgem considered this practice legitimate and in keeping with the 'undue discrimination requirement', arguing that prepayment meter consumers cost more to serve (e.g. more costly meters, payment infrastructure, more frequent call-out costs). However, most prepayment meter consumers live on low incomes, although many low income households (particularly pensioners) do not use this method of payment. The Direct Debit/ prepayment differential led many to argue that low income groups were losing out from energy market liberalisation (e.g. Baker, 2001; Klein, 2003).

In 2002, Ofgem removed all remaining price controls on the grounds that competition was sufficiently advanced without the need for controls (Ofgem, 2002). The decision was highly controversial, with consumer groups particularly opposed (as was, apparently, the DTI). Opposition focussed in particular on the lack of competitive offers for prepayment meter consumers, an issue that continues to cause concern to this day (see, for example, the 5th annual report of the Government's Fuel Poverty Advisory Group (FPAG, 2007)).

Ofgem's decision was taken after a period of prolonged decline in gas and electricity prices – a decline that undoubtedly made it easier for Ofgem to push through the change. Both the

Government and Ofgem attributed the 15 year decline in prices prior to 2003 to the privatisation and liberalisation of the energy market (DTI, 2005). Other commentators have argued that the decline in prices would have occurred regardless, due to declining world fossil fuel prices, under-valuation of the industry's pre-privatisation assets and adoption of more efficient generation technology (Thomas, 2004).

The consequence of the removal of price controls is that Ofgem no longer has any direct ability to influence suppliers' tariff structures, other than through its general Competition Act powers. This has important implications for the introduction of sustainable and social tariffs.

Ofgem and social tariffs

Interestingly, Ofgem has taken a more benign interpretation of existing 'social tariffs' in energy than other stakeholders and than the UK water industry regulator, Ofwat. While Ofwat has taken the view that water affordability problems should be addressed through the tax and benefits system, Ofgem issued guidance to suppliers that the Competition Act did not preclude suppliers from introducing social tariffs for which suppliers "may make less profit than those offered to non-vulnerable customers" (Ofgem, 2004) The only caveat was that suppliers should not use non-supply parts of the company to cross subsidise loss-making social tariffs.

Ofgem views social tariffs within the context of suppliers' corporate social responsibility (CSR). Given that CSR activities are nominally entirely voluntary, this implies that suppliers are perfectly entitled to stop offering social tariffs or other forms of help to low income/vulnerable groups (other than those proscribed by licence). Ofgem is firmly opposed to making it a requirement on suppliers to offer social tariffs. It argues that social tariffs may not be the most effective tool for tackling fuel poverty (Ofgem, 2007). More fundamentally, it views compulsion as going against the general Government and Ofgem policy of gradual withdrawal from intervening in energy markets. It has also expressed concern that compulsory social tariffs will create distortions within the competitive energy market (CSE/NRFC, 2006; Ofgem, 2007).

Ofgem is in the process of developing a reporting framework that will help 'shine a light' on the different offerings each supplier has and their respective features and benefits (ibid). It suggests that for a supplier's offer to be classed as a social tariff:

- the offer should relate to a reduction to ongoing charges levied on customers for the provision of energy. While this may be delivered alongside other help and support offered to vulnerable customers such as energy efficiency measures, it should be clearly distinguishable from that help;
- the offer is equal to, or lower than, a supplier's current lowest available standard offering (any categorisation will need to recognise the existence of non-standard offerings such as fixed price tariffs as well as the possible emergence of energy service contracts); and
- the offer is available to all customers who meet the qualification criteria.

Ofgem also states that greater clarity is required on expenditure by suppliers on social offers, which it expects its reporting framework to help deliver. The Government subsequently formalised Ofgem's work in its Energy White Paper. However, the White Paper gives the work more teeth by stating that the Government will introduce legislation in which the Secretary of State will be given "powers to require companies to have an adequate programme of support for their most vulnerable customers” if he/she considers certain suppliers are not doing enough (see section 3.1.2). This raises the interesting prospect of the Government making suppliers’ CSR activities compulsory and/or the Secretary of State using the ‘reserve’ powers to enforce better practice.

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7 Modelling and Analysis of Increasing Block Tariffs for Household Energy Use

7.1 Approach to Modelling Increasing Block Tariffs (IBTs)

Following the review and discussion of the various options for social and sustainability tariffs, this section sets out the way in which CSE approached the modelling and analysis of a set of potential new One-Size-Fits-All Increasing Block Tariffs.

As referred to in Section 1, the Expenditure and Food Survey provides sufficient data to construct a tariff model, with which the overall and distributional effects of various new tariff structures on UK households can be investigated. The impacts of any new IBTs that are of particular interest are:

- Environmental: effects on overall energy demand and associated CO_2 emissions;
- Economic: effect on overall revenue to suppliers, and the effect on the average unit costs of electricity and gas;
- Social: Distribution by income of households gaining and losing financially under the new tariffs.

The parameters CSE used to define the IBTs are:

1. the number of price blocks
2. the cutpoints between price blocks, in kWh (which also define block widths), and
3. the unit energy price for each block (based here on multiples of the average for 2004).

In addition, to assess the effect of the IBTs on energy demand, it was necessary to make an assumption regarding price elasticities of demand for electricity and gas. The value used here were -0.25 for both electricity and gas. It should be noted that this was based on a brief literature review (see Section 3.2), and the results of the modelling are very sensitive to the choice made. Furthermore, advanced analysis of price elasticity effects in situations where price varies with volume (as is the case with an IBT) requires modelling of the way in which price elasticity itself varies with volume and price. This is beyond the scope of the current project for WWF-UK, and requires information on various household details which are not available from the Expenditure and Food Survey (eg numbers of different types of electrical appliance etc).

Of necessity, a simpler approach has been adopted here. This involves (i) identifying a reasonable estimate of the average price elasticities of demand for electricity and gas, and (ii) assuming that a household experiences an IBT in terms of its overall annual effect on energy costs (rather than as a set of price bands, each with its own price elasticity of demand) – allowing the average price elasticity to be applied to the overall annual cost change so as to generate household demand responses to the IBT.

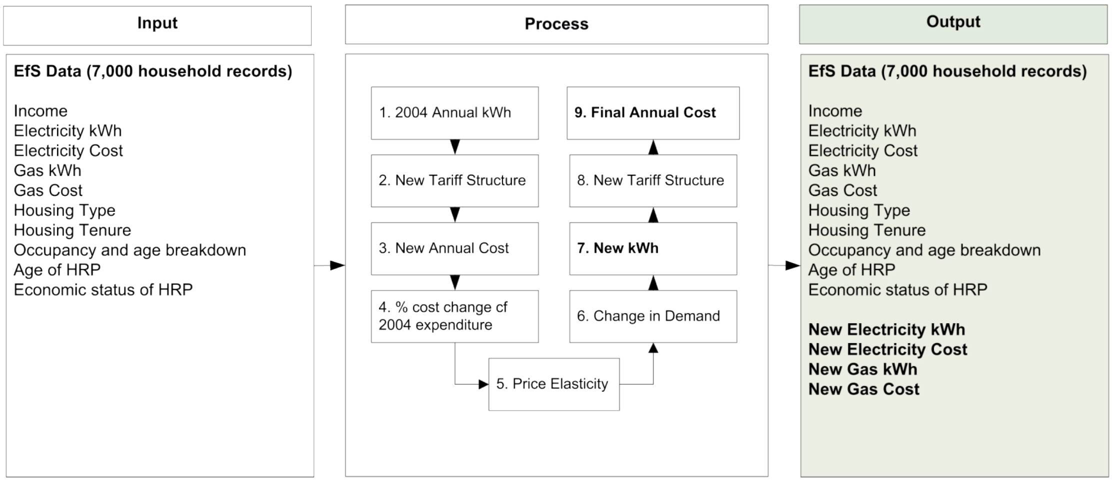
The main outputs of CSE's tariff modelling exercise were, for each household in the survey sample:

1. the % change in price for the year 2004 energy demand under the new tariff
2. the % change in energy demand (and associated CO_2 emissions) resulting from the price elasticity demand effect derived from (1), and

3. the cost of the new (changed) energy demand under the new tariff

Figure 5 below illustrates the sequence of steps involved in CSE's modelling of the effects of an IBT. New energy consumption and cost data are calculated for every household in the EFS survey sample, and sample weightings are applied to extrapolate the results across the UK. This allows detailed analysis of the distribution of households who would gain and lose financially under the new tariffs, and calculation of the total energy demand and carbon dioxide emission reductions resulting from the tariff, along with their distributions by income decile.

Figure 5: The Tariff Modelling Process



7.2 Potential new Increasing Block Tariffs and their effects

Through discussion with WWF, it was agreed that three IBT types would be modelled for both gas and electricity, prioritising environmental, economic, and social factors as follows:

1. overall household electricity and gas demand and CO_2 reductions (environmental)
2. balancing total revenue to energy suppliers (economic)
3. economic redistribution from high to low income households (social)

The 'demand reduction' tariffs (1) seek to maximise reductions in energy use and consequent CO_2 emissions, by progressively increasing gas and electricity unit prices from their 2004 average, in line with increasing household consumption.

By slightly discounting initial units, but compensating with increased costs for higher levels of consumption, the 'revenue balancing' tariffs (2) attempt to hold the overall sales revenue to energy suppliers (and hence the overall average unit cost) constant while achieving demand reductions.

Finally, the 'redistribution' tariffs (3) offer more significant discounts for early units, balanced with more dramatic price increases for later units in an effort to maximise the transfer of cost burden from lower to higher income households, while achieving demand reductions.

Each of the tariffs was developed by refining the model in an iterative process. This entailed starting with a 'flat' tariff, and progressively altering the structure and analysing the distributional effects of each change – a process which was repeated until the overall distributional impacts of each of the tariffs was consistent with the criteria set out above, at the level of average changes for each income decile. At this point the tariff models were 'locked', and more detailed within-income-decile distributional effects investigated.

This iterative approach avoids the need to define 'necessary' or 'basic' energy requirements as part of the tariff design process, which as we saw in 5.3 vary widely and are therefore difficult to define for the population as a whole. It also avoids the difficulty of assessing the appropriate long run total and marginal social costs of energy use (discussed in Section 2.3).

Note that the modelled impacts of a tariff are sensitive to relatively small changes to the design parameters (ie the number, location, width, and prices of the blocks). This is particularly true for changes affecting the prices for early units of consumption, which represent a higher proportion of overall demand, and affect the largest number of households.

In designing the tariffs, we have attempted to restrict the overall and distributional economic effects to reasonable proportions – in other words to avoid obviously unrealistic or extreme outcomes. The modelling process was therefore not entirely unconstrained, and this has resulted in tariffs which may appear, in terms of their defining parameters, to be subtly different. Nevertheless, as Table 5 shows, the outcomes do vary significantly.

The result is a set of tariffs which (1) illustrate a range outcomes that could result from different IBT structures, and (2) represent IBTs likely to achieve energy demand and CO_2 emissions reductions while minimising regressive economic effects.

The final electricity tariffs are labelled E1 (Demand Reduction), E2 (Revenue Neutral) and E3 (Redistribution) respectively. Similarly the gas tariffs are labelled G1, G2 and G3 respectively. Table 5 below sets out the six individual tariffs created by CSE, including the positioning of the blocks, the unit price (including relative to 2004 levels - the 'multiplier') and summarises their overall effects on household electricity and gas demand, carbon emissions, and total revenue to energy suppliers.

The subsequent two pages show six pairs of graphs, each relating to one of the six tariffs. Each figure shows the locations of the tariff block cutpoints as vertical lines. The first figure in each pair (on the left-hand side of the page) then plots the annual gas or electricity bill (on the y-axis) that would result from a given level of consumption (on the x-axis), firstly for the new IBTs (red points), and secondly, for average 2004 prices (black points). This allows visualisation of the way in which the new tariffs diverge from current (ie 2004) pricing. On these graphs, the unit price determines the slope of the line (£ / kWh): it can be seen clearly that as the unit prices increase from block to block, the slope of the line also increases.

The second graph in each pair (on the right-hand side of the page) is a histogram showing the proportion of households (y-axis) in each consumption range (x-axis). On each histogram there are two lines. The red lines show the modelled distribution of gas or electricity consumption that results from the application of the new IBT, while the blue lines show the actual distribution as per the 2004 Expenditure and Food Survey. By comparing the blue lines and the red lines, the graphs allow a ‘before and after’ analysis of the effects of each of the tariffs on the demand distribution.

Note that the 24% of UK households that do not have access to gas are not shown on the gas graphs. Hence the percentage figures for the gas consumption histograms relate to the total number of households that use gas, rather than the total number of households in the UK.

Table 5: New modelled Household Electricity and Gas Tariffs (E1 to G3) Summarised

E1: Electricity Demand Reduction

Blocks (kWh)	% kWh in block before	% kWh in block after	Multiplier	Price (p)
0 - 3,000	54.4%	58.7%	1	6.7
3000 - 8,500	38.6%	37.4%	1.5	10.1
8,500 - 16,000	6.3%	3.9%	2	13.4
16,000 - 29,000	0.6%	0.0%	4	26.8
Demand Reduction (TWh)			**7.29**	**7.4%**
CO_2 reduction (Mt)			**3.84**	
Revenue Change (£ Bn)			**+0.92**	**+13.8%**

G1: Gas Demand Reduction

Blocks (kWh)	% kWh in block before	% kWh in block after	Multiplier	Price (p)
0 - 11,000	45.5%	49.5%	1	1.6
11,000 - 35,000	46.9%	46.3%	1.5	2.4
35,000 - 100,000	7.0%	4.1%	2	3.2
100,000 - 143,000	0.1%	0.0%	3	4.8
Demand Reduction (TWh)			**28.66**	**7.9%**
CO_2 reduction (Mt)			**5.56**	
Revenue Change (£ Bn)			**+1.02**	**+17.6%**

E2: Electricity Revenue Neutral

Blocks (kWh)	% kWh in block before	% kWh in block after	Multiplier	Price (p)
0 - 1,500	28.7%	29.0%	0.5	3.4
1,500 - 4,500	44.2%	46.3%	1	6.7
4,500 - 8,000	18.9%	18.9%	1.5	10.1
8,000 - 24,000	8.1%	5.5%	2	13.4
24,000 - 29,000	0.0%	0.0%	3	20.1
Demand Reduction (TWh)			**1.19**	**1.2%**
CO_2 reduction (Mt)			**0.63**	
Revenue Change (£ Bn)			**-0.02**	**-0.3%**

G2: Gas Revenue Neutral

Blocks (kWh)	% kWh in block before	% kWh in block after	Multiplier	Price (p)
0 - 5,000	21.6%	21.9%	0.5	0. 8
5,000 - 23,000	57.7%	59.9%	1	1.6
23,000 - 36,000	13.7%	13.6%	1.5	2.4
36,000 - 65,000	6.2%	4.2%	2	3.2
65,000 - 143,000	0.2%	0.2%	3	4.8
Demand Reduction (TWh)			**4.97**	**1.4%**
CO_2 reduction (Mt)			**0.96**	
Revenue Change (£ Bn)			**+0.01**	**+0.2%**

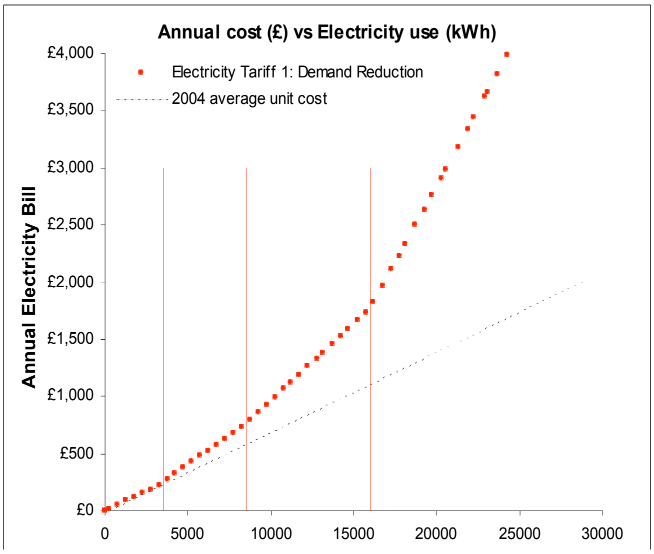
E3: Electricity Redistribution

Blocks (kWh)	% kWh in block before	% kWh in block after	Multiplier	Price (p)
0 - 1,500	28.7%	29.2%	0.5	3.4
1,500 - 2,500	17.8%	18.5%	0.75	5.0
2,500 - 5,000	30.8%	33.3%	1	6.7
5,000 - 16,500	22.1%	18.8%	2	13.4
16,500 - 29,000	0.5%	0.0%	4	26.8
Demand Reduction (TWh)			**1.58**	**1.6%**
CO_2 reduction (Mt)			**0.83**	
Revenue Change (£ Bn)			**-0.11**	**-1.7%**

G3: Gas Redistribution

Blocks (kWh)	% kWh in block before	% kWh in block after	Multiplier	Price (p)
0 - 4,000	17.3%	17.8%	0.5	0.8
4,000 - 12,000	31.9%	33.2%	0.75	1.2
12,000 - 21,000	26.1%	28.2%	1	1.6
21,000 - 69,000	24.1%	20.7%	2	3.2
69,000 - 143,000	0.8%	0.0%	4	6.4
Demand Reduction (TWh)			**9.05**	**2.5%**
CO_2 reduction (Mt)			**1.76**	
Revenue Change (£ Bn)			**+0.06**	**+1.1%**

Figure 8: (i) E1 Cost vs Consumption



(ii) E1 Consumption Histogram

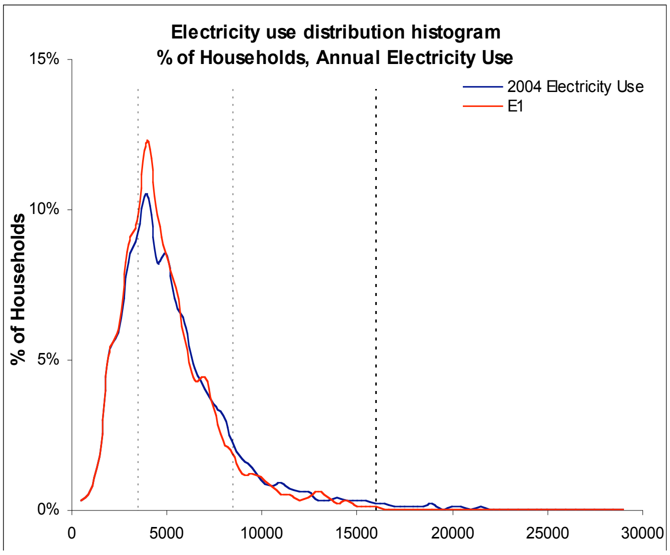
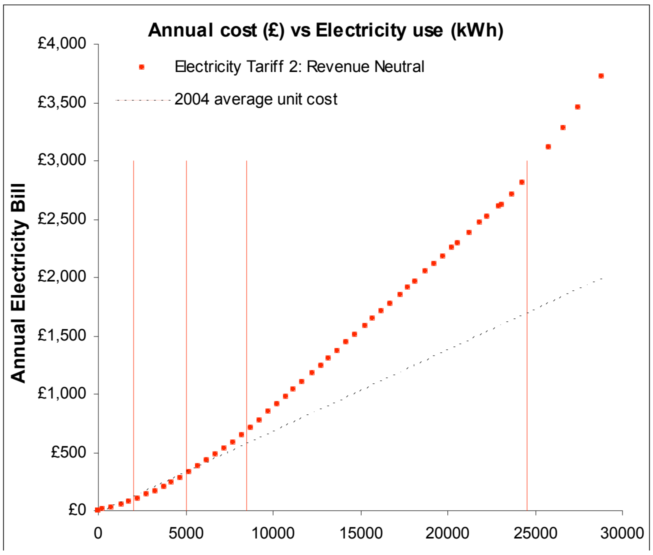


Figure 6: (i) E2 Cost vs Consumption



(ii) E2 Consumption Histogram

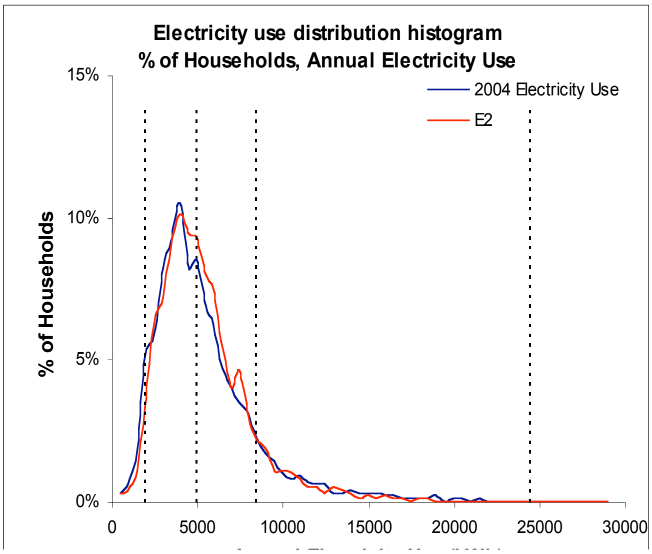
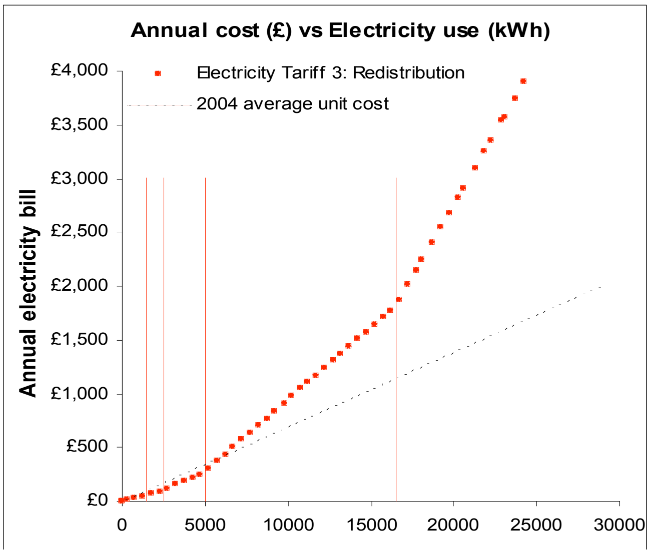


Figure 10: (i) E3 Cost vs Consumption



(ii) E3 Consumption Histogram

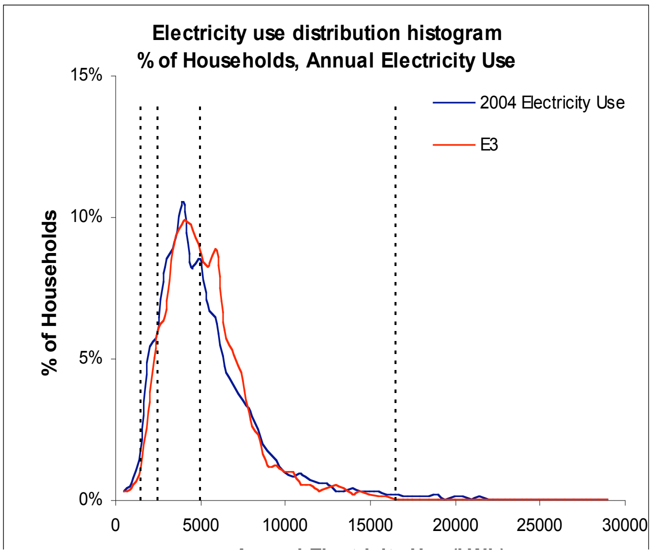
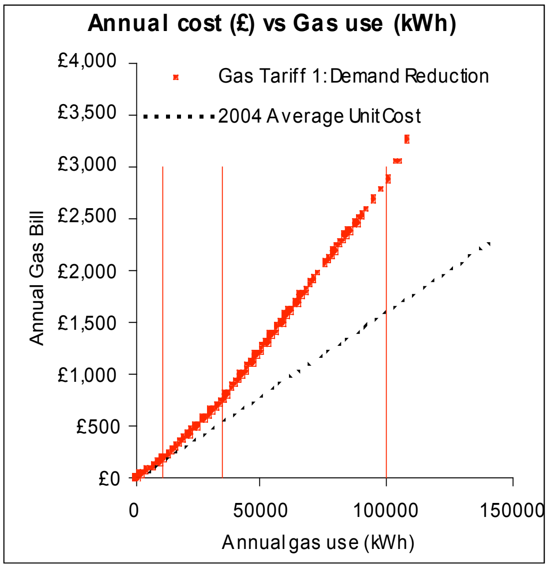


Figure 11: (i) G1 Cost vs Consumption **(ii) G1 Consumption Histogram**



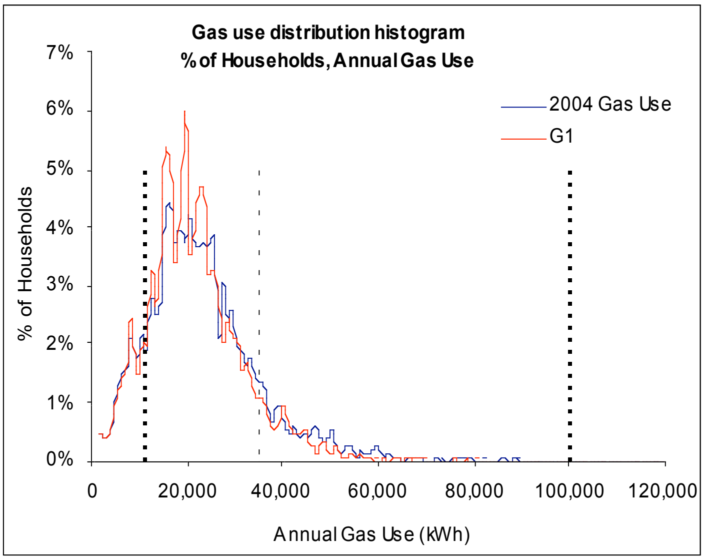
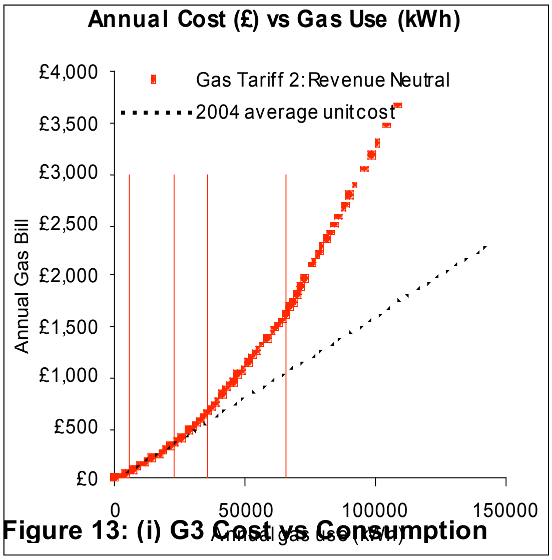


Figure 7: (i) G2 Cost vs Consumption **(ii) G2 Consumption Histogram**



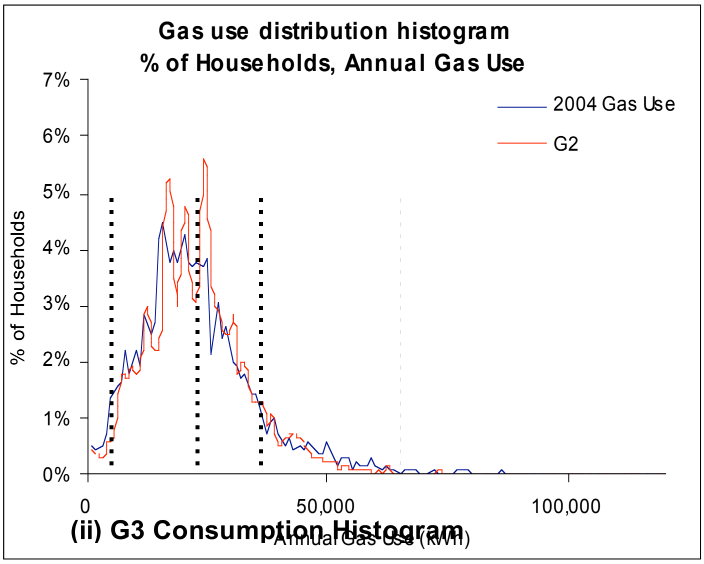
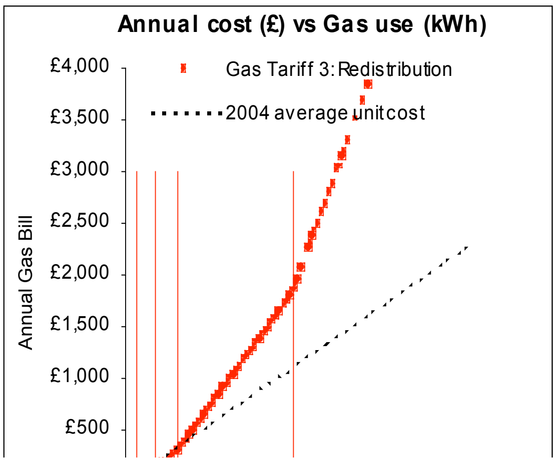
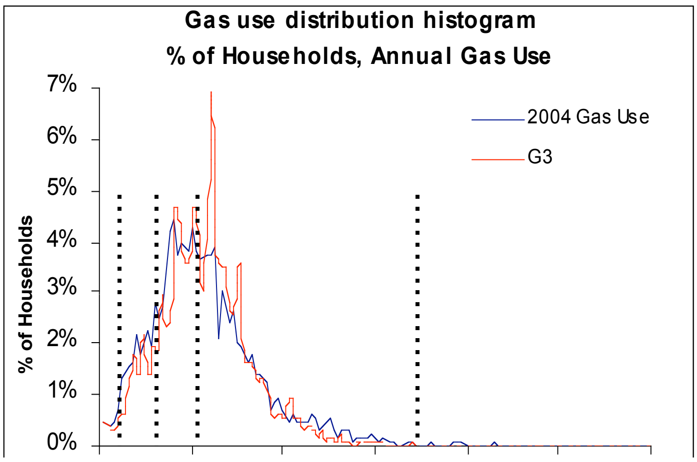


Figure 13: (i) G3 Cost vs Consumption **(ii) G3 Consumption Histogram**





7.3 Electricity Tariff summaries

E1 – Demand Reduction: Four rising price blocks with no discount

Overall, the main effects of this tariff are:

1. Environmental effects: A significant overall demand reduction of 7.4% with a resulting 3.8Mt reduction in CO_2 emissions.
2. Economic effects: A 13.8% increase in revenue to energy suppliers (despite the decrease in demand). As a result, the average unit price across all households increases by 22%, from 6.7p to 8.2p.
3. Social effects: All households paying the average unit price in 2004 will pay more under this tariff while consuming less electricity.

The effects of this tariff are distributed across income deciles, such that:

- Households in the first (lowest) income decile are on average just over £0.50 per week worse off, with a 5% demand reduction.
- Households in the tenth (highest) income decile are on average £1.50 per week worse off with a 10% demand reduction.
- Within income decile 1, 2% of households are £1 per week or more worse off under tariff E1.

A more detailed analysis of low income (defined as income deciles 1-3) households losing more than £1 per week under this tariff reveals the following:

- 22% of low income households lose more than £1 per week under tariff E1 (equal to 6.5% of all households).
- These households tend to have higher electricity use (57%) as a proportion of total energy use than either low income households as a whole, or the population in general.
- They are also more likely to be childless households, own their property outright and be retired/ pensioners.

E2 – Revenue Neutral: Five Blocks: 1 Discounted, 1 Average, 3 Incremented

Overall, the effects of this tariff are:

1. Environmental effects: An overall demand reduction of 1.2% and a resulting reduction in CO_2 emissions of 0.6Mt.
2. Economic effects: A decrease in revenue to energy suppliers by 0.33%, despite an overall small increase in average unit cost of 1.5%, to 6.8p.
3. Social effects: The majority of households (88%) paying the average unit price in 2004 will pay less under this tariff, with 70% being £1 or more a week better off, and 10% £2 a week or more better off.

The effects of this tariff are distributed across income deciles, such that:

- Households in the first (lowest) income decile are on average just over £0.30 per week better off, and increase their electricity use by about 1.2%.
- Households in the tenth (highest) income decile are on average about £0.60 per week worse off, with a 4% reduction in consumption.

- There are still 0.8% of households in the lowest income decile that are more than £1 per week worse off.
- 0.4% of households in the highest income decile are £1 or more a week better off.

A more detailed analysis of low income (defined as income deciles 1-3) households losing more than £1 per week under this tariff reveals the following:

- 7% of low income households lose more than £1 per week under tariff E2 (equal to 2% of the whole population).
- They tend to have significantly higher electricity use (71%) as a proportion of total energy use than either low income households as a whole, or the population in general.
- They are also more likely to be childless households, in terraced/semi-detached houses or purpose built flats/maisonettes, own their property and be retired/over-65s.

E3 – Redistribution: Five Blocks: 2 Discounted, 1 Average, 2 Incremented

Overall, the main effects of this tariff are:

1. Environmental effects: An overall demand reduction of 1.6% with associated CO_2 emissions reductions of 0.8Mt.
2. Economic effects: A decrease in revenue to energy suppliers of 1.7%, whilst the overall average unit cost remains the same as 2004 prices, at 6.7p/unit.
3. Social effects: The majority of households paying the average unit price in 2004 will pay less under this tariff, with 71% of households being £1 or more a week better off, 21% £2 a week or more better off and only 9% £1 a week or more worse off.

The effects of this tariff are distributed across income deciles, such that:

- Households in the first (lowest) income decile are on average nearly £0.50 per week better off, with an increase in demand of 1.3%.
- Households in the tenth (highest) income decile are on average nearly £0.60 per week worse off, with a decrease in demand of 5.4%.
- Within income decile 1, there are 1% of households £1 or more a week worse off under this tariff.
- Similarly, 1% of households £1 or more a week better off are in the highest income decile.

A more detailed analysis of low income (defined as income deciles 1-3) households losing more than £1 per week under this tariff reveals the following:

- 10% of low income households lose more than £1 per week under tariff E3 (which corresponds to nearly 3% of the whole population).
- They tend to have significantly higher electricity use (68%) as a proportion of total energy use than either low income households as a whole, or the population in general.
- They are also more likely to be childless households, owner occupied (or LA/HA accommodation), with a high proportion retired or ‘unoccupied’.

7.4 Gas Tariff summaries

G1 – Demand Reduction: Four rising price blocks with no discount

Overall, the main effects of this tariff are:

1. Environmental effects: A significant overall demand reduction of 7.9%, with associated CO_2 emissions reductions of 5.6Mt.
2. Economic effects: A 17.6% increase in revenue to energy suppliers (despite the decrease in demand). As a result, the average unit price across all households increases by 27.5%, from 1.6p to 2.04p.
3. Social effects: All households paying the average unit price in 2004 will pay more under this tariff while consuming less gas.

The effects of this tariff are distributed across income deciles, such that:

- Households in the first (lowest) income decile are on average just over £0.70 per week worse off, and reduce their gas use by about 6%.
- Households in the tenth (highest) income decile are on average around £1.90 per week worse off with a 10% demand reduction.
- There are nearly 2% of households in the lowest income decile who are £1 or more per week worse off under tariff G1.

A more detailed analysis of low income (defined as income deciles 1-3) households losing more than £1 per week under this tariff reveals the following:

- 30% of low income households lose more than £1 per week under tariff G1 (which equates to 7.8% of the whole population).
- They tend to have lower electricity use (just 12.6%, and therefore higher gas use) as a proportion of total energy use than either low income households generally, or the population as a whole.
- They are also more likely to be childless households, own their property, be retired and over 65.

G2 – Demand Reduction: Five Blocks: 1 Discounted, 1 Average, 3 Incremented

Overall, the main effects of this tariff are:

1. Environmental effects: Overall demand is reduced by 1.4% and there is an associated reduction in CO_2 emissions of 1Mt.
2. Economic effects: Revenue to energy suppliers increases by 0.2%. The overall average unit price increases only a fraction from 1.60p to 1.62p, an increase of just 1.25% on 2004 prices.
3. Social effects: The majority of households (88%) paying the average unit price in 2004 will pay less under this tariff, with 70% being £1 or more a week better off.

The effects of this tariff are distributed across income deciles, such that:

- Households in the first (lowest) income decile are just over £0.30 per week better off, and increase their gas use by about 0.8%.
- Households in the tenth (highest) income decile are on average approximately £0.60 per week worse off, with a near 5% reduction in consumption.
- 0.5% of households £1 or more a week worse off are in income decile one.

A more detailed analysis of low income (defined as income deciles 1-3) households losing more than £1 per week under this tariff reveals the following:

- 6% of low income households lose more than £1 per week under tariff G2 (1.7% of the whole population).
- They tend to have significantly lower electricity use (at just 11.4%, and therefore higher gas use) as a proportion of total energy use than either low income households as a whole, or the population in general.
- They are also more likely to be childless, detached or semi-detached households, with a high proportion of retired/over-65s and own their property outright.

G3 – Redistribution: Five Blocks: 2 Discounted, 1 Average, 2 Incremented

Overall, the main effects of this tariff are:

1. Environmental effects: An overall demand reduction of 2.5% and associated reduction in CO_2 emissions of 1.8Mt.
2. Economic effects: Revenue to energy suppliers increases by 1.1%. The overall average unit cost increases by 3.75% on 2004 prices, to 1.66p/unit.
3. Social effects: The majority of households paying the average unit price in 2004 will pay less under this tariff, with 64% being £1 or more a week better off, and 14% £2 a week or more better off.

The effects of this tariff are distributed across income deciles, such that:

- Households in the first (lowest) income decile are on average £0.40 per week better off, with an associated increase in demand of 0.86%.
- Households in the tenth (highest) income decile are, on average, just over £0.70 a week worse off, with a reduction in demand of nearly 7%.
- 0.7% of households £1 or more a week worse off under this tariff are in the lowest income decile.
- Just over 1% of households £1 or more a week better off are in the highest income decile.

A more detailed analysis of low income (defined as income deciles 1-3) households losing more than £1 per week under this tariff reveals the following:

- 4% of low income households lose more than £1 per week under tariff G3 (which corresponds to 2.6% of the whole population).
- They tend to have the lowest electricity use (at 11.14%, and therefore the highest gas use) as a proportion of total energy use of all the other 'populations' analysed (the whole population, income deciles 1-3 and losers under the different gas tariffs).
- They consist of a high proportion of childless households, owned outright, with retired/over-65 occupants.

7.5 The ‘Dual Fuel’ Tariffs

Combined Tariff E1 + G1

This tariff combines the pricing structure for electricity and gas under tariffs E1 and G1 respectively.

Overall the main effects of this combined tariff are:

1. Environmental effects: An overall demand reduction resulting in a 9.4Mt reduction in CO_2 emissions; a reduction of 8% on 2004 levels.
2. Economic effects: Simply combining the revenue gains associated with the individual tariffs gives an overall increase in revenue to suppliers of 15.6% under this dual fuel tariff.
3. Social effects: Under this combined tariff structure, the overall proportion of ‘winners’ is reduced and the extent of loss ‘stretches’. However, overall 38% of households paying the average unit prices in 2004 are better off financially, although only 11% of these experience a reduction of £1 or more per week.

The effects of this tariff are distributed across income deciles, such that:

- Households in the first (lowest) income decile are on average £1.27 per week worse off, with a demand-related reduction in CO_2 emissions of 6%.
- Households in the tenth (highest) income decile are on average £3.45 a week worse off, with an associated reduction in CO_2 emissions of 10%.
- 1.6% of households £1 or more a week worse off are in the lowest income decile.

A more detailed analysis of low income (defined as income deciles 1-3) households losing more than £1 per week under this combined tariff reveals the following:

- 21% of low income households are £1 per week or more worse off under the combined tariffs of E1 and G1 (which corresponds to 6% of the whole population).
- Their electricity use (at 37.5%) as a proportion of total energy use is similar to the average for the lower 3 income deciles generally.
- They are also more likely to be childless households, owned outright, with single occupancy, by a retired/over-65 person.

Combined Tariff E2 + G2

This tariff combines the pricing structure of tariffs E2 and G2, therefore constituting a dual-fuel revenue neutral tariff.

Overall the main effects of this combined tariff are:

1. Environmental effects: An overall demand reduction resulting in a 1.6Mt reduction in CO_2 emissions; a reduction of 1% on 2004 levels.
2. Economic effects: Simply combining the revenue gains/losses associated with the individual tariffs gives an overall decrease in revenue to suppliers of 0.08% under this dual fuel tariff.
3. Social effects: Under this combined tariff structure, 66% of the population are £1 or more a week better off. However, the proportion of losers compared to these two tariffs individually, increases slightly as a result of combining them, as does the extent of loss.

The effects of this tariff are distributed across income deciles, such that:

- Households in the first (lowest) income decile are on average £0.65 per week better off, with a demand-related reduction in CO_2 emissions of 1%.
- Households in the tenth (highest) income decile are on average £1.12 a week worse off, with an associated reduction in consumption and CO_2 emissions of 4%.
- 0.6% of households £1 or more a week worse off are in the lowest income decile.
- There are 4% of households in the highest income decile £1 or more a week better off.

A more detailed analysis of low income (defined as income deciles 1-3) households losing more than £1 per week under this combined tariff reveals the following:

- 5% of low income households lose £1 per week or more under the combined tariffs of E2 and G2 (which corresponds to 1.6% of the whole population).
- Their electricity use (at 51.7%) as a proportion of total energy use is higher than the average for the whole population and income deciles 1-3 generally.
- They are also more likely to be childless, owner occupied households, with occupants over-65/ retired and with a relatively high proportion of detached properties.

Combined Tariff E3 + G3

This tariff includes the pricing structures as specified under electricity tariff 3 and gas tariff 3, thus constituting a dual-fuel redistribution tariff.

Overall the main effects of this combined tariff are:

1. Environmental effects: An overall demand reduction resulting in a 2.6Mt reduction in CO_2 emissions; a reduction of 2% on 2004 levels.
2. Economic effects: Simply combining the revenue gains/losses associated with the individual tariffs gives an overall decrease in revenue to suppliers of 0.4% under this dual fuel tariff.
3. Social effects: Under this combined tariff structure, 65% of the population are £1 or more a week better off. However, the proportion of losers, compared to these two tariffs individually, increases slightly as a result of combining the two pricing structures, with 16% of the population being £1 or more a week worse off.

The effects of this tariff are distributed across income deciles, such that:

- Households in the first (lowest) income decile are on average just over £0.80 per week better off, with a demand-related reduction in CO_2 emissions of 1%.
- Households in the tenth (highest) income decile are on average £1.30 a week worse off, with an associated reduction in consumption and CO_2 emissions of 6%.
- 0.8% of households £1 or more a week worse off are in the lowest income decile.
- There are 4% of households in the highest income decile £1 or more a week better off.

A more detailed analysis of low income (defined as income deciles 1-3) households losing more than £1 per week under this combined tariff reveals the following:

- 8% of low income households lose more than £1 per week under the combined tariffs of E3 and G3 (which corresponds to 2% of the whole population).

- Their electricity use (at 48.1%) as a proportion of total energy use is higher than the average for the whole population and income deciles 1-3 generally.
- They are also more likely to be childless households, owned outright, with a high proportion of retired/over-65s.

8 Conclusions

1 Significant reductions in CO_2 emissions from household electricity and gas use are a vital component of the very large cuts in UK greenhouse gas emissions required to avert dangerous climate change. Against a 'business as usual' backdrop of long-term growth in household demand for electricity and gas, and recent increases in the carbon intensity of UK electricity generation, a far more radical approach to household energy demand management is needed.

At the same time, recent estimates suggest that there are almost three million fuel poor households in England alone[22]. It is therefore essential that any set of measures adopted to reduce household emissions also addresses the social issue of fuel poverty. This report has considered several possible approaches to achieving this.

2 CSE's modelling of the impacts of Increasing Block Tariffs (IBTs) suggests that they could deliver significant household energy demand and emissions reductions. The electricity and gas 'Demand Reduction' Tariffs (E1 & G1) could both trigger demand reductions of 7-8% in UK household energy consumption, with consequent annual reductions in CO_2 emissions from all UK households of 3.8 Mt and 5.6 Mt respectively. Adding these figures together gives a total potential reduction of almost 10MtCO_2 per year, or a 1.7% reduction on UK CO_2 emissions in 2005. Put another way, this tariff combination could potentially more than offset the growth in UK emissions between 2000 and 2005.

3 On average all the IBTs presented in this report alter household energy costs in proportion to incomes and are therefore socially progressive overall. However the wide variation in energy use within income deciles means that there are always some low-income losers (many of whom will be fuel poor), and some high-income winners. While the Demand Reduction Tariffs achieve the biggest demand and emissions reductions, they also entail cost increases for the vast majority of households, and increased unit revenues to suppliers.

4 The 'Revenue Neutral' (E2 & G2) tariffs lead to more modest demand reductions, did not significantly affect supplier revenues, and would create the smallest number of low-income losers.

5 Finally, the 'Redistribution' (E3 & G3) tariffs create the largest aggregate 'transfer of wealth' from high income households to low income households, while reducing demand slightly more than the 'Revenue Neutral' tariffs. However they also create significant numbers of high-income winners. More importantly, these tariffs would lead to transfer of wealth *between* low-income households, as well as from high to low income households. Consequently the 'Redistribution' tariffs lead to larger losses among those low income households that do lose out.

6 This means that there is a tension between the social and environmental objectives (set out in Section 2) of IBTs. This could be resolved by compromising on the achievement of more dramatic demand reductions, and so minimising the number of

[22] 2.96 million fuel poor household in England in Q4 2006 – Impact of Fuel Price Rises on Fuel Poverty in the Managed Housing Sector, ACE, CSE and Dr Richard Moore, EEPFh 2007.

low income households made significantly worse off. In effect there appears to be a modest ‘comfort zone’ within which overall demand reductions of 1-2% are possible alongside progressive social impacts. The demand savings associated with the Revenue Neutral Tariffs translate into emissions reductions of 0.6 and 1.0 $MtCO_2$ from gas and electricity respectively. The total saving of 1.6Mt CO_2 represents 0.3% of UK emissions in 2005.

Alternatively this tension could be addressed through effective targeting of low-income households losing out under the new tariffs, and/or the creation of a genuine, nationally available passport-based social tariff, as discussed in Section 1. However this would mean that the elegance and administrative simplicity of a one-size-fits-all tariff would be lost. Furthermore our analysis of the socio-economic characteristics of the low income ‘losers’ (see Appendix 2) suggests that there are few if any consistently distinguishing features that set these households apart from other low income households – making it more difficult to efficiently target assistance at those who need it most.

The exception to this is that low-income losers under the electricity tariffs tend to have higher electricity use as a proportion of their total energy consumption. A simple approach to assisting such households would be to make available a discounted electricity tariff (along the lines of Economy 7) for low-income households using electricity as their primary heating fuel, and better still would be a targeted program to install gas-fired heating in all on-gas-network homes currently heated electrically.

7 Increasing Block Tariffs could be introduced and administered without the need for smart meters, under current quarterly manual meter-reading arrangements. However the associated real-time demand-feedback possibilities offered by smart meters would be extremely valuable to households as they adapted their demand to the new price signals created by the tariffs, and could be expected to enhance the effectiveness of the new tariffs in stimulating demand reductions. They would also be useful for energy suppliers as they monitored the impact of the new tariffs on the level and distribution of demand for gas and electricity.

8 In the current policy, regulatory, and competitive context, energy suppliers are unlikely to offer IBTs unilaterally, since one could assume that only those customers who stood to benefit from such tariffs would sign up for them. This would lead to price increases for other customers, who would then switch away to companies offering flat tariffs – a competitive nightmare that suppliers would avoid.

Hence for IBTs to become a reality in the current context, they would need to be made mandatory across all suppliers. This goes against the grain of the liberalisation of UK energy markets over the last 20 years. However this period also saw large increases in household demand for gas and electricity, and we simply cannot allow the continuation of these trends, in light of the absolute need to reduce CO_2 emissions. In any case, it would be possible to stipulate the structure of an IBT (in terms of the positions and widths of the blocks, and the price ratios between them), without specifying the prices themselves. This would not resemble price control in the classical sense, and it would leave suppliers free to compete on price.

9 This report highlights that in the short term increasing Block Tariffs are a means to environmental and social ends (reductions in CO_2 emissions from household gas and electricity use, and a simultaneous reduction of the cost of basic energy needs). However, in the longer term other potential solutions to these problems also exist. As briefly discussed in Section 2.3, a Cap and Trade system (such as the Supplier Obligation) is an alternative to price signals as a means of stimulating household emissions reductions. Such a system could operate either at the level of the end-user (downstream), or at the level of the supplier (upstream). The Supplier Obligation currently being mooted by the Government as a successor to the new CERT scheme is an example of the latter, and would set a limit on the total emissions from household gas and electricity consumption, with compliance the responsibility of gas and electricity suppliers.

Under such a system, gas and electricity suppliers would face (presumably harsh) penalties for non-compliance. They would therefore be incentivised to assist/stimulate their customers to reduce their emissions (or be forced to buy surplus emissions credits from their competitors). The most cost-efficient way to achieve this would be through demand reduction, achieved via energy efficiency improvements and behaviour change (the more expensive alternative being the development of lower-carbon sources of heat and power). In this scenario suppliers could see Increasing Block Tariffs as a potentially cost-effective option for ensuring compliance with their targets under the Supplier Obligation.

10 It is important to note that assumptions regarding price elasticity of energy demand strongly influence the modelling results in this report. In reality the price elasticity of demand for electricity and gas would be a source of uncertainty. Lower than expected elasticity would lead to large increases in profit for energy suppliers, but little demand saving. Conversely, high elasticity would mean a more dramatic response to the IBT, with a large proportion of consumption 'migrating' into lower cost blocks. This would give larger demand reductions, but it would also reduce the average unit price received by the suppliers.

11 This problem could be addressed through a risk-sharing arrangement between energy suppliers and the Government: on the one hand, excessive 'windfall' increases in supplier profit resulting from a low demand response are invested in domestic energy efficiency improvements, which in turn facilitate demand reductions. On the other, the Government (ie the taxpayer) compensates energy suppliers for losses resulting from a high demand response. This ensures that energy suppliers raise sufficient revenue to cover their operating costs (including profits).

Such an arrangement, in addition to other proposals in this report, would require a redefinition of the relationship between energy suppliers and the regulator and Government.

Appendix 1: Distributional Effects of Electricity and Gas Tariffs E1 to G3

This appendix summarises the distributional effects of each tariff in tables and figures.

The first table in each section, 'Summary of changes', shows the average change in bills per income decile resulting from the tariff, before and after demand reduction. It also shows the total TWh consumed per income decile: 'initial' refers to consumption in 2004, and 'final' refers to consumption resulting from the tariff, after demand reduction. Consumption is then presented in kWh averages per household for each income decile, and the change (from 2004 consumption to consumption under the tariff) is also shown as a percentage change.

The first figure in each section, 'Distribution of change in bills per income group', groups the income deciles into three income groups; deciles 1-3, 4-7, and 8-10. The graphs show what percentage of each income group experiences what change in their electricity or gas bills per week. The vertical axis shows the change in bills per week: for example, <-1 means a reduction of between £1.00 and £1.99 in weekly bills and <5 means an increase in weekly bills of between £4.01 and £5.00. Therefore the more 'bottom heavy' the graph, the more benefit the income group has experienced from the tariff, because a high proportion of households in the income group have experienced reductions in their bills.

The total change in bills for each income group is shown in the second figure in each section, 'Aggregate change in bills for income groups'. The aggregate change is the sum of all changes in bills for all households in the income group and, in the last column, for the whole population. A positive aggregate change means that overall the income group is paying more under the tariff in question than in 2004, while a negative change means that overall they are paying less.

A1.1 Electricity Demand Reduction Tariff (E1)

Table A1.1.1 Summary of changes resulting from the tariff (Tariff E1)

	Average £ / year change in bills		**TWh totals per Decile**			**kWh averages per HH**			**% change per HH**
Income Decile	**E1 (no DR)**	**E1 (after DR)**	**Initial**	**Final**	**Change**	**Initial**	**Final**	**kWh change per HH**	
1 low	£56.32	£28.19	7.82	7.41	-0.41	4106.7	3891.4	-215.3	-5.2%
2	£59.76	£31.92	8.27	7.83	-0.44	4330.6	4100.2	-230.4	-5.3%
3	£61.13	£29.70	8.18	7.73	-0.45	4299.7	4063.2	-236.5	-5.5%
4	£91.77	£42.37	9.43	8.73	-0.70	4931.6	4565.6	-366.0	-7.4%
5	£85.96	£44.55	9.66	9.02	-0.64	5074.4	4738.2	-336.2	-6.6%
6	£86.23	£44.35	9.67	9.03	-0.64	5073.9	4738.1	-335.8	-6.6%
7	£114.95	£57.86	10.79	9.92	-0.87	5654.3	5198.4	-455.9	-8.1%
8	£125.83	£57.99	11.00	10.06	-0.94	5779.7	5285.8	-493.9	-8.5%
9	£133.97	£65.07	11.46	10.48	-0.98	6015.7	5501.3	-514.4	-8.5%
10 high	£165.64	£79.48	12.70	11.48	-1.22	6661.5	6021.5	-640.0	-9.6%
Total (TWh)			**98.98**	**91.69**	**-7.29**				
				Total ($MtCO_2$)	**-3.84**				

Figure A1.1.1 Distribution of change in bills per income group (Tariff E1)

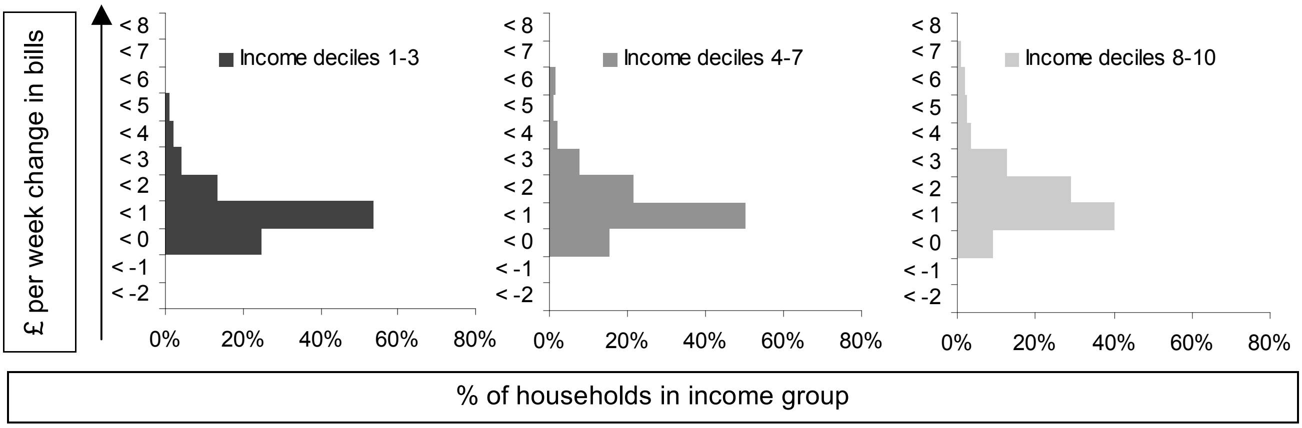
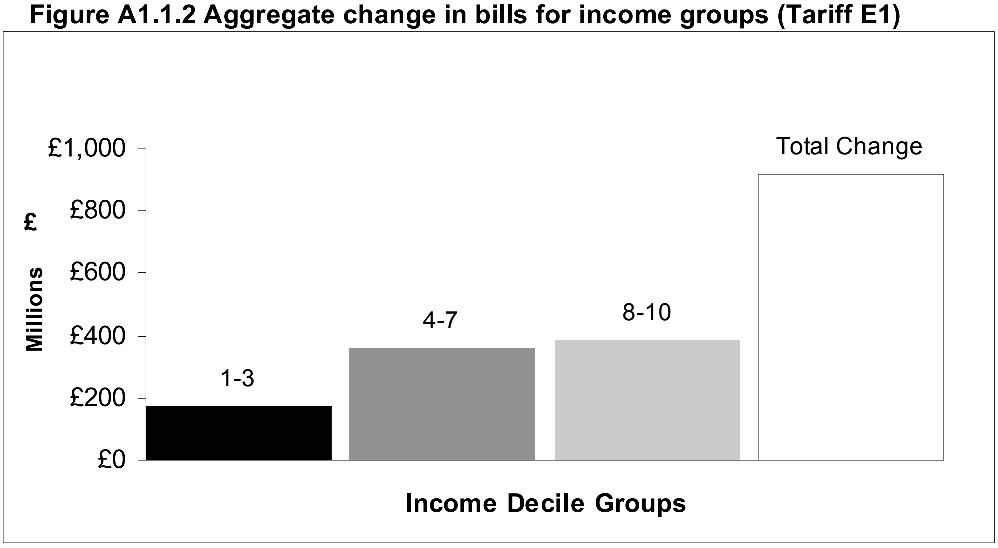


Figure A1.1.2 Aggregate change in bills for income groups (Tariff E1)



A1.2 Electricity Revenue Neutral Tariff (E2)

Table A1.2.1 Summary of changes resulting from the tariff (Tariff E2)

	Average £ / year change in bills		**TWh totals per Decile**			**kWh averages per HH**			**% change per HH**
Income Decile	**E2 (no DR)**	**E2 (after DR)**	**Initial**	**Final**	**Change**	**Initial**	**Final**	**kWh change per HH**	
1 low	-£15.04	-£17.74	7.82	7.91	0.09	4106.7	4153.9	47.2	1.2%
2	-£14.75	-£16.66	8.27	8.36	0.09	4330.6	4377.7	47.1	1.1%
3	-£15.63	-£17.56	8.18	8.27	0.09	4299.7	4347.0	47.3	1.1%
4	£8.50	-£4.86	9.43	9.33	-0.10	4931.6	4879.3	-52.3	-1.1%
5	£2.02	-£6.58	9.66	9.62	-0.04	5074.4	5053.4	-21.0	-0.4%
6	£1.72	-£6.54	9.67	9.64	-0.03	5073.9	5058.2	-15.7	-0.3%
7	£26.56	£6.57	10.79	10.56	-0.23	5654.3	5533.8	-120.5	-2.1%
8	£28.20	£8.14	11.00	10.77	-0.23	5779.7	5658.8	-120.9	-2.1%
9	£40.65	£14.58	11.46	11.15	-0.31	6015.7	5853.0	-162.7	-2.7%
10 high	£68.42	£29.48	12.70	12.18	-0.52	6661.5	6388.7	-272.8	-4.1%
Total (TWh)			**98.98**	**97.79**	**-1.19**				
				Total ($MtCO_2$)	**-0.63**				

Figure A1.2.1 Distribution of change in bills per income group (Tariff E2)

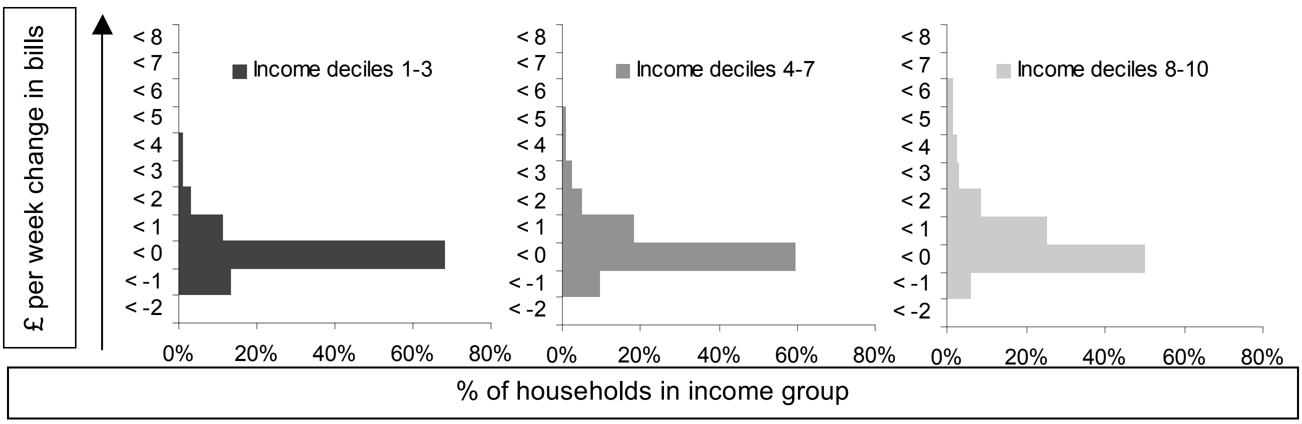
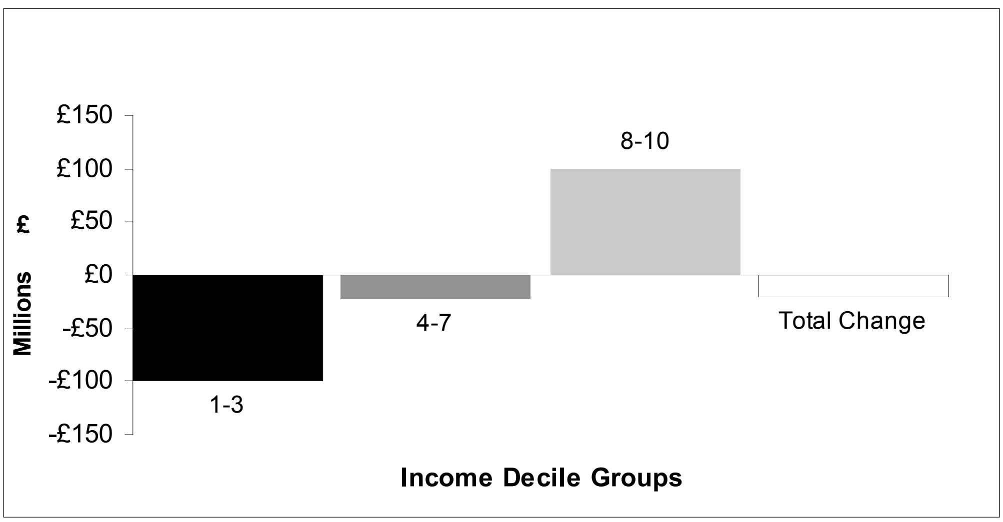


Figure A1.2.2 Aggregate change in bills for income groups (Tariff E2)



A1.3 Electricity Redistribution Tariff (E3)

Table A1.3.1 Summary of changes resulting from the tariff (Tariff E3)

	Average £ / year change in bills		TWh totals per Decile			kWh averages per HH			% change per HH
Income Decile	**E3 (no DR)**	**E3 (after DR)**	**Initial**	**Final**	**Change**	**Initial**	**Final**	**kWh change per HH**	
1 low	-£16.00	-£23.82	7.82	7.92	0.10	4106.7	4159.2	52.50	1.3%
2	-£18.23	-£22.86	8.27	8.39	0.12	4330.6	4393.4	62.80	1.5%
3	-£17.97	-£25.10	8.18	8.29	0.11	4299.7	4357.6	57.90	1.3%
4	£13.35	-£11.23	9.43	9.29	-0.14	4931.6	4858.4	-73.20	-1.5%
5	£3.10	-£11.56	9.66	9.62	-0.04	5074.4	5053.4	-21.00	-0.4%
6	£4.29	-£11.51	9.67	9.62	-0.05	5073.9	5047.7	-26.20	-0.5%
7	£33.39	£3.06	10.79	10.51	-0.28	5654.3	5507.6	-146.70	-2.6%
8	£40.15	£2.11	11.00	10.68	-0.32	5779.7	5611.5	-168.20	-2.9%
9	£53.43	£11.68	11.46	11.06	-0.40	6015.7	5805.7	-210.00	-3.5%
10 high	£90.70	£29.46	12.70	12.02	-0.68	6661.5	6304.8	-356.70	-5.4%
Total (TWh)			**98.98**	**97.40**	**-1.58**				
				Total ($MtCO_2$)	**-0.83**				

Figure A1.3.1 Distribution of change in bills per income group (Tariff E3)

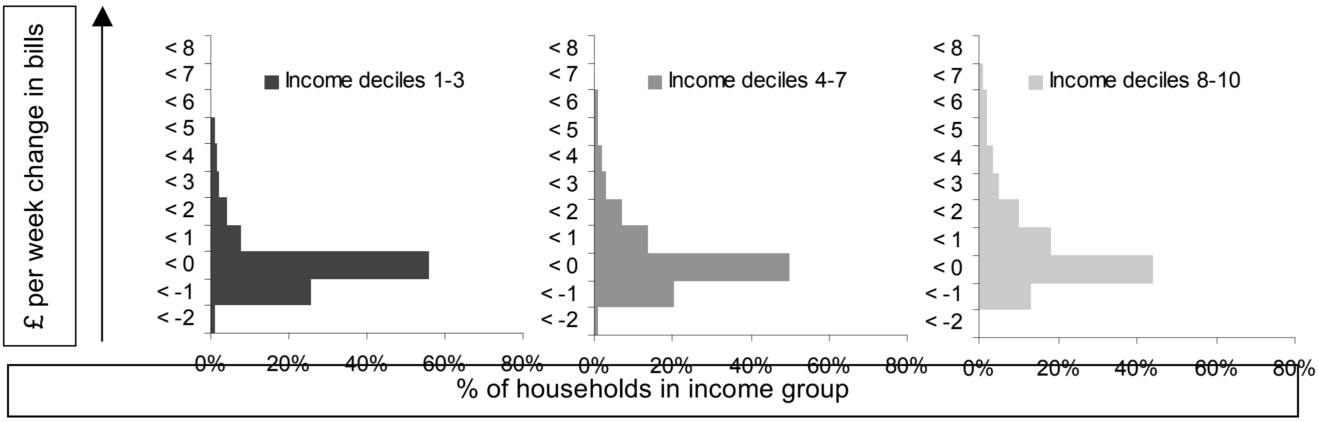
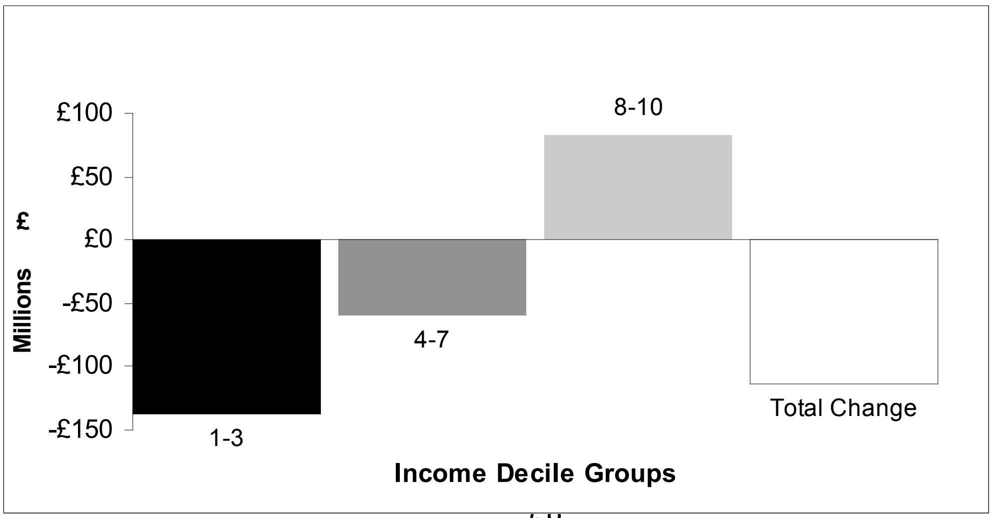


Figure A1.3.2 Aggregate change in bills for income groups (Tariff E3)



A1.4 Gas Demand Reduction Tariff (G1)

Table A1.4.1 Summary of changes resulting from the tariff (Tariff G1)

	Average £ / year change in bills		TWh totals per Decile			kWh averages per HH			% change per HH
Income Decile	**G1 (no DR)**	**G1 (after DR)**	**Initial**	**Final**	**Change**	**Initial**	**Final**	**kWh change per HH**	
1 low	£66.24	£37.84	22.44	21.10	-1.34	17,619	16,568	-1,052	-6.0%
2	£75.95	£44.99	26.66	25.03	-1.63	19,553	18,360	-1,196	-6.1%
3	£78.25	£47.11	29.23	27.42	-1.81	19,782	18,556	-1,225	-6.2%
4	£86.74	£50.86	33.20	30.95	-2.25	20,426	19,042	-1,384	-6.8%
5	£113.98	£65.84	36.98	34.11	-2.87	23,248	21,442	-1,804	-7.8%
6	£106.80	£61.61	37.09	34.28	-2.81	22,368	20,672	-1,695	-7.6%
7	£112.13	£63.93	37.69	34.67	-3.02	22,496	20,693	-1,803	-8.0%
8	£132.49	£74.24	43.64	39.92	-3.72	24,820	22,704	-2,116	-8.5%
9	£143.04	£80.43	46.21	42.20	-4.01	26,169	23,898	-2,271	-8.7%
10 high	£185.17	£99.69	51.58	46.40	-5.18	29,343	26,396	-2,947	-10.0%
Total (TWh)			**364.72**	**336.08**	**28.66**				
		Total ($MtCO_2$)			**-5.56**				

Figure A1.4.1 Distribution of change in bills per income group (Tariff G1)

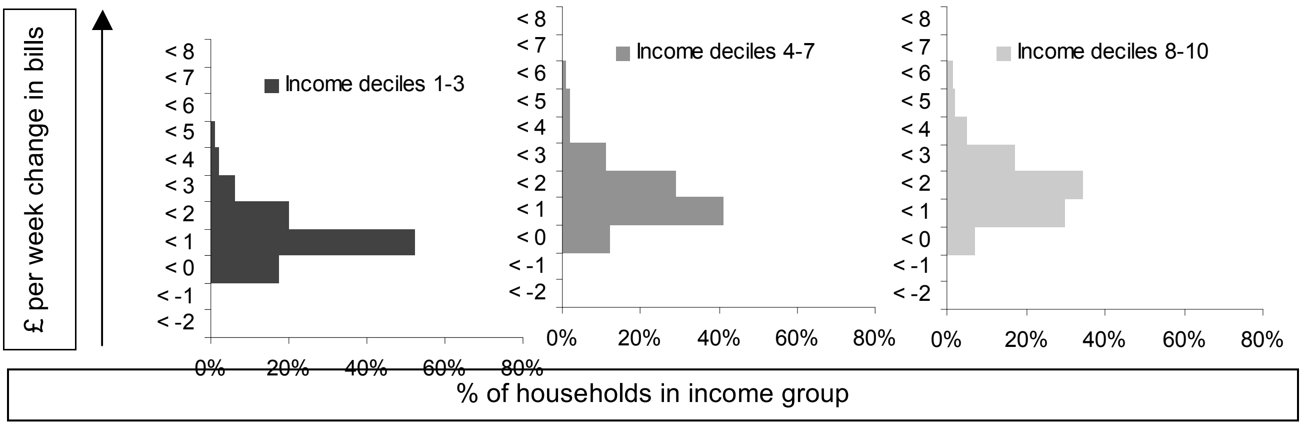
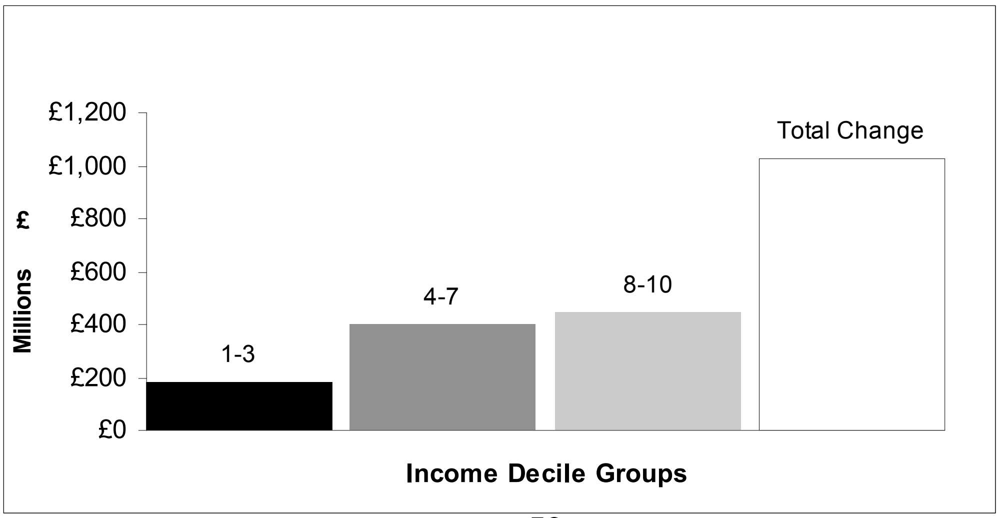


Figure A1.4.2 Aggregate change in bills for income groups (Tariff G1)



A1.5 Gas Revenue Neutral Tariff (G2)

Table A1.5.1 Summary of changes resulting from the tariff (Tariff G2)

	Average £ / year change in bills		TWh totals per Decile			kWh averages per HH			% change per HH
Income Decile	**G2 (no DR)**	**G2 (after DR)**	**Initial**	**Final**	**Change**	**Initial**	**Final**	**kWh change per HH**	
1 low	-£11.08	-£16.18	22.44	22.62	0.18	17,619	17,762	141	0.8%
2	-£10.15	-£12.82	26.66	26.86	0.20	19,553	19,702	147	0.8%
3	-£9.48	-£13.05	29.23	29.44	0.21	19,782	19,923	142	0.7%
4	-£2.62	-£9.75	33.20	33.22	0.02	20,426	20,439	12	0.1%
5	£16.05	£0.58	36.98	36.56	-0.42	23,248	22,983	-264	-1.1%
6	£10.49	-£1.23	37.09	36.79	-0.30	22,368	22,186	-181	-0.8%
7	£16.38	-£0.49	37.69	37.22	-0.47	22,496	22,215	-281	-1.2%
8	£31.30	£7.11	43.64	42.74	-0.90	24,820	24,308	-512	-2.1%
9	£38.54	£12.01	46.21	45.11	-1.10	26,169	25,546	-623	-2.4%
10 high	£84.91	£28.66	51.58	49.20	-2.38	29,343	27,988	-1,354	-4.6%
Total (TWh)			**364.72**	**359.76**	**-4.98**				
				Total ($MtCO_2$)	**-0.96**				

Figure A1.5.1 Distribution of change in bills per income group (Tariff G2)

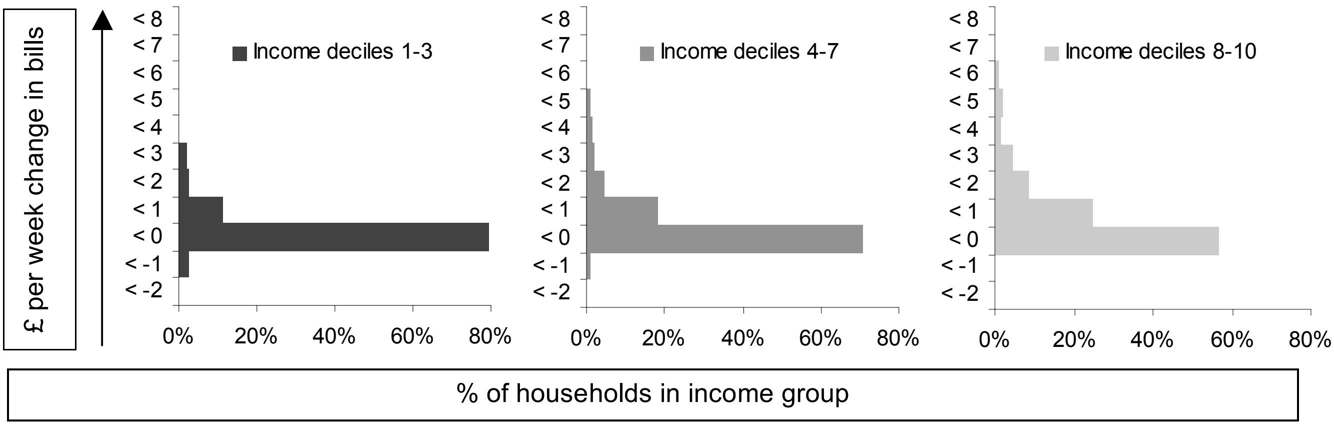
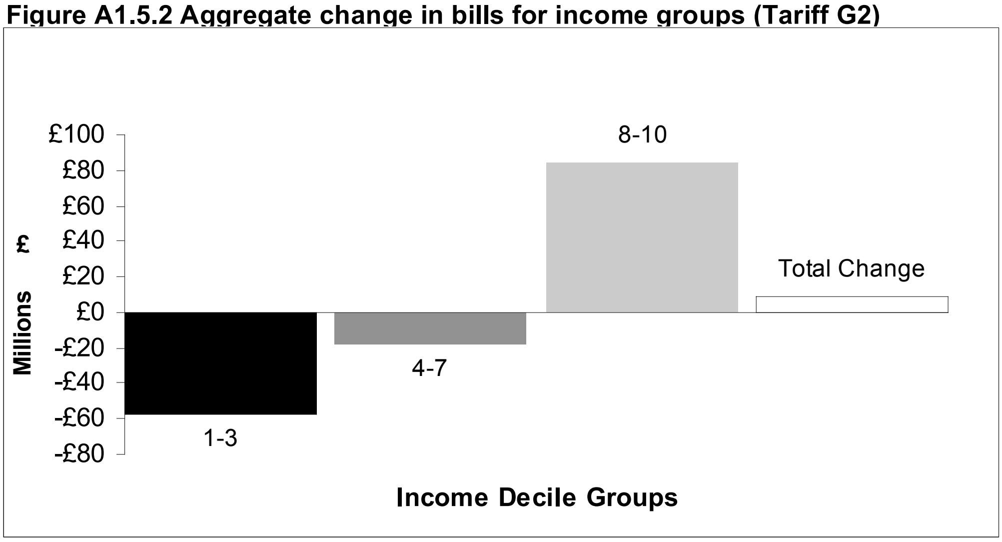


Figure A1.5.2 Aggregate change in bills for income groups (Tariff G2)



A1.6 Gas Redistribution Tariff (G3)

Table A1.6.1 Summary of changes resulting from the tariff (Tariff G3)

	Average £ / year change in bills		**TWh totals per Decile**			**kWh averages per HH**			**% change per HH**
Income Decile	**G3 (no DR)**	**G3 (after DR)**	**Initial**	**Final**	**Change**	**Initial**	**Final**	**kWh change per HH**	
1 low	-£11.76	-£19.62	22.44	22.63	0.19	17,619	17,769	149	0.8%
2	-£5.64	-£14.26	26.66	26.77	0.11	19,553	19,636	81	0.4%
3	-£6.80	-£14.56	29.23	29.38	0.15	19,782	19,882	102	0.5%
4	£5.35	-£10.12	33.20	33.01	-0.19	20,426	20,310	-117	-0.6%
5	£31.78	£5.21	36.98	36.17	-0.81	23,248	22,737	-509	-2.2%
6	£25.06	£2.33	37.09	36.42	-0.67	22,368	21,963	-404	-1.8%
7	£28.59	£2.39	37.69	36.89	-0.80	22,496	22,018	-478	-2.1%
8	£55.24	£11.54	43.64	42.07	-1.57	24,820	23,927	-893	-3.6%
9	£65.85	£22.37	46.21	44.35	-1.86	26,169	25,116	-1,053	-4.0%
10 high	£128.39	£38.03	51.58	47.99	-3.59	29,343	27,300	-2,042	-7.0%
Total (TWh)			**364.72**	**355.68**	**-9.05**				
				Total ($MtCO_2$)	**-1.76**				

Figure A1.6.1 Distribution of change in bills per income group (Tariff G3)

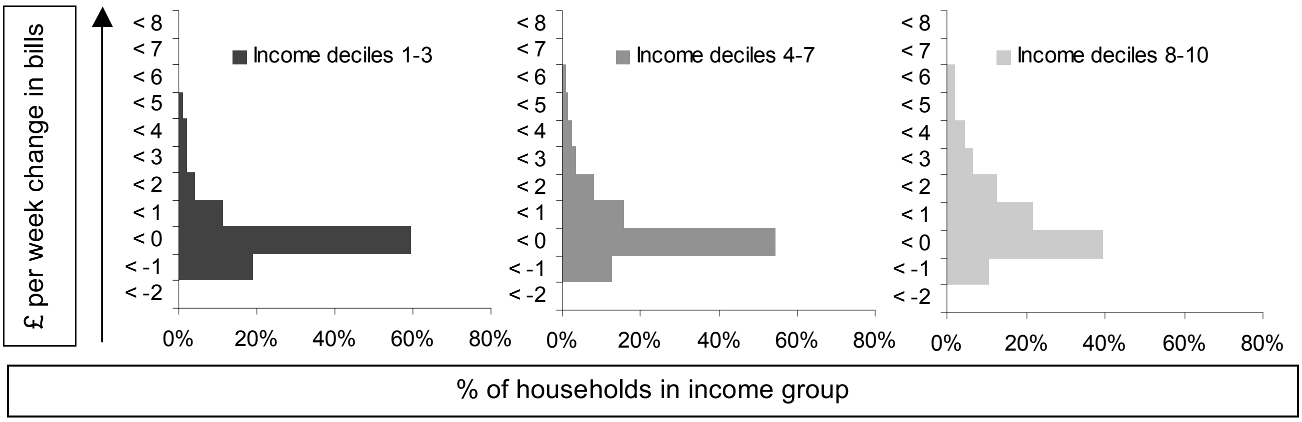
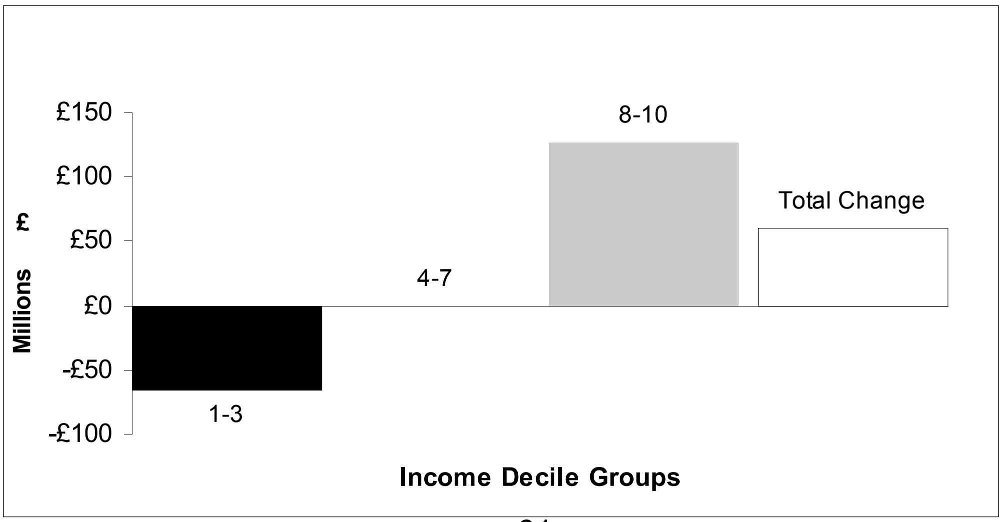


Figure A1.6.2 Aggregate change in bills for income groups (Tariff G3)



A1.7 Dual Fuel: Electricity and Gas Demand Reduction Tariffs (E1 +G1)

Table A1.7.1 Summary of changes resulting from the tariff (Tariff E1 + G1)

	Average £ / year change in bills		Total tonnes CO_2 per Decile			Average tonnes CO_2 per HH			% change / HH
Income Decile	**E1 + G1 (no DR)**	**E1 + G1 (after DR)**	**Initial**	**Final**	**Change**	**Initial**	**Final**	**Change per HH**	
1 low	£100.94	£53.96	8,474,306	7,997,944	-476,362	4.45	4.20	-0.25	-6%
2	£120.32	£67.81	9,529,748	8,982,622	-547,126	4.99	4.70	-0.29	-6%
3	£120.83	£65.56	9,981,868	9,392,740	-589,128	5.25	4.94	-0.31	-6%
4	£171.03	£88.35	11,410,216	10,604,230	-805,986	5.97	5.55	-0.42	-7%
5	£174.53	£95.81	12,265,522	11,370,397	-895,125	6.44	5.97	-0.47	-7%
6	£173.51	£95.14	12,291,938	11,408,261	-883,677	6.45	5.99	-0.46	-7%
7	£213.89	£114.18	12,998,384	11,954,258	-1,044,126	6.81	6.26	-0.55	-8%
8	£245.61	£124.21	14,263,160	13,045,872	-1,217,288	7.49	6.85	-0.64	-9%
9	£263.63	£135.90	15,003,966	13,710,426	-1,293,540	7.88	7.20	-0.68	-9%
10 high	£317.30	£163.24	16,699,808	15,050,907	-1,648,901	8.76	7.89	-0.86	-10%
Total ($MtCO_2$)			**122.92**	**113.52**	**-9.40**				

Figure A1.7.1 Distribution of change in bills per income group (Tariff E1 + G1)

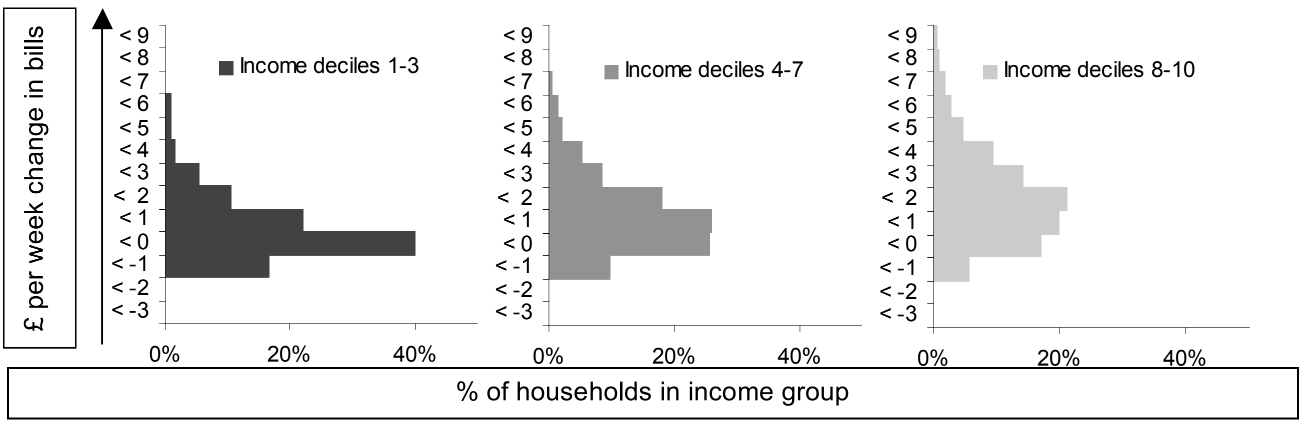
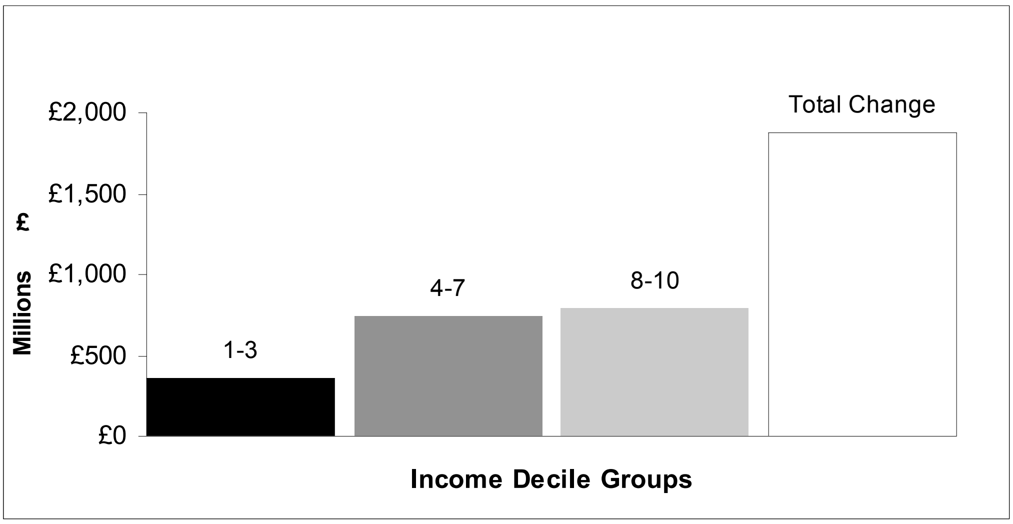


Figure A1.7.2 Aggregate change in bills for income groups (Tariff E1 + G1)



A1.8 Electricity and Gas Revenue Neutral Tariffs (E2 +G2)

Table A1.8.1 Summary of changes resulting from the tariff (Tariff E2 + G2)

	Average £ / year change in bills		**Total tonnes CO_2 per Decile**			**Average tonnes CO_2 per HH**			**% change / HH**
Income Decile	**E2 + G2 (no DR)**	**E2 + G2 (after DR)**	**Initial**	**Final**	**Change**	**Initial**	**Final**	**Change / HH**	
1 low	-£24.28	-£29.87	8,474,306	8,556,222	81,916	4.45	4.49	0.04	1%
2	-£20.29	-£25.18	9,529,748	9,616,733	86,985	4.99	5.04	0.05	1%
3	-£23.91	-£27.75	9,981,868	10,069,756	87,888	5.25	5.29	0.05	1%
4	£11.21	-£10.37	11,410,216	11,360,802	-49,414	5.97	5.94	-0.03	0%
5	£13.47	-£6.85	12,265,522	12,162,471	-103,051	6.44	6.39	-0.05	-1%
6	£7.16	-£9.22	12,291,938	12,218,087	-73,851	6.45	6.41	-0.04	-1%
7	£45.57	£8.63	12,998,384	12,785,590	-212,794	6.81	6.70	-0.11	-2%
8	£59.37	£16.30	14,263,160	13,967,308	-295,852	7.49	7.34	-0.16	-2%
9	£82.05	£26.43	15,003,966	14,626,799	-377,167	7.88	7.68	-0.20	-3%
10 high	£134.02	£52.50	16,699,808	15,962,705	-737,103	8.76	8.37	-0.39	-4%
Total ($MtCO_2$)			**122.92**	**121.336**	**-1.59**				

Figure A1.8.1 Distribution of change in bills per income group (Tariff E2 + G2)

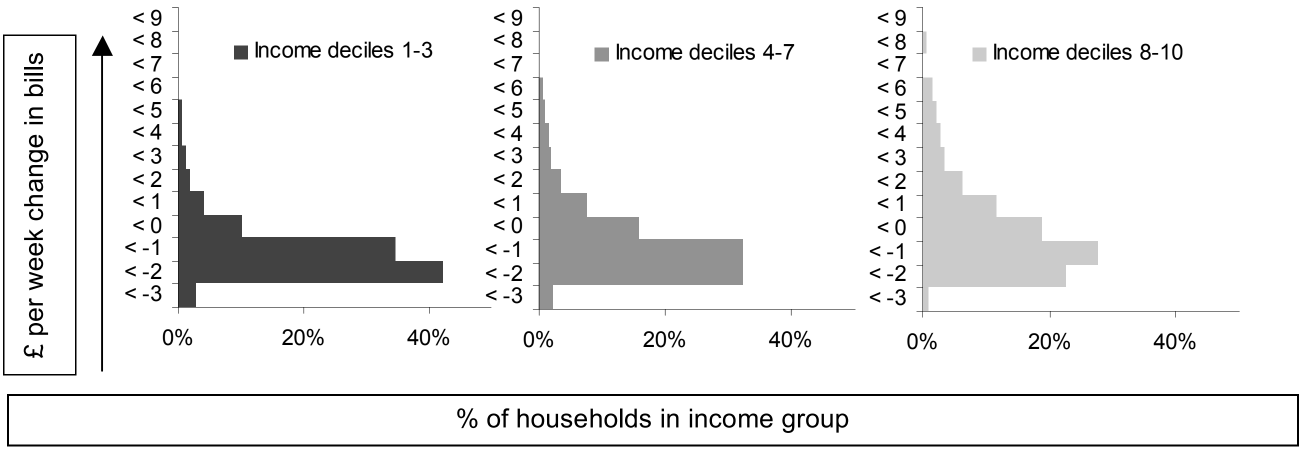
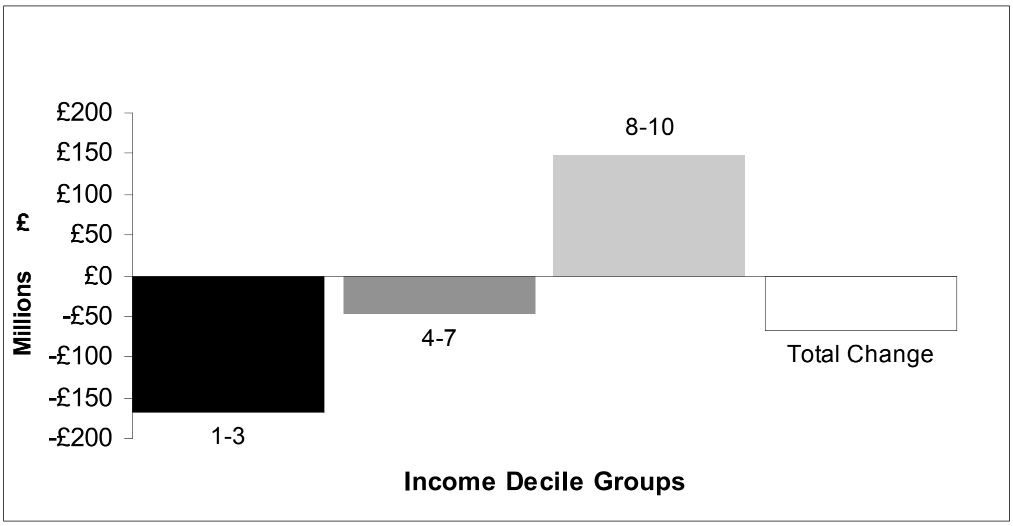


Figure A1.8.2 Aggregate change in bills for income groups (Tariff E2 + G2)



A1.9 Electricity and Gas Redistribution Tariffs (E3 +G3)

Table A1.9.1 Summary of changes resulting from the tariff (Tariff E3 + G3)

	Average £ / year change in bills		**Total tonnes CO_2 per Decile**			**Average tonnes CO_2 per HH**			**% change per HH**
Income Decile	**E3 + G3 (no DR)**	**E3 + G3 (after DR)**	**Initial**	**Final**	**Change**	**Initial**	**Final**	**Change per HH**	
1 low	-£26.15	-£38.57	8,474,306	8,564,559	90,253	4.45	4.50	0.05	1%
2	-£20.26	-£32.27	9,529,748	9,614,640	84,892	4.99	5.03	0.04	1%
3	-£23.54	-£36.12	9,981,868	10,068,801	86,933	5.25	5.29	0.05	1%
4	£23.75	-£15.90	11,410,216	11,299,780	-110,436	5.97	5.91	-0.06	-1%
5	£26.93	-£8.35	12,265,522	12,085,997	-179,525	6.44	6.35	-0.09	-1%
6	£20.44	-£11.99	12,291,938	12,134,777	-157,161	6.45	6.37	-0.08	-1%
7	£64.86	£8.27	12,998,384	12,695,185	-303,199	6.81	6.65	-0.16	-2%
8	£92.67	£14.47	14,263,160	13,789,598	-473,562	7.49	7.25	-0.25	-3%
9	£122.55	£29.65	15,003,966	14,432,747	-571,219	7.88	7.58	-0.30	-4%
10 high	£190.23	£63.02	16,699,808	15,644,862	-1,054,946	8.76	8.21	-0.55	-6%
Total ($MtCO_2$)			**122.92**	**120.33**	**-2.59**				

Figure A1.9.1 Distribution of change in bills per income group (Tariff E3 + G3)

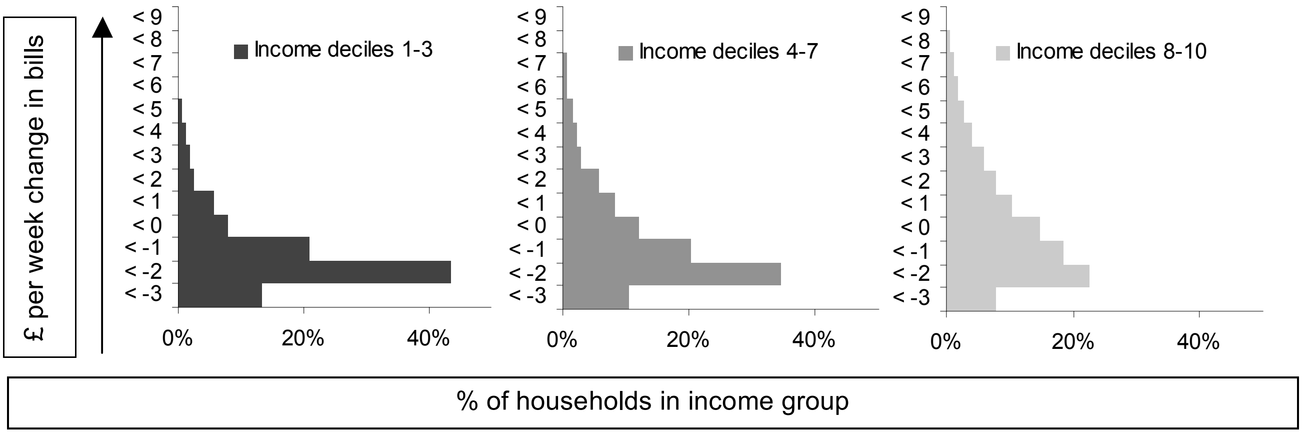
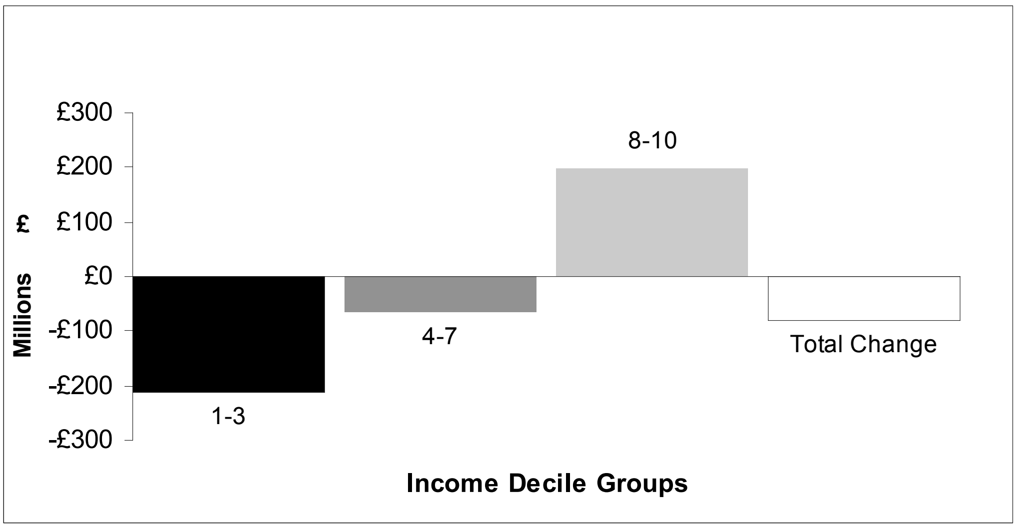


Figure A1.9.2 Aggregate change in bills for income groups (Tariff E3 + G3)



Appendix 2: Socio economic characteristics of low-income losers under each tariff

Figure 8: Characteristics of 'losers' in income deciles 1-3 under tariff E1

'Whole population' means all households in all income deciles. 'Income deciles 1-3' refers to all households in these deciles, while 'losers' means those households in income deciles 1-3 who spend £1 per week or more on electricity under this tariff than they did in 2004.

Electricity payment method	Budgeting Scheme	account	electricity card, disc, token, electro	slot meter	COCD	DSS pay the whole bill	some other method	paid direct by someone outside the house
Whole population	***70.3%***	***12.4%***	***13.1%***	***3.1%***	***0.9%***	***0.2%***	***0.1%***	
Losers under Tariff E1	*81.1%*	*7.9%*	*9.2%*	*0.9%*	*0.6%*	*0.2%*		

Dwelling type	Whole hse, bungalow-semi-dtchd	Whole hse, bungalow-terraced	Whole hse,bungalow-detached	Purpose-built flat maisonette	Part of house converted flat	Others		
Income deciles 1-3	***27.7%***	***29.8%***	***10.7%***	***24.7%***	***4.6%***	***2.4%***		
Losers under Tariff E1	*36.7%*	*20.3%*	*15.8%*	*12.9%*	*8.4%*	*3.4%*	*2.0%*	*0.5%*
Whole population	***25.7%***	***12.0%***	***45.2%***	***7.4%***	***7.7%***	***1.9%***	***0.02%***	
Income deciles 1-3	***49.6%***	***40.5%***	***9.9%***					

Losers under Tariff E1	*53.2%*	*34.1%*	*12.7%*	***6.6%***	***4.0%***	***4.4%***	***0.1%***
Losers under Tariff E1	***47.6%***	***23.8%***	***10.2%***	***6.7%***	***6.1%***	***5.4%***	***0.2%***
Number of over- 65s per household	**0**	**1**	**2**	**3**			
Whole population	*72.2%*	*18.4%*	*9.4%*	*0.03%*			

	time loyee	Self-employed	Unemployed	Work related govt train prog

					Priv. rented (unfurn)	**Rent free**	**Priv. rented (furnished)**	**Owned by rental purchase**
Whole population	*29.2%*	*11.9%*	*40.5%*	*7.0%*	*7.0%*	*1.7%*	*2.5%*	*0.2%*
Income deciles 1-3	*35.9%*	*24.9%*	*10.4%*	*14.8%*	*8.0%*	*3.1%*	*2.8%*	*0.1%*

Figure 9: Characteristics of 'losers' in income deciles 1-3 under tariff E2

Tariff E2									
	Electricity payment method	**Budgeting Scheme**	**account**	**electricity card, disc, token, electro**	**slot meter**	**COCD**	**DSS pay the whole bill**	**some other method**	**paid direct by someone outside the house**
	Whole population	*45.7%*	*37.6%*	*14.5%*	*1.2%*	*0.009%*	*0.1%*	*0.1%*	*0.8%*
	Income deciles 1-3	*31.7%*	*40.8%*	*24.3%*	*1.5%*	*0.0%*	*0.1%*	*0.2%*	*1.4%*
	Losers under tariff E2	***38.3%***	***40.7%***	***20.0%***	***0.7%***	***0.2%***			
	Number of children per household	**0**	**1**	**2**	**3**	**4**	**5**	**6**	
	Whole population	*70.3%*	*12.4%*	*13.1%*	*3.1%*	*0.9%*	*0.2%*	*0.1%*	
	Income deciles 1-3	*84.6%*	*7.8%*	*6.7%*	*0.8%*	*0.1%*	*0.0%*		
	Losers under tariff E2	***84.3%***	***5.3%***	***9.3%***	***0.5%***	***0.6%***			
	Occupants per household	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Whole population	*27.6%*	*35.6%*	*17.3%*	*12.9%*	*4.9%*	*1.3%*	*0.3%*	*0.1%*
	Income deciles 1-3	*62.1%*	*26.7%*	*7.6%*	*2.2%*	*1.1%*	*0.2%*	*0.0%*	
	Losers under tariff E2	***52.6%***	***30.8%***	***11.0%***	***3.4%***	***1.6%***	***0.6%***		
	Dwelling type	**Whole hse, bungalow-semi-dtchd**	**Whole hse, bungalow-terraced**	**Whole hse,bungalow-detached**	**Purpose-built flat maisonette**	**Part of house converted flat**	**Others**		
	Whole population	*32.5%*	*28.0%*	*21.1%*	*13.1%*	*3.1%*	*2.1%*		
	Income deciles 1-3	*27.7%*	*29.8%*	*10.7%*	*24.7%*	*4.6%*	*2.4%*		
	Losers under tariff E2	***29.2%***	***32.0%***	***10.8%***	***21.8%***	***3.2%***	***3.1%***		
	Housing tenure	**Owned outright**	**LA (furnished unfurnished)**	**Owned with mortgage**	**Hsng Assn (furnished unfrnish)**	**Priv. rented (unfurn)**	**Rent free**	**Priv. rented (furnished)**	**Owned by rental purchase**
	Whole population	*29.2%*	*11.9%*	*40.5%*	*7.0%*	*7.0%*	*1.7%*	*2.5%*	*0.2%*
	Income deciles 1-3	*35.9%*	*24.9%*	*10.4%*	*14.8%*	*8.0%*	*3.1%*	*2.8%*	*0.1%*
	Losers under tariff E2	***39.3%***	***21.3%***	***13.4%***	***13.0%***	***5.1%***	***4.2%***	***3.0%***	***0.8%***

	Economic status of household reference person	Ret unoc over min ni age	Unoc - under min ni age	Full time employee	Part time employee	Self-employed	Unemployed	Work related govt train prog	
	Whole population	*25.7%*	*12.0%*	*45.2%*	*7.4%*	*7.7%*	*1.9%*	*0.02%*	
	Income deciles 1-3	*52.2%*	*24.3%*	*8.4%*	*6.6%*	*4.0%*	*4.4%*	*0.1%*	
	Losers under tariff E2	***53.4%***	***21.5%***	***8.9%***	***7.1%***	***5.0%***	***4.0%***	***0%***	
	Number of over- 65s per household	**0**	**1**	**2**	**3**				
	Whole population	*72.2%*	*18.4%*	*9.4%*	*0.03%*				
	Income deciles 1-3	*49.6%*	*40.5%*	*9.9%*					
	Losers under tariff E2	***48.7%***	***35.6%***	***15.7%***					

Figure 10: Characteristics of 'losers' in income deciles 1-3 under tariff E3

	Electricity payment method	Budgeting Scheme	account	electricity card, disc, token, electro	slot meter	COCD	DSS pay the whole bill	some other method	paid direct by someone outside the house
Tariff E3	*Whole population*	*45.7%*	*37.6%*	*14.5%*	*1.2%*	*0.009%*	*0.1%*	*0.1%*	*0.8%*
	Income deciles 1-3	*31.7%*	*40.8%*	*24.3%*	*1.5%*	*0.0%*	*0.1%*	*0.2%*	*1.4%*
	Losers under tariff E3	***38.5%***	***36.9%***	***23.9%***	***0.5%***	***0.2%***			
	Number of children per household	**0**	**1**	**2**	**3**	**4**	**5**	**6**	
	Whole population	*70.3%*	*12.4%*	*13.1%*	*3.1%*	*0.9%*	*0.2%*	*0.1%*	
	Income deciles 1-3	*84.6%*	*7.8%*	*6.7%*	*0.8%*	*0.1%*	*0.0%*		
	Losers under tariff E3	***81.3%***	***6.8%***	***10.3%***	***1.2%***	***0.4%***			
	Occupants per household	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
	Whole population	*27.6%*	*35.6%*	*17.3%*	*12.9%*	*4.9%*	*1.3%*	*0.3%*	
	Income deciles 1-3	*62.1%*	*26.7%*	*7.6%*	*2.2%*	*1.1%*	*0.2%*	*0.0%*	
	Losers under tariff E3	***51.1%***	***29.9%***	***12.5%***	***3.3%***	***2.7%***	***0.4%***		
	Dwelling type	**Whole hse, bungalow-semi-dtchd**	**Whole hse, bungalow-terraced**	**Whole hse,bungalo w-detached**	**Purpose-built flat maisonette**	**Part of house converted**	**Others**		

					flat			
Whole population	*32.5%*	*28.0%*	*21.1%*	*13.1%*	*3.1%*	*2.1%*		
Income deciles 1-3	*27.7%*	*29.8%*	*10.7%*	*24.7%*	*4.6%*	*2.4%*		
Losers under tariff E3	***27.2%***	***29.4%***	***11.2%***	***24.1%***	***4.5%***	***3.6%***		
Housing tenure	**Owned outright**	**LA (furnished unfurnished)**	**Owned with mortgage**	**Hsng Assn (furnished unfrnish)**	**Priv. rented (unfurn)**	**Rent free**	**Priv. rented (furnished)**	**Owned by rental purchase**
Whole population	*29.2%*	*11.9%*	*40.5%*	*7.0%*	*7.0%*	*1.7%*	*2.5%*	*0.2%*
Income deciles 1-3	*35.9%*	*24.9%*	*10.4%*	*14.8%*	*8.0%*	*3.1%*	*2.8%*	*0.1%*
Losers under tariff E3	***36.4%***	***21.6%***	***12.9%***	***15.4%***	***5.7%***	***3.6%***	***3.9%***	***0.6%***
Economic status of household reference person	**Ret unoc over min ni age**	**Unoc - under min ni age**	**Full time employee**	**Part time employee**	**Self-employed**	**Unemployed**	**Work related govt train prog**	
Whole population	*25.7%*	*12.0%*	*45.2%*	*7.4%*	*7.7%*	*1.9%*	*0.02%*	
Income deciles 1-3	*52.2%*	*24.3%*	*8.4%*	*6.6%*	*4.0%*	*4.4%*	*0.1%*	
Losers under tariff E3	***46.2%***	***26.8%***	***8.7%***	***6.7%***	***4.8%***	***6.9%***	***0%***	
Number of over- 65s per household	**0**	**1**	**2**					
Whole population	*72.2%*	*18.4%*	*9.4%*	*0.03%*				

Whole population	***27.6%***	***35.6%***	***17.3%***	***12.9%***	***4.9%***	***1.3%***	***0.3%***	***0.1%***	
Income deciles 1-3	*62.1%*	*26.7%*	*7.6%*	*2.2%*	*1.1%*	*0.2%*	*0.0%*		*).1%*
Tariff E3	*81.3%*	*6.8%*	*10.3%*	*1.2%*	*0.4%*				
Tariff E2		*38.3%*	*40.7%*	*20.0%*	*0.7%*	*0.2%*			

Income deciles 1-3	*49.6%*	*40.5%*	*9.9%*					
Losers under tariff E3	***54.1%***	***33.7%***	***12.2%***					

Figure 11: Comparison of the three electricity tariffs

C (	**Electricity payment method**	**Budgeting Scheme**	**account**	**electricity card, disc, token, electro**	**slot meter**	**COCD**	**DSS pay the whole bill**	**some other method**	**paid direct by someone outside the house**
	Tariff E3	***38.5%***	***36.9%***	***23.9%***	***0.5%***	***0.2%***			
	Income deciles 1-3	***84.6%***	***7.8%***	***6.7%***	***0.8%***	***0.1%***	***0.0%***		
	Occupants per household	1	2	3	4	5	6	7	8

Tariff E1	***48.7%***	***33.2%***	***11.8%***	***3.3%***	***2.2%***	***0.6%***	***0.2%***	
Whole population	***32.5%***	***28.0%***	***21.1%***	***13.1%***	***3.1%***	***2.1%***		
Tariff E2	***29.2%***	***32.0%***	***10.8%***	***21.8%***	***3.2%***	***3.1%***		
Income deciles 1-3	***35.9%***	***24.9%***	***10.4%***	***14.8%***	***8.0%***	***3.1%***	***2.8%***	***0.1%***
Tariff E3	***36.4%***	***21.6%***	***12.9%***	***15.4%***	***5.7%***	***3.6%***	***3.9%***	***0.6%***
Tariff E1	***47.6%***	***23.8%***	***10.2%***	***6.7%***	***6.1%***	***5.4%***	***0.2%***	
Number of over- 65s per household	0	1	2	3				
Tariff E2	***48.7%***	***35.6%***	***15.7%***					

Figure 12: Socio-Economic Characteristics of 'Losers' under tariff G1

Gas Payment Method	**Budgeting Scheme**	**account**	**gas card, or disc**	**slot meter**	**DSS pay the whole bill**	**DSS pay part of the bill**	**some other method**	**Paid direct by someone outside household**	**Not applicable**
Whole population	*41.2%*	*30.1%*	*9.9%*	*0.7%*	*0.1%*	*0.0%*	*0.0%*	*0.8%*	*17.1%*
Income deciles 1-3	*27.9%*	*29.8%*	*16.9%*	*1.0%*	*0.1%*	*0.0%*	*0.1%*	*1.4%*	*22.7%*
Losers under Tariff G1	***55.3%***	***34.3%***	***9.5%***	***0.5%***	***0.2%***	***0.2%***			

Tariff E3	***54.1%***	***33.7%***	***12.2%***	***3%***	der min	Full time employee	Part time employee	Self-employed	Unemployed	Work related govt train prog
Income deciles 1-3	*49.6%*	*40.5%*	*9.9%*							
Tariff E1	*53.2%*	*34.1%*	*12.7%*			*45.2%*	*7.4%*	*7.7%*	*1.9%*	*0.02%*
Income deciles 1-3		*52.2%*		*24.3%*		*8.4%*	*6.6%*	*4.0%*	*4.4%*	*0.1%*
population	*29.2%*	*11.9%*	*40.5%*	*7.0%*	*7.0%*	*1.7%*	*2.5%*	*0.2%*		

Number of children per household	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
Whole population	*70.3%*	*12.4%*	*13.1%*	*3.1%*	*0.9%*	*0.2%*	*0.1%*		
Income deciles 1-3	*84.6%*	*7.8%*	*6.7%*	*0.8%*	*0.1%*	*0.0%*			
Losers under Tariff G1	***83.9%***	***5.5%***	***9.4%***	***0.7%***	***0.2%***	***0.2%***			
Occupants per household	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Whole population	*27.6%*	*35.6%*	*17.3%*	*12.9%*	*4.9%*	*1.3%*	*0.3%*	*0.1%*	
Income deciles 1-3	*62.1%*	*26.7%*	*7.6%*	*2.2%*	*1.1%*	*0.2%*	*0.0%*		

Losers under Tariff G1	***49.8%***	***35.6%***	***9.4%***	***3.5%***	***1.3%***	***0.2%***	***0.2%***		
Dwelling type	**Whole hse, bungalow-semi-dtchd**	**Whole hse, bungalow-terraced**	**Whole hse,bungalow-detached**	**Purpose-built flat maisonette**	**Part of house converted flat**	**Others**			
Whole population	*32.5%*	*28.0%*	*21.1%*	*13.1%*	*3.1%*	*2.1%*			
Income deciles 1-3	*27.7%*	*29.8%*	*10.7%*	*24.7%*	*4.6%*	*2.4%*			
Losers under Tariff G1	***35.8%***	***31.4%***	***17.6%***	***12.4%***	***1.5%***	***1.3%***			
Housing tenure	**Owned outright**	**LA (furnished unfurnished)**	**Owned with mortgage**	**Hsng Assn (furnished unfrnish)**	**Priv. rented (unfurn)**	**Rent free**	**Priv. rented (furnished)**	**Owned by rental purchase**	
Whole population	*29.2%*	*11.9%*	*40.5%*	*7.0%*	*7.0%*	*1.7%*	*2.5%*	*0.2%*	
Income deciles 1-3	*35.9%*	*24.9%*	*10.4%*	*14.8%*	*8.0%*	*3.1%*	*2.8%*	*0.1%*	
Losers under Tariff G1	***48.4%***	***17.4%***	***16.6%***	***8.2%***	***6.0%***	***1.4%***	***2.0%***		
Economic status of household reference person	**Ret unoc over min ni age**	**Unoc - under min ni age**	**Full time employee**	**Part time employee**	**Self-employed**	**Unemployed**	**Work related govt train prog**		
Whole population	*25.7%*	*12.0%*	*45.2%*	*7.4%*	*7.7%*	*1.9%*	*0.02%*		
Income deciles 1-3	*52.2%*	*24.3%*	*8.4%*	*6.6%*	*4.0%*	*4.4%*	*0.1%*		
Losers under Tariff G1	***55.5%***	***24.1%***	***8.1%***	***4.7%***	***5.4%***	***2.3%***			
Number of over- 65s per household	**0**	**1**	**2**						
Whole population	*72.2%*	*18.4%*	*9.4%*	*0.03%*					
Income deciles 1-3	*49.6%*	*40.5%*	*9.9%*						
Losers under Tariff G1	***45.4%***	***38.5%***	***16.0%***						

Figure 13: Socio-Economic Characteristics of Losers under Tariff G2

Tariff G2

Gas Payment Method	Budgeting Scheme	account	gas card, or disc	slot meter	DSS pay the whole bill	DSS pay part of the bill	some other method	Paid direct by someone outside household	Not applicable
Whole population	*41.2%*	*30.1%*	*9.9%*	*0.7%*	*0.1%*	*0.0%*	*0.0%*	*0.8%*	*17.1%*
Income deciles 1-3	*27.9%*	*29.8%*	*16.9%*	*1.0%*	*0.1%*	*0.0%*	*0.1%*	*1.4%*	*22.7%*
Losers under Tariff G2	***50.6%***	***33.5%***	***13.8%***	***2.2%***					
Number of children per household	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
Whole population	*70.3%*	*12.4%*	*13.1%*	*3.1%*	*0.9%*	*0.2%*	*0.1%*		
Income deciles 1-3	*84.6%*	*7.8%*	*6.7%*	*0.8%*	*0.1%*	*0.0%*			
Losers under Tariff G2	***79.2%***	***7.7%***	***13.1%***						
Occupants per household	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Whole population	*27.6%*	*35.6%*	*17.3%*	*12.9%*	*4.9%*	*1.3%*	*0.3%*	*0.1%*	
Income deciles 1-3	*62.1%*	*26.7%*	*7.6%*	*2.2%*	*1.1%*	*0.2%*	*0.0%*		
Losers under Tariff G2	***40.5%***	***38.1%***	***10.8%***	***8.0%***	***2.7%***				
Dwelling type	**Whole hse, bungalow-semi-dtchd**	**Whole hse, bungalow-terraced**	**Whole hse,bungalow-detached**	**Purpose-built flat maisonette**	**Part of house converted flat**	**Others**			
Whole population	*32.5%*	*28.0%*	*21.1%*	*13.1%*	*3.1%*	*2.1%*			
Income deciles 1-3	*27.7%*	*29.8%*	*10.7%*	*24.7%*	*4.6%*	*2.4%*			
Losers under Tariff G2	***37.3%***	***27.3%***	***25.1%***	***6.9%***	***2.3%***	***1.1%***			
Housing tenure	**Owned outright**	**LA (furnished unfurnished)**	**Owned with mortgage**	**Hsng Assn (furnished unfrnish)**	**Priv. rented (unfurn)**	**Rent free**	**Priv. rented (furnished)**	**Owned by rental purchase**	
Whole population	*29.2%*	*11.9%*	*40.5%*	*7.0%*	*7.0%*	*1.7%*	*2.5%*	*0.2%*	
Income deciles 1-3	*35.9%*	*24.9%*	*10.4%*	*14.8%*	*8.0%*	*3.1%*	*2.8%*	*0.1%*	
Losers under Tariff G2	***54.0%***	***11.7%***	***16.1%***	***4.2%***	***8.7%***	***2.2%***	***3.0%***		

Economic status of household reference person	Ret unoc over min ni age	Unoc - under min ni age	Full time employee	Part time employee	Self-employed	Unemployed	Work related govt train prog		
Whole population	*25.7%*	*12.0%*	*45.2%*	*7.4%*	*7.7%*	*1.9%*	*0.02%*		
Income deciles 1-3	*52.2%*	*24.3%*	*8.4%*	*6.6%*	*4.0%*	*4.4%*	*0.1%*		
Losers under Tariff G2	***48.1%***	***24.9%***	***8.4%***	***7.9%***	***8.6%***	***2.1%***			
Number of over- 65s per household	**0**	**1**	**2**						
Whole population	*72.2%*	*18.4%*	*9.4%*	*0.03%*					
Income deciles 1-3	*49.6%*	*40.5%*	*9.9%*						
Losers under Tariff G2	***51.7%***	***32.7%***	***15.6%***						

Figure 14: Socio-Economic Characteristics of Losers under Tariff G3

Tariff G3

Gas Payment Method	Budgeting Scheme	account	gas card, or disc	slot meter	DSS pay the whole bill	DSS pay part of the bill	some other method	Paid direct by someone outside household	Not applicable
Whole population	*41.2%*	*30.1%*	*9.9%*	*0.7%*	*0.1%*	*0.0%*	*0.0%*	*0.8%*	*17.1%*
Income deciles 1-3	*27.9%*	*29.8%*	*16.9%*	*1.0%*	*0.1%*	*0.0%*	*0.1%*	*1.4%*	*22.7%*
Losers under Tariff G3	***48.2%***	***38.9%***	***10.9%***	***1.4%***	***0.5%***				
Number of children per household	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
Whole population	*70.3%*	*12.4%*	*13.1%*	*3.1%*	*0.9%*	*0.2%*	*0.1%*		
Income deciles 1-3	*84.6%*	*7.8%*	*6.7%*	*0.8%*	*0.1%*	*0.0%*			
Losers under Tariff G3	***82.0%***	***7.6%***	***9.8%***						
Occupants per household	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Whole population	*27.6%*	*35.6%*	*17.3%*	*12.9%*	*4.9%*	*1.3%*	*0.3%*	*0.1%*	
Income deciles 1-3	*62.1%*	*26.7%*	*7.6%*	*2.2%*	*1.1%*	*0.2%*	*0.0%*		
Losers under Tariff G3	***42.9%%***	***39.2%***	***10.4%***	***5.1%***	***1.7%***		***0.7%***		
Dwelling type	**Whole hse, bungalow-semi-dtchd**	**Whole hse, bungalow-terraced**	**Whole hse,bungalow-**	**Purpose-built flat maisonette**	**Part of house converted**	**Others**			

				detached		flat				
	Whole population	*32.5%*	*28.0%*	*21.1%*	*13.1%*	*3.1%*	*2.1%*			
	Income deciles 1-3	*27.7%*	*29.8%*	*10.7%*	*24.7%*	*4.6%*	*2.4%*			
	Losers under Tariff G3	***34.9%***	***27.4%***	***27.4%***	***6.8%***	***1.5%***	***2.0%***			
	Housing tenure	**Owned outright**	**LA (furnished unfurnished)**	**Owned with mortgage**	**Hsng Assn (furnished unfrnish)**	**Priv. rented (unfurn)**	**Rent free**	**Priv. rented (furnished)**	**Owned by rental purchase**	
	Whole population	*29.2%*	*11.9%*	*40.5%*	*7.0%*	*7.0%*	*1.7%*	*2.5%*	*0.2%*	
	Income deciles 1-3	*35.9%*	*24.9%*	*10.4%*	*14.8%*	*8.0%*	*3.1%*	*2.8%*	*0.1%*	
	Losers under Tariff G3	***57.8%***	***9.0%***	***16.8%***	***5.5%***	***6.9%***	***2.1%***	***1.9%***		
	Economic status of household reference person	**Ret unoc over min ni age**	**Unoc - under min ni age**	**Full time employee**	**Part time employee**	**Self-employed**	**Unemployed**	**Work related govt train prog**		
	Whole population	*25.7%*	*12.0%*	*45.2%*	*7.4%*	*7.7%*	*1.9%*	*0.02%*		
	Income deciles 1-3	*52.2%*	*24.3%*	*8.4%*	*6.6%*	*4.0%*	*4.4%*	*0.1%*		
	Losers under Tariff G3	***49.5%***	***24.6%***	***8.8%***	***6.6%***	***7.8%***	***2.6%***			
	Number of over- 65s per household	**0**	**1**	**2**						
	Whole population	*72.2%*	*18.4%*	*9.4%*	*0.03%*					
	Income deciles 1-3	*49.6%*	*40.5%*	*9.9%*						
	Losers under Tariff G3	***49.7%***	***35.0%***	***15.3%***						

Figure 15: Comparison of Socio-Economic Characteristics of Losers under Gas Tariffs 1 to 3.

Comparison	Gas Payment Method	Budgeting Scheme	account	gas card, or disc	slot meter	DSS pay the whole bill	DSS pay part of the bill	some other method	Paid direct by someone outside household	Not applicable
	Whole population	*41.2%*	*30.1%*	*9.9%*	*0.7%*	*0.1%*	*0.0%*	*0.0%*	*0.8%*	*17.1%*
	Income deciles 1-3	*27.9%*	*29.8%*	*16.9%*	*1.0%*	*0.1%*	*0.0%*	*0.1%*	*1.4%*	*22.7%*
	Tariff G1	***55.3%***	***34.3%***	***9.5%***	***0.5%***	***0.2%***	***0.2%***			
	Tariff G2	***50.6%***	***33.5%***	***13.8%***	***2.2%***					
	Tariff G3	***48.2%***	***38.9%***	***10.9%***	***1.4%***	***0.5%***				
	Number of children per household	**0**	**1**	**2**	**3**	**4**	**5**	**6**		
	Whole population	*70.3%*	*12.4%*	*13.1%*	*3.1%*	*0.9%*	*0.2%*	*0.1%*		
	Income deciles 1-3	*84.6%*	*7.8%*	*6.7%*	*0.8%*	*0.1%*	*0.0%*			
	Tariff G1	***83.9%***	***5.5%***	***9.4%***	***0.7%***	***0.2%***	***0.2%***			
	Tariff G2	***79.2%***	***7.7%***	***13.1%***						
	Tariff G3	***82.0%***	***7.6%***	***9.8%***						
	Occupants per household	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
	Whole population	*27.6%*	*35.6%*	*17.3%*	*12.9%*	*4.9%*	*1.3%*	*0.3%*	*0.1%*	
	Income deciles 1-3	*62.1%*	*26.7%*	*7.6%*	*2.2%*	*1.1%*	*0.2%*	*0.0%*		
	Tariff G1	***49.8%***	***35.6%***	***9.4%***	***3.5%***	***1.3%***	***0.2%***	***0.2%***		
	Tariff G2	***40.5%***	***38.1%***	***10.8%***	***8.0%***	***2.7%***				
	Tariff G3	***42.9%%***	***39.2%***	***10.4%***	***5.1%***	***1.7%***		***0.7%***		
	Dwelling type	**Whole hse, bungalow-semi-dtchd**	**Whole hse, bungalow-terraced**	**Whole hse,bungalow-detached**	**Purpose-built flat maisonette**	**Part of house converted flat**	**Others**			
	Whole population	*32.5%*	*28.0%*	*21.1%*	*13.1%*	*3.1%*	*2.1%*			
	Income deciles 1-3	*27.7%*	*29.8%*	*10.7%*	*24.7%*	*4.6%*	*2.4%*			
	Tariff G1	***35.8%***	***31.4%***	***17.6%***	***12.4%***	***1.5%***	***1.3%***			

Tariff G2	***37.3%***	***27.3%***	***25.1%***	***6.9%***	***2.3%***	***1.1%***			
Tariff G3	***34.9%***	***27.4%***	***27.4%***	***6.8%***	***1.5%***	***2.0%***			
Housing tenure	**Owned outright**	**LA (furnished unfurnishe d)**	**Owned with mortgage**	**Hsng Assn (furnished unfrnish)**	**Priv. rented (unfurn)**	**Rent free**	**Priv. rented (furnished)**	**Owned by rental purchase**	
Whole population	*29.2%*	*11.9%*	*40.5%*	*7.0%*	*7.0%*	*1.7%*	*2.5%*	*0.2%*	
Income deciles 1-3	*35.9%*	*24.9%*	*10.4%*	*14.8%*	*8.0%*	*3.1%*	*2.8%*	*0.1%*	
Tariff G1	***48.4%***	***17.4%***	***16.6%***	***8.2%***	***6.0%***	***1.4%***	***2.0%***		
Tariff G2	***54.0%***	***11.7%***	***16.1%***	***4.2%***	***8.7%***	***2.2%***	***3.0%***		
Tariff G3	***57.8%***	***9.0%***	***16.8%***	***5.5%***	***6.9%***	***2.1%***	***1.9%***		
Economic status of household reference person	**Ret unoc over min ni age**	**Unoc - under min ni age**	**Full time employee**	**Part time employee**	**Self-employed**	**Unemploye d**	**Work related govt train prog**		
Whole population	*25.7%*	*12.0%*	*45.2%*	*7.4%*	*7.7%*	*1.9%*	*0.02%*		
Income deciles 1-3	*52.2%*	*24.3%*	*8.4%*	*6.6%*	*4.0%*	*4.4%*	*0.1%*		
Tariff G1	***55.5%***	***24.1%***	***8.1%***	***4.7%***	***5.4%***	***2.3%***			
Tariff G2	***48.1%***	***24.9%***	***8.4%***	***7.9%***	***8.6%***	***2.1%***			
Tariff G3	***49.5%***	***24.6%***	***8.8%***	***6.6%***	***7.8%***	***2.6%***			
Number of over- 65s per household	**0**	**1**	**2**	**3**					
Whole population	*72.2%*	*18.4%*	*9.4%*	*0.03%*					
Income deciles 1-3	*49.6%*	*40.5%*	*9.9%*						
Tariff G1	***45.4%***	***38.5%***	***16.0%***						
Tariff G2	***51.7%***	***32.7%***	***15.6%***						
Tariff G3	***49.7%***	***35.0%***	***15.3%***						

Figure 16: Comparison of Socio-Economic Characteristics of Losers under combined tariff E1 +G1

Tariffs E1 and G1									
	Electricity payment method	**Budgeting Scheme**	**account**	**electricity card, disc, token, electro**	**slot meter**	**COCD**	**DSS pay the whole bill**	**some other method**	**paid direct by someone outside the house**
	Whole population	*45.7%*	*37.6%*	*14.5%*	*1.2%*	*0.009%*	*0.1%*	*0.1%*	*0.8%*
	Income deciles 1-3	*31.7%*	*40.8%*	*24.3%*	*1.5%*	*0.0%*	*0.1%*	*0.2%*	*1.4%*
	Losers under E1 + G1	***44.0%***	***42.1%***	***12.9%***	***0.8%***	***0.02%***	***0.1%***	***0.1%***	
	Gas payment method	**Budgeting Scheme**	**account**	**gas card or disc**	**slot meter**	**DSS pay the whole bill**	**DSS pay part of the bill**	**or by some other method**	**Paid direct by someone outside the house**
	Whole population	*41.2%*	*30.1%*	*9.9%*	*0.7%*	*0.1%*	*0.015%*	*0.05%*	*0.8%*
	Income deciles 1-3	*27.9%*	*29.8%*	*16.9%*	*1.0%*	*0.1%*	*0%*	*0.1%*	*1.4%*
	Losers under E1 + G1	***38.1%***	***30.5%***	***10.2%***	***0.8%***	***0.2%***	***0.1%***	***0.1%***	***0.5%***
	Number of children per household	**0**	**1**	**2**	**3**	**4**	**5**	**6**	
	Whole population	*70.3%*	*12.4%*	*13.1%*	*3.1%*	*0.9%*	*0.2%*	*0.1%*	
	Income deciles 1-3	*84.6%*	*7.8%*	*6.7%*	*0.8%*	*0.1%*	*0.0%*		
	Losers under E1 + G1	***86.9%***	***6.2%***	***6.1%***	***0.6%***	***0.1%***	***0.1%***		
	Occupants per household	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
	Whole population	*27.6%*	*35.6%*	*17.3%*	*12.9%*	*4.9%*	*1.3%*	*0.3%*	
	Income deciles 1-3	*62.1%*	*26.7%*	*7.6%*	*2.2%*	*1.1%*	*0.2%*	*0.0%*	
	Losers under E1 + G1	***60.0%***	***29.0%***	***7.3%***	***2.3%***	***1.1%***	***0.2%***	***0.1%***	
	Dwelling type	**Whole hse, bungalow-semi-dtchd**	**Whole hse, bungalow-terraced**	**Whole hse,bungalow-detached**	**Purpose-built flat maisonette**	**Part of house converted flat**	**Others**		
	Whole population	*32.5%*	*28.0%*	*21.1%*	*13.1%*	*3.1%*	*2.1%*		
	Income deciles 1-3	*27.7%*	*29.8%*	*10.7%*	*24.7%*	*4.6%*	*2.4%*		
	Losers under E1 + G1	***30.9%***	***30.2%***	***12.2%***	***21.2%***	***3.2%***	***2.2%***		
	Housing tenure	**Owned outright**	**LA (furnished unfurnished)**	**Owned with mortgage**	**Hsng Assn (furnished unfrnish)**	**Priv. rented (unfurn)**	**Rent free**	**Priv. rented (furnished)**	**Owned by rental purchase**

Whole population	*29.2%*	*11.9%*	*40.5%*	*7.0%*	*7.0%*	*1.7%*	*2.5%*	*0.2%*
Income deciles 1-3	*35.9%*	*24.9%*	*10.4%*	*14.8%*	*8.0%*	*3.1%*	*2.8%*	*0.1%*
Losers under E1 + G1	***43.1%***	***19.7%***	***12.1%***	***12.8%***	***7.3%***	***2.9%***	***1.9%***	***0.1%***
Economic status of household reference person	**Ret unoc over min ni age**	**Unoc - under min ni age**	**Full time employee**	**Part time employee**	**Self-employed**	**Unemployed**	**Work related govt train prog**	
Whole population	*25.7%*	*12.0%*	*45.2%*	*7.4%*	*7.7%*	*1.9%*	*0.02%*	
Income deciles 1-3	*52.2%*	*24.3%*	*8.4%*	*6.6%*	*4.0%*	*4.4%*	*0.1%*	
Losers under E1 + G1	***57.8%***	***19.8%***	***8.7%***	***6.1%***	***4.5%***	***2.9%***	***0.1%***	
Number of over- 65s per household	**0**	**1**	**2**					
Whole population	*72.2%*	*18.4%*	*9.4%*	*0.03%*				
Income deciles 1-3	*49.6%*	*40.5%*	*9.9%*					
Losers under E1 + G1	***43.5%***	***43.4%***	***13.1%***					

Figure 17: Comparison of Socio-Economic Characteristics of Losers under combined tariff E2 +G2

Tariffs E2 and G2	**Electricity payment method**	**Budgeting Scheme**	**account**	**electricity card, disc, token, electro**	**slot meter**	**COCD**	**DSS pay the whole bill**	**some other method**	**paid direct by someone outside the house**
	Whole population	*45.7%*	*37.6%*	*14.5%*	*1.2%*	*0.009%*	*0.1%*	*0.1%*	*0.8%*
	Income deciles 1-3	*31.7%*	*40.8%*	*24.3%*	*1.5%*	*0.0%*	*0.1%*	*0.2%*	*1.4%*
	Losers under E2 + G2	***47.5%***	***35.1%***	***16.8%***	***0.5%***	***0.1%***			
	Gas payment method(does not sum to 100% because remainder comprises households without gas)	**Budgeting Scheme**	**account**	**gas card or disc**	**slot meter**	**DSS pay the whole bill**	**DSS pay part of the bill**	**or by some other method**	**Paid direct by someone outside the house**
	Whole population	*41.2%*	*30.1%*	*9.9%*	*0.7%*	*0.1%*	*0.015%*	*0.05%*	*0.8%*
	Income deciles 1-3	*27.9%*	*29.8%*	*16.9%*	*1.0%*	*0.1%*	*0%*	*0.1%*	*1.4%*
	Losers under E2 + G2	***34.1%***	***19.5%***	***10.3%***	***1.0%***	***0%***	***0%***	***0%***	***0.2%***
	Number of children per household	**0**	**1**	**2**	**3**	**4**	**5**	**6**	
	Whole population	*70.3%*	*12.4%*	*13.1%*	*3.1%*	*0.9%*	*0.2%*	*0.1%*	
	Income deciles 1-3	*84.6%*	*7.8%*	*6.7%*	*0.8%*	*0.1%*	*0.0%*		
	Losers under E2 + G2	***83.4%***	***5.1%***	***9.8%***	***0.8%***	***0.6%***	***0.2%***		
	Occupants per household	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
	Whole population	*27.6%*	*35.6%*	*17.3%*	*12.9%*	*4.9%*	*1.3%*	*0.3%*	
	Income deciles 1-3	*62.1%*	*26.7%*	*7.6%*	*2.2%*	*1.1%*	*0.2%*	*0.0%*	
	Losers under E2 + G2	***48.7%***	***33.8%***	***10.0%***	***4.3%***	***2.4%***	***0.6%***	***0.2%***	
	Dwelling type	**Whole hse, bungalow-semi-dtchd**	**Whole hse, bungalow-terraced**	**Whole hse,bungalo w-detached**	**Purpose-built flat maisonette**	**Part of house converted flat**	**Others**		
	Whole population	*32.5%*	*28.0%*	*21.1%*	*13.1%*	*3.1%*	*2.1%*		

Income deciles 1-3	*27.7%*	*29.8%*	*10.7%*	*24.7%*	*4.6%*	*2.4%*		
Losers under E2 + G2	***29.6%***	***25.3%***	***20.2%***	***18.9%***	***2.8%***	***3.2%***		
Housing tenure	**Owned outright**	**LA (furnished unfurnished)**	**Owned with mortgage**	**Hsng Assn (furnished unfrnish)**	**Priv. rented (unfurn)**	**Rent free**	**Priv. rented (furnished)**	**Owned by rental purchase**
Whole population	*29.2%*	*11.9%*	*40.5%*	*7.0%*	*7.0%*	*1.7%*	*2.5%*	*0.2%*
Income deciles 1-3	*35.9%*	*24.9%*	*10.4%*	*14.8%*	*8.0%*	*3.1%*	*2.8%*	*0.1%*
Losers under E2 + G2	***42.9%***	***15.8%***	***16.3%***	***11.7%***	***7.7%***	***3.3%***	***2.1%***	***0.3%***
Economic status of household reference person	**Ret unoc over min ni age**	**Unoc - under min ni age**	**Full time employee**	**Part time employee**	**Self-employed**	**Unemployed**	**Work related govt train prog**	
Whole population	*25.7%*	*12.0%*	*45.2%*	*7.4%*	*7.7%*	*1.9%*	*0.02%*	
Income deciles 1-3	*52.2%*	*24.3%*	*8.4%*	*6.6%*	*4.0%*	*4.4%*	*0.1%*	
Losers under E2 + G2	***50.0%***	***22.0%***	***10.1%***	***6.6%***	***7.3%***	***4.1%***		
Number of over- 65s per household	**0**	**1**	**2**					
Whole population	*72.2%*	*18.4%*	*9.4%*	*0.03%*				
Income deciles 1-3	*49.6%*	*40.5%*	*9.9%*					
Losers under E2 + G2	***50.2%***	***36.3%***	***13.6%***					

Figure 18: Comparison of Socio-Economic Characteristics of Losers under combined tariff E3 +G3

Tariffs E3 and G3	**Electricity payment method**	**Budgeting Scheme**	**account**	**electricity card, disc, token, electro**	**slot meter**	**COCD**	**DSS pay the whole bill**	**some other method**	**paid direct by someone outside the house**
	Whole population	*45.7%*	*37.6%*	*14.5%*	*1.2%*	*0.009%*	*0.1%*	*0.1%*	*0.8%*
	Income deciles 1-3	*31.7%*	*40.8%*	*24.3%*	*1.5%*	*0.0%*	*0.1%*	*0.2%*	*1.4%*
	Losers under E3 + G3	***44.0%***	***37.2%***	***18.2%***	***0.4%***	***0.1%***			
	Gas payment method(does not sum to 100% because remainder comprises households without gas)	**Budgeting Scheme**	**account**	**gas card or disc**	**slot meter**	**DSS pay the whole bill**	**DSS pay part of the bill**	**or by some other method**	**Paid direct by someone outside the house**
	Whole population	*41.2%*	*30.1%*	*9.9%*	*0.7%*	*0.1%*	*0.015%*	*0.05%*	*0.8%*
	Income deciles 1-3	*27.9%*	*29.8%*	*16.9%*	*1.0%*	*0.1%*	*0%*	*0.1%*	*1.4%*
	Losers under E3 + G3	***32.5%***	***22.9%***	***11.7%***	***1.0%***	***0.2%***	***0%***	***0%***	***0.5%***
	Number of children per household	**0**	**1**	**2**	**3**	**4**	**5**	**6**	
	Whole population	*70.3%*	*12.4%*	*13.1%*	*3.1%*	*0.9%*	*0.2%*	*0.1%*	
	Income deciles 1-3	*84.6%*	*7.8%*	*6.7%*	*0.8%*	*0.1%*	*0.0%*		
	Losers under E3 + G3	***83.4%***	***5.6%***	***9.4%***	***0.8%***	***0.6%***	***0.2%***		
	Occupants per household	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
	Whole population	*27.6%*	*35.6%*	*17.3%*	*12.9%*	*4.9%*	*1.3%*	*0.3%*	
	Income deciles 1-3	*62.1%*	*26.7%*	*7.6%*	*2.2%*	*1.1%*	*0.2%*	*0.0%*	
	Losers under E3 + G3	***49.4%***	***33.3%***	***10.5%***	***3.8%***	***2.3%***	***0.6%***	***0.2%***	
	Dwelling type	**Whole hse, bungalow-semi-dtchd**	**Whole hse, bungalow-terraced**	**Whole hse,bungalow-detached**	**Purpose-built flat maisonette**	**Part of house converted flat**	**Others**		
	Whole population	*32.5%*	*28.0%*	*21.1%*	*13.1%*	*3.1%*	*2.1%*		
	Income deciles 1-3	*27.7%*	*29.8%*	*10.7%*	*24.7%*	*4.6%*	*2.4%*		
	Losers under E3 + G3	***29.3%***	***26.0%***	***19.8%***	***18.8%***	***2.8%***	***3.2%***		

Housing tenure	Owned outright	LA (furnished unfurnished)	Owned with mortgage	Hsng Assn (furnished unfrnish)	Priv. rented (unfurn)	Rent free	Priv. rented (furnished)	Owned by rental purchase
Whole population	*29.2%*	*11.9%*	*40.5%*	*7.0%*	*7.0%*	*1.7%*	*2.5%*	*0.2%*
Income deciles 1-3	*35.9%*	*24.9%*	*10.4%*	*14.8%*	*8.0%*	*3.1%*	*2.8%*	*0.1%*
Losers under E3 + G3	***44.8%***	***15.7%***	***15.3%***	***11.7%***	***6.9%***	***2.9%***	***2.5%***	***0.2%***
Economic status of household reference person	**Ret unoc over min ni age**	**Unoc - under min ni age**	**Full time employee**	**Part time employee**	**Self-employed**	**Unemployed**	**Work related govt train prog**	
Whole population	*25.7%*	*12.0%*	*45.2%*	*7.4%*	*7.7%*	*1.9%*	*0.02%*	
Income deciles 1-3	*52.2%*	*24.3%*	*8.4%*	*6.6%*	*4.0%*	*4.4%*	*0.1%*	
Losers under E3 + G3	***50.2%***	***22.7%***	***9.8%***	***6.8%***	***6.6%***	***3.8%***	***0%***	
Number of over- 65s per household	**0**	**1**	**2**					
Whole population	*72.2%*	*18.4%*	*9.4%*	*0.03%*				
Income deciles 1-3	*49.6%*	*40.5%*	*9.9%*					
Losers under E3 + G3	***49.7%***	***36.3%***	***14.0%***					

Figure 19: Comparison of the combined tariffs

Comparison of combinations of gas and electricity tariffs

Electricity payment method	**Budgeting Scheme**	**account**	**electricity card, disc, token, electro**	**slot meter**	**COCD**	**DSS pay the whole bill**	**some other method**	**Paid direct by someone outside the house**
Whole population	*45.7%*	*37.6%*	*14.5%*	*1.2%*	*0.009%*	*0.1%*	*0.1%*	*0.8%*
Income deciles 1-3	*31.7%*	*40.8%*	*24.3%*	*1.5%*	*0.0%*	*0.1%*	*0.2%*	*1.4%*
Losers under E1 + G1	*44.0%*	*42.1%*	*12.9%*	*0.8%*	*0.02%*	*0.1%*	*0.1%*	
Losers under E2 + G2	*47.5%*	*35.1%*	*16.8%*	*0.5%*	*0.1%*			
Losers under E3 + G3	*44.0%*	*37.2%*	*18.2%*	*0.4%*	*0.1%*			
Gas payment method[23]	**Budgeting Scheme**	**Account**	**gas card or disc**	**slot meter**	**DSS pay the whole bill**	**DSS pay part of the bill**	**or by some other method**	**Paid direct by someone outside the house**
Whole population	*41.2%*	*30.1%*	*9.9%*	*0.7%*	*0.1%*	*0.015%*	*0.05%*	*0.8%*
Income deciles 1-3	*27.9%*	*29.8%*	*16.9%*	*1.0%*	*0.1%*	*0%*	*0.1%*	*1.4%*
Losers under E1 + G1	*38.1%*	*30.5%*	*10.2%*	*0.8%*	*0.2%*	*0.1%*	*0.1%*	*0.5%*
Losers under E2 + G2	*34.1%*	*19.5%*	*10.3%*	*1.0%*	*0%*	*0%*	*0%*	*0.2%*
Losers under E3 + G3	*32.5%*	*22.9%*	*11.7%*	*1.0%*	*0.2%*	*0%*	*0%*	*0.5%*
Number of children per household	**0**	**1**	**2**	**3**	**4**	**5**	**6**	
Whole population	*70.3%*	*12.4%*	*13.1%*	*3.1%*	*0.9%*	*0.2%*	*0.1%*	
Income deciles 1-3	*84.6%*	*7.8%*	*6.7%*	*0.8%*	*0.1%*	*0.0%*		
Losers under E1 + G1	*86.9%*	*6.2%*	*6.1%*	*0.6%*	*0.1%*	*0.1%*		
Losers under E2 + G2	*83.4%*	*5.1%*	*9.8%*	*0.8%*	*0.6%*	*0.2%*		
Losers under E3 + G3	*83.4%*	*5.6%*	*9.4%*	*0.8%*	*0.6%*	*0.2%*		

[23]**Does not sum to 100% because remainder comprises households without gas**

Occupants per household	1	2	3	4	5	6	7	8
Whole population	*27.6%*	*35.6%*	*17.3%*	*12.9%*	*4.9%*	*1.3%*	*0.3%*	*0.1%*
Income deciles 1-3	*62.1%*	*26.7%*	*7.6%*	*2.2%*	*1.1%*	*0.2%*	*0.0%*	
Losers under E1 + G1	*60.0%*	*29.0%*	*7.3%*	*2.3%*	*1.1%*	*0.2%*	*0.1%*	
Losers under E2 + G2	*48.7%*	*33.8%*	*10.0%*	*4.3%*	*2.4%*	*0.6%*	*0.2%*	
Losers under E3 + G3	*49.4%*	*33.3%*	*10.5%*	*3.8%*	*2.3%*	*0.6%*	*0.2%*	
Dwelling type	**Whole hse, bungalow-semi-dtchd**	**Whole hse, bungalow-terraced**	**Whole hse,bungalow-detached**	**Purpose-built flat maisonette**	**Part of house converted flat**	**Others**		
Whole population	*32.5%*	*28.0%*	*21.1%*	*13.1%*	*3.1%*	*2.1%*		
Income deciles 1-3	*27.7%*	*29.8%*	*10.7%*	*24.7%*	*4.6%*	*2.4%*		
Losers under E1 + G1	*30.9%*	*30.2%*	*12.2%*	*21.2%*	*3.2%*	*2.2%*		
Losers under E2 + G2	*29.6%*	*25.3%*	*20.2%*	*18.9%*	*2.8%*	*3.2%*		
Losers under E3 + G3	*29.3%*	*26.0%*	*19.8%*	*18.8%*	*2.8%*	*3.2%*		
Housing tenure	**Owned outright**	**LA (furnished unfurnished)**	**Owned with mortgage**	**Hsng Assn (furnished unfrnish)**	**Priv. rented (unfurn)**	**Rent free**	**Priv. rented (furnished)**	**Owned by rental purchase**
Whole population	*29.2%*	*11.9%*	*40.5%*	*7.0%*	*7.0%*	*1.7%*	*2.5%*	*0.2%*
Income deciles 1-3	*35.9%*	*24.9%*	*10.4%*	*14.8%*	*8.0%*	*3.1%*	*2.8%*	*0.1%*
Losers under E1 + G1	*43.1%*	*19.7%*	*12.1%*	*12.8%*	*7.3%*	*2.9%*	*1.9%*	*0.1%*
Losers under E2 + G2	*42.9%*	*15.8%*	*16.3%*	*11.7%*	*7.7%*	*3.3%*	*2.1%*	*0.3%*
Losers under E3 + G3	*44.8%*	*15.7%*	*15.3%*	*11.7%*	*6.9%*	*2.9%*	*2.5%*	*0.2%*
Economic status of household reference person	**Ret unoc over min ni age**	**Unoc - under min ni age**	**Full time employee**	**Part time employee**	**Self-employed**	**Unemployed**	**Work related govt train prog**	
Whole population	*25.7%*	*12.0%*	*45.2%*	*7.4%*	*7.7%*	*1.9%*	*0.02%*	
Income deciles 1-3	*52.2%*	*24.3%*	*8.4%*	*6.6%*	*4.0%*	*4.4%*	*0.1%*	
Losers under E1 + G1	*57.8%*	*19.8%*	*8.7%*	*6.1%*	*4.5%*	*2.9%*	*0.1%*	

	Losers under E2 + G2	*50.0%*	*22.0%*	*10.1%*	*6.6%*	*7.3%*	*4.1%*		
	Losers under E3 + G3	*50.2%*	*22.7%*	*9.8%*	*6.8%*	*6.6%*	*3.8%*	*0%*	
	Number of over- 65s per household	**0**	**1**	**2**	**3**				
	Whole population	*72.2%*	*18.4%*	*9.4%*	*0.03%*				
	Income deciles 1-3	*49.6%*	*40.5%*	*9.9%*					
	Losers under E1 + G1	*43.5%*	*43.4%*	*13.1%*					
	Losers under E2 + G2	*50.2%*	*36.3%*	*13.6%*					
	Losers under E3 + G3	*49.7%*	*36.3%*	*14.0%*					

Appendix 3: Review of literature on Price Elasticities of Demand for Energy

Price Elasticity

A selection of academic and grey literature on the price elasticity of demand, in relation to energy consumption (focusing principally on domestic electricity and gas) were reviewed. The estimates of elasticity's of demand for electricity and gas vary widely in the literature, as does the level of detail studied (e.g. national to regional to sub-regional), the data used, the model type and estimation technique applied (Garcia-Cerrutti, 2000). A selection of the different approaches discussed in the literature is included below, to provide an indication of the differences in methodology and results. Several of the papers reviewed here usefully provide discussions of findings from further literature and these have been summarised in the table below. Given the time constraints of this study, it is not possible to conduct a full, in-depth review of price-elasticity literature, thus these summaries have been used here to gauge an understanding of the range of values of price elasticity and subsequently estimate a suitable figure for use in this research.

Taylor (1975) provides one of the first literature reviews of the existing studies on residential, commercial, and industrial electricity demand. For residential electricity, Taylor states that short-run price elasticities varied from –0.90 to –0.13 and long-run price elasticities ranged from –2.00 to near zero (Bernstein and Griffin, 2005).

A further review of studies on energy demand, conducted by Bohi and Zimmerman (1984) concluded that the consensus estimates for residential electricity price elasticities was –0.2 in the short run and –0.7 in the long run. For residential gas consumption, values of –0.2 in the short run and –0.3 in the long run were reported (Bernstien and Griffin, 2005).

Clements and Madlener (1999) in their paper on UK residential energy demand, discuss the varying methods that have been applied in estimating price (and income) elasticity of demand. They include a useful summary of previous studies, methods employed and results obtained, the relevant ones of which have been included in the table below.

Garcia-Cerrutti (2000) estimated price elasticities for residential electricity and natural gas demand at county level in California, including a discussion of different model approaches and comparative results. For residential electricity, Garcia-Cerrutti estimate a mean value of -0.17.

Of particular relevance to this research, are the difficulties in assessing price elasticity under block-rate tariffs (as opposed to standard, flat rate tariffs), as discussed by Herriges and King (1994). Herriges and King subsequently report the findings of their own study using data from a residential rate experiment, estimating the price elasticities of demand under an inverted block rate tariff, concluding that elasticity will be different under the different blocks, but overall finding the short-term price elasticity to be fairly inelastic (with estimates of -0.1 to -0.2).

Lijesen (2006) explores the real-time price elasticity of electricity demand (the price elasticity of demand on an hour-by-hour basis) and discusses previous estimates of elasticities of electricity , distinguishing between long term elasticities, short term elasticities (of one year of less) and elasticities from time-of-use studies (Lijesen, 2006). This includes a summary of some published empirical estimates of elasticity of electricity, the relevant ones of which have been included in the summary table below.

A study commissioned by the United States National Renewable Energy Laboratory (NREL) and conducted under the Environment, Energy and Economic Development Programme (EEED) within RAND Infrastructure, Safety and Enviornment (ISE) of the RAND Corporation, in 2005, explores the relationship between energy demand and energy prices in the United States. Specifically, the study investigates any regional, state or sub-state differences in the relationship between prices and demand, by using different levels of data (national, regional and state-level) for electricity and natural gas use in the residential sector. The results of this study are of interest to this research on an individual and holistic level. On the whole the RAND study found demand to be relatively inelastic to price, but with strong regional and state differences. The national level results for electricity estimate short-run price elasticity to be –0.2, and long-run price elasticity to be –0.32. For natural gas the short-term price elasticity is –0.12, and long-term price elasticity is –0.36.

At a regional level, the study found estimates of short-run elasticities for electricity to range from -0.04 to -0.31 and long-run elasticities to range from approximately -0.05 to -0.55. For natural gas at a regional level, these estimates range from –0.03 to –0.18 and long-run elasticities range from approximately -0.05 to -0.5.

In summary, previous studies show significant variations in price elasticities of demand for domestic electricity and gas consumption. However, the higher figures for long run elasticity generally suggest that demand is more inelastic in the short run and more elastic in the long run (Bernstein and Griffin, 2005). The table below summarises the short and long run estimates quoted in the various papers reviewed here. These figures have been used to calculate an overall average.

Table 6: Estimates of Price Elasticity of Demand

Original Study	Source for this study (if applicable)	Area/ Data used	Price Elasticity of Demand					
			Electricity		Gas		'Energy' (Aggregate)	
			Short run	Long run	Short run	Long run	Short run	Long run
Al Faris (2002)	Lejisen (2007)	Saudi Arabia, UAE, Kuwait, Oman, Bahrain and Qatar/ Annual time series 1970-1997	-0.11	-2.105				
Beenstock et al (1999)	Lejisen (2007)	Isreal/ Quarterly time series 1973 - 1994	-0.124	-0.579				
Bernstein, M.A. and Griffin, J. (2005)	-	U.S./ Panel data 1977–2004	-0.2	-0.32	-0.12	-0.36		
Bohi and Zimmerman (1984)	Bernstein and Griffin (2005)	Reviewed existing research	-0.2	-0.7	-0.2	-0.3		
Boonekamp (2007)	Lejisen (2007)	Netherlands/ Annual time series 1990-2000		-0.22				
Fouquet (1995)	-	UK/ Quarterly 1974 - 1994	-1.01	-0.39	-0.5	-0.92		
Garcia-Cerrutti (2000)	Bernstein and Griffin (2005)	California		-0.17				
Holtedahl & Loutz (2004)	Lejisen (2007)	Taiwan/ Annual time series, 1955-1996	-0.15	-0.16				
Hunt & Manning (1989)	Clements and Madlener (1999)	UK/ Annual data (1967-86)					-0.1	-0.33
Maddala et al. (1997)	Bernstein and Griffin (2005)	U.S/ Panel Data					-0.16	-0.24
Madlener (1996)	Clements and Madlener (1999)	Austria/ Annual data (1970 - 93)						-0.02
Taylor (1975)	Bernstein and Griffin (2005)	Reviewed existing research	-0.9 to -0.13	-2.00 to near 0				
Vaage (1993)	Clements and Madlener (1999)	Norway/ Annual data (1960-89)		-0.265				
Zachariadis & Pashourtidou (2007)	Lejisen (2007)	Cyprus/ Annual time series, 1960-2004		-0.7				

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