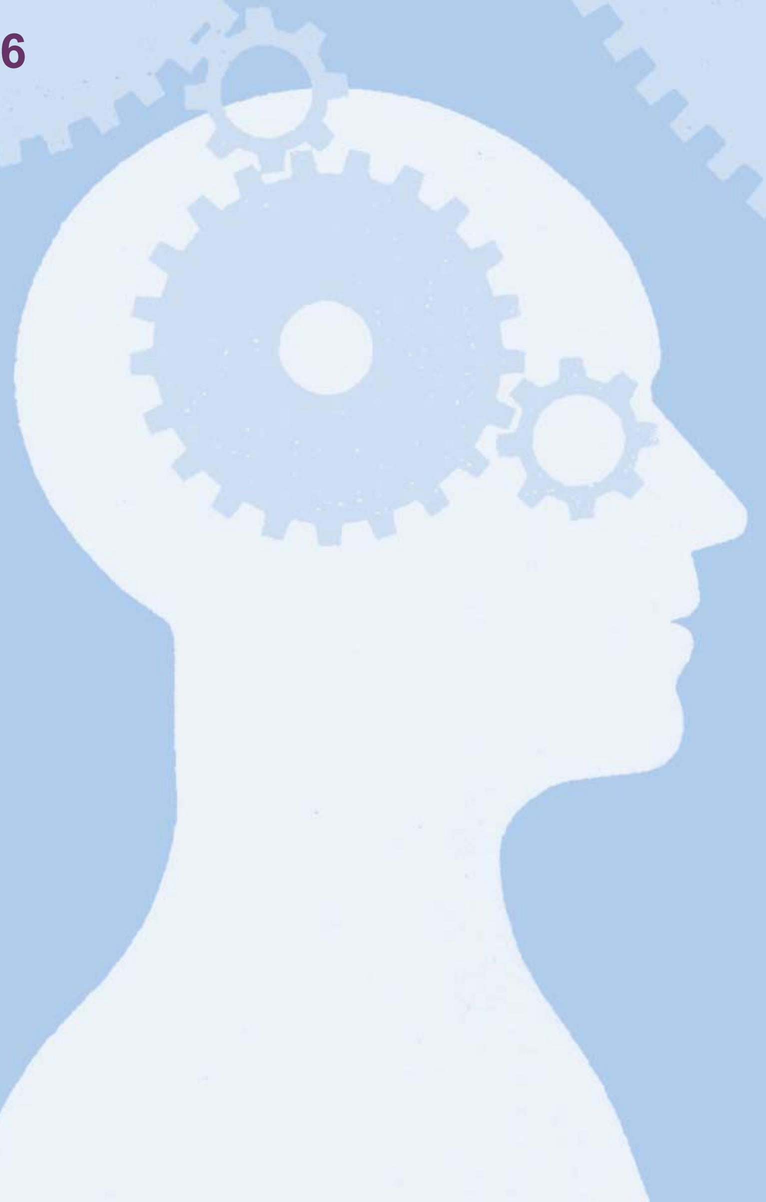
Oxera

# Policies for energy efficiency in the UK household sector

## Report prepared for Defra

January 2006



# Executive summary

## Why consumers adopt energy efficiency measures

There has been much speculation about the explanation for the low take-up in the UK domestic housing sector of energy-efficient products and energy efficiency measures such as insulation. To ensure that *appropriate* policies are designed to encourage people to adopt such measures, it is important to know why they do not currently do so. Indeed, in understanding the reasons, it is possible to determine how to make energy efficiency improvements more attractive to householders.

Although energy efficiency policies absorb hundreds of millions of pounds a year in direct or indirect public expenditure, there are gaps in the empirical evidence needed to support the evaluation of policies or to understand the market failures that justify Government intervention. This study goes some way to correct that imbalance.

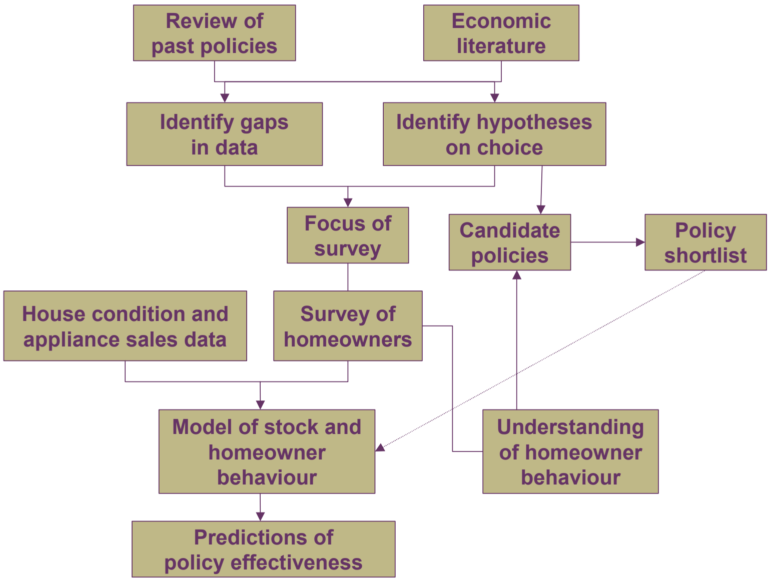
The study began by consolidating evaluations of previous and existing policies, combining this with an extensive economic literature review of what affects energy efficiency take-up by households. As a result, several hypotheses of the reaction of householders to policies were identified, and the strength of evidence supporting these hypotheses was assessed. This process identified gaps in knowledge that need to be plugged in order to make policy decisions more confidently. A clear case emerged for more primary evidence to be gathered, and a survey approach was chosen. The review also identified suggestions for designs for policy and issues to be taken into account in determining whether intervention is desirable.

To focus the survey work, statistics on the use of energy in the home were examined to reveal the trends and current character of energy efficiency in homes. This showed where the most important savings might come from, and enabled the study to concentrate on those areas with the greatest potential for energy savings.

The survey was designed to gather data to fill gaps in existing knowledge and to allow testing of hypotheses about how people make choices about energy efficiency. In-depth interviews, each lasting around 30 minutes, were carried out with a representative sample of more than 1,000 homeowners, and covered insulation, appliances and lighting. Analysis of this data revealed the significant drivers of choice and the magnitude of their influence was estimated precisely. The survey did not cover householders' change in energy-consuming behaviour upon adopting energy efficiency measures—the 'rebound effect' or 'comfort factor'—because this has been studied by others before.

Once the main influences of choice had been identified, models were built, representing the character of the UK housing and appliance stock and the preferences driving homeowners' decisions. These drivers, such as prices, were linked to potential policy levers, such as price discounts and awareness campaigns. The model was then used to predict the take-up of energy efficiency measures by homeowners in response to a range of candidate policies, and hence to determine how effective those policies would be. The figure below illustrates the steps undertaken in the study.

## Figure 1 Elements of the study




Source: Oxera.

The most important finding is that future energy savings do not appear to be an important factor in a householder's decision to fit insulation or to buy efficient appliances. Other factors have much more influence in the decision, including, in all circumstances, the price. If the energy savings are considered as part of the decision at all, they only feature weakly. Changing the value of energy savings is therefore unlikely to have a significant impact on the take-up of energy efficiency measures. This result also means that the introduction of the Home Information Pack, which tells buyers how efficient their new property is, may not cause any change in relative house prices between efficient and inefficient homes. More precisely, it will not do so as a result of the revealed value of energy savings, although it might do so as an indicator of the care taken of the property by previous owners.

Also of great importance is the finding that most households have very poor knowledge of the characteristics of energy efficiency measures—for example, having little idea about the costs of common insulation measures. Of those who do have some idea, most have over-inflated expectations of the costs, and only a small minority have accurate knowledge. This ignorance extends to awareness of the schemes that accredit the installers of domestic insulation. Householders profess great concern about accreditation, but only 8% are informed about the existing schemes. What is striking is that the current policies targeting consumers' knowledge, such as appliance labelling and awareness campaigns, have not succeeded in remedying this awareness gap. There is an opportunity cost for householders in finding out about and weighing up these issues, and many will not do so without prompting or the promise of a reward. This suggests that the extent and objectives of both labelling and awareness campaigns could be reassessed.

## Table 1 The perception gap

| | Median perceived value | Mean perceived value | Mean actual value |
|---|---|---|---|
| Cavity wall installation cost | £600 | £1,139 | £400 |
| Loft installation cost | £300 | £530 | £300 |
| Cavity wall installation time | 1 day | 2.1 days | 0.5 days* |
| Loft installation time | 1 day | 1.4 days | 0.5–1 day* |

Note: * Estimated. The mean actual values do not include discounts offered through the Energy Efficiency Commitment.
Source: Oxera.

## How to improve efficiency in lighting and appliances

While consumers can be persuaded to switch to more energy-efficient appliances and lighting through financial inducements, the cost is much greater for appliances than for insulation. This is because consumers purchase some efficient appliances and lighting in the absence of an inducement, and unless it is possible to price-discriminate and to direct the inducement towards consumers who would not otherwise buy the goods, there is a large deadweight effect. In other words, the deadweight effect is the lost revenue from the discounting of prices for goods that would have been sold had prices not been discounted. Targeted discounting is an attempt to offer discounts only to those consumers who would not have purchased the goods at the full price. Financial incentives are not the only means of promoting energy-efficient appliances; the alternatives are labelling and product standards.

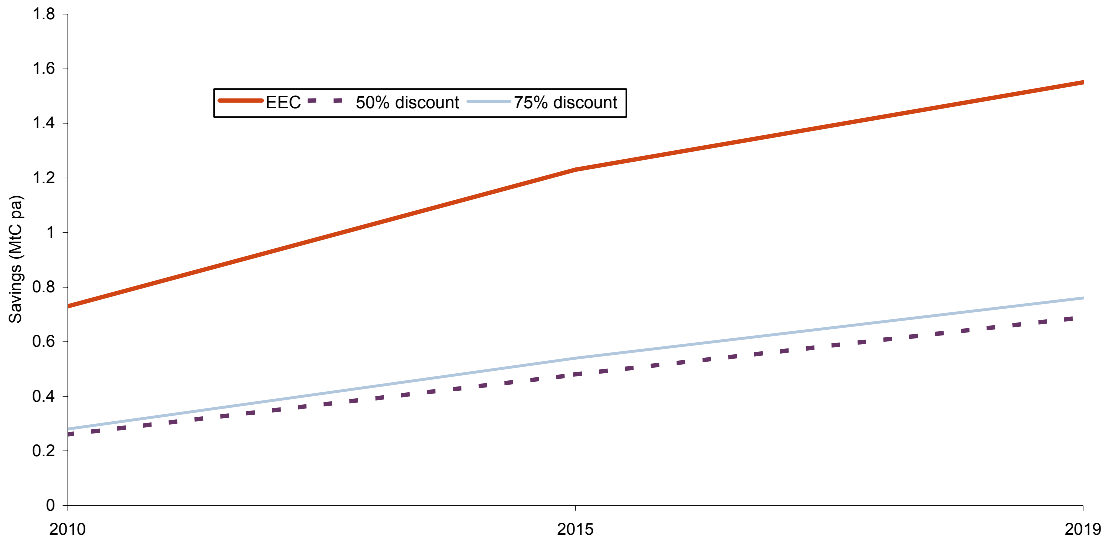
Labelling seems to have been effective in the past, although it is unclear whether consumers have been influenced by the prospect of energy efficiency per se, or whether labels of A or A* energy performance confer an impression of high overall product quality. The survey tested the influence on consumers of a simple energy efficiency performance label, which grades performance alphabetically, and one that also states the value of energy savings per annum. The additional information on the value of energy savings was found to have no effect on consumers. This finding is consistent with several hypotheses, including that energy labelling is effective for some reason other than that it allows consumers to identify products that offer energy savings; that consumers correctly infer savings from the alphabetic label alone; and that consumers do not care about the value of energy savings.

In comparison to labelling, regulation is certain to be effective, but could only be applied at a European level. The evaluation of policies here is incomplete because there is no data available on the costs of manufacturing appliances of a higher standard; hence the costs of doing so cannot be compared against the benefits.

## The roles of suppliers and government

Analysis of current and future trends in take-up shows that the obligation on energy suppliers to persuade households to adopt energy efficiency measures (the Energy Efficiency Commitment, or EEC) is much more effective than the subsidy levels they offer would suggest alone (see Figure 2 below). The suppliers’ success can probably be attributed to the level of access to, and skill with which they reach, customers, inform them, and trigger a decision to invest in energy efficiency. The empirical evidence suggests that the suppliers’ role is crucial, and that the key value of the EEC’s design is, in fact, its involvement of suppliers. Future policies that maintain the involvement of suppliers are likely to be most cost-effective. Such policies are likely to achieve greater take-up levels for a given level of price discount on energy-efficient goods, through effective marketing.

**Figure 2 Effectiveness of EEC in comparison to simple discounts on installation price, savings relative to 2005**



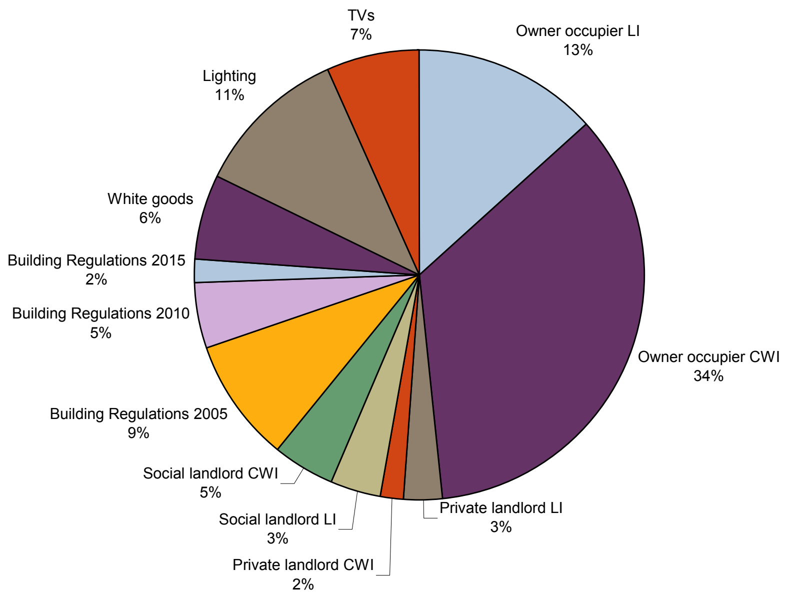

Source: Oxera.

However important the suppliers are, the Government's role is still essential. It has to create the demand for energy efficiency through incentives or obligations—without such external prompting, the market itself would only deliver low volumes of measures. This is because householders' appetite for energy efficiency measures is naturally low because householders do not attribute value to energy savings. The Government's role is also to facilitate choice by householders through the provision of information and by raising the profile of installer accreditation schemes. The data suggests that an effective awareness campaign could enable the EEC scheme to deliver 50% more savings for the same level of discount.

## Future scope for savings

The greatest scope for savings among the efficiency measures lies in cavity wall insulation (CWI), followed by loft insulation (LI) and lighting. While the total potential savings from these measures are around 6MtC, only around 3.5–4.0MtC is likely to be accessible through policy initiatives. This is because a proportion of householders have preferences that make them hard to persuade. It is also apparent, as shown in Figure 3 below, that owner-occupiers (the majority of householders) hold the keys to unlock the greatest energy efficiency measures. Registered social landlords and local authority landlords offer little savings beyond the next few years: having been effectively targeted by recent policies, all their accessible potential will have been taken up. The potential savings available through other measures, such as more efficient boilers, solid wall insulation, and building standards, are at least as great as from the measures examined in this study.

**Figure 3 Share of realistic potential carbon savings by 2020**




Note: Excludes solid wall insulation, which is much more expensive than the other measures shown.
Source: Oxera.

Little is known about one group of landlords, the private landlords, other than that they are likely to be hard to reach. Energy efficiency hardly features in the arithmetic of private rental property, and landlords have no incentive to make energy efficiency investments. Meanwhile, the alternative to financial incentives—namely, the enforcement of any new requirement to install measures—also looks problematic, being administratively expensive. This leaves financial incentives as a possible solution. While these would have to be large in order to have any effect, they would at least remain small relative to rental cash flows, and would thus be affordable to private landlords.

Not all of the carbon savings described above may be subtracted from the published greenhouse gas emissions forecasts. These forecasts amalgamate growth in demand for energy services with some improvements in efficiency to produce an overall trend in emissions. This report does not estimate savings relative to published forecasts, but further work is ongoing elsewhere to address this question.[1]

## Building Regulations

BRE (the Building Research Establishment) modelled the effects of introducing tighter regulations on the standards to which new houses would be required to comply. These measures were modelled as a series of updates to Building Regulations coming into force in 2005, 2010 and 2015, and took the following forms:

– *for 2005*—as defined in the consultation document for part L of the 2005 Building Regulations;

[1] See DTI (2005), 'Progress on the development of indicators', July, Joint Working Group on Energy and the Environment, available at http://www.dti.gov.uk/energy/environment/jwgee/ewp_2nd_annual_jwgee_report.pdf.

– *for 2010*—a 25% reduction in emissions, translating into the installation of energy-efficient lighting and high levels of insulation in all homes, and the addition of solar water heating for oil-heated homes and the use of heat pumps in electrically heated homes;

– *for 2015*—a further 25% reduction in emissions, meaning the installation of photovoltaic (PV) cells for gas- and oil-heated homes, additional insulation measures for electrically heated homes and the use of heat pumps.

In parallel, a further scenario was developed modelling the savings that might be achievable by obliging all homeowners who undertake extension work to ensure that LI and CWI is installed in their property, starting from 2006. The results of this modelling showed the following reductions in annual energy consumption and carbon emissions by 2020:

– *2005 regulations*: reduction in energy consumption of 5.0TWh per annum and in carbon emissions of 0.33MtC per annum;

– *2010 regulations*: further reduction in energy consumption of 2.8TWh per annum and in carbon emissions of 0.17MtC per annum;

– *2015 regulations*: reduction in energy consumption of 1.0TWh per annum and in carbon emissions of 0.06MtC per annum.

The obligation to ensure that CWI and LI are installed in all properties on which extensions are undertaken is modelled as achieving reductions of 3.8TWh per annum and 0.2MtC per annum.

These reductions in energy consumption (and carbon emissions) through tighter regulations on building standards for new houses rely on an assumption of similar levels of compliance to those in the recent past. If compliance were worse, the actual reductions in energy consumption and carbon emissions would be lower than those shown above.

## Costs

Across the full range of policies, all the measures generate financial savings over their lifetimes in excess of the costs, before even taking into account the value of carbon savings. These savings are substantial and energy efficiency policies highly attractive. The net present benefit of a full suite of policies (excluding the costs of compliance with lighting and appliance standards) is in the range £25–£30 billion.

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# 1 Introduction

## 1.1 Background

Energy efficiency has a crucial role to play in the Government's current and future set of energy policies. It contributes to the central objective of environmental improvements and reductions in emissions, while reducing the need for investment in energy infrastructure and contributing to the elimination of fuel poverty.

The UK's main international commitment on energy is the Kyoto Protocol, under which it has committed to reducing greenhouse gas emissions by 12.5% from 1990 levels by 2008–12. Under the Government's Climate Change Programme 2000, a more ambitious goal was set, which involved cutting the UK's $CO_2$ emissions to 20% below 1990 levels by 2010.

The 2004 Energy White Paper anticipated that more than half the reductions in the existing Climate Change Programme—around 10MtC per annum by 2010—would come from energy efficiency.[2] Households would account for around 5MtC of the expected savings. The White Paper suggested that measures had been put in place to deliver around 1.5MtC reductions by 2010. The measures expected to deliver the remaining 3.5MtC include the following:

- progressively raising standards to that of the most efficient boiler type, namely condensing boilers, and installing around 5m new units, saving around 0.6MtC;
- during the period from 2005 to 2010, insulating around 4.5m cavity walls, saving around 1.2MtC;
- installing an extra 100m energy-saving lights, beyond the 60m already anticipated by 2005, saving around 0.5MtC;
- faster improvements in the standards of new household appliances and significantly increasing the take-up of A-rated appliances, which could save 0.4MtC; and
- other insulation measures, improved heating controls, higher standards of new build and refurbishment, revisions to the Building Regulations, and community heating with combined heat and power (CHP), saving around 1MtC.

Energy efficiency was projected to contribute around half of the additional 15–25MtC savings that are considered desirable in the period to 2020. This figure included a further 4–6MtC of annual savings from households and a further 4–6MtC from the business and public sectors. Savings of this magnitude equate to an approximate doubling of the rate of energy efficiency improvement seen over the past 30 years.

Following on from the White Paper in 2003, the Government published a full plan of action setting out in further detail the ways in which the targets in the White Paper will be achieved.[3] It also provides updated information on the potential of specific measures to contribute towards the overall objective of a 20% reduction in carbon emissions by 2010.

The Plan for Action includes:

- measures to increase energy efficiency in households;
- measures to tackle fuel poverty, in the form of a Fuel Poverty Implementation Plan to be published later in 2005;

[2] DTI (2003), 'Our Energy Future: Creating a Low Carbon Economy', February.

[3] Defra (2004), 'Energy Efficiency: The Government's Plan for Action', April.

– R&D activities aimed at the development of 'low carbon technologies', under the remit of the Carbon Trust;
– information programmes to encourage the take-up of energy efficiency measures, under the remit of the Energy Saving Trust.

The role of domestic energy efficiency is clear—the household sector is targeted to achieve one-third of the overall gains in energy efficiency in the period to 2010. Given the size of the challenge, the requirement to formulate efficient and effective policies towards energy efficiency is paramount.

## 1.2 About this study

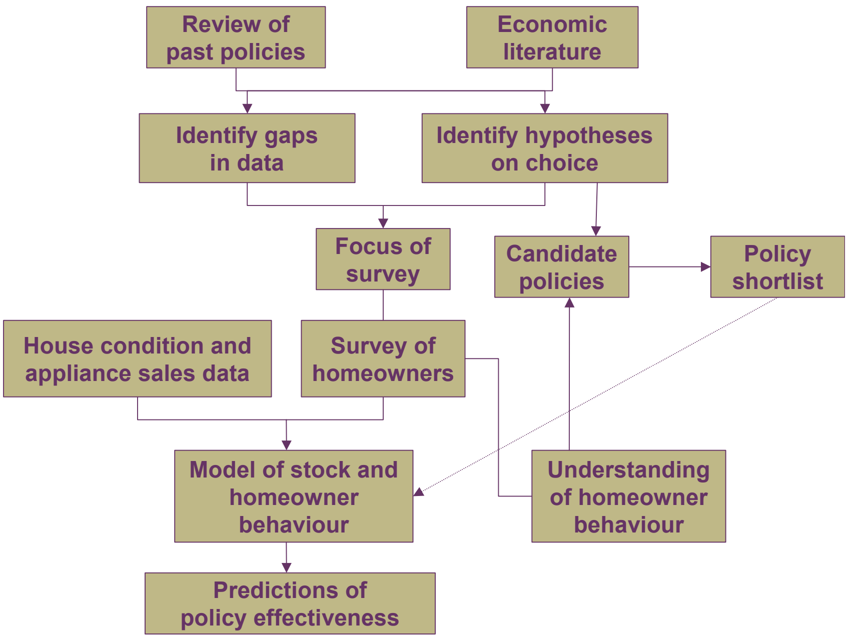
In seeking to promote energy efficiency, the Government can opt for a number of policy approaches, the main measures being:

– direct regulation (eg, mandatory performance standards);
– direct provision of energy efficiency investment (eg, the Energy Efficiency Commitment, or EEC), where either the amount of investment is set or a level of energy savings is targeted;
– 'awareness' measures (ie, making consumers aware of the benefits of energy efficiency measures and attempting to change their preferences/behaviour);
– fiscal measures (ie, the application of taxes and subsidies to promote the take-up of energy efficiency measures, and to discourage the take-up of energy-*inefficient* measures).

The challenge of achieving efficiency gains where there are many individuals, each concerned with decisions affecting energy efficiency on a range of measures and appliances, is well known. Direct regulation does not rely heavily on consumers' choices and behaviour. However, the other forms of intervention, which seek to raise awareness and to apply financial instruments, rely on a response from consumers. Accordingly, an understanding of how consumers make decisions with respect to energy efficiency measures is a critical input to policy choice.

The approach taken in this study is summarised in Figure 1.1 and explained thereafter.

**Figure 1.1 Overview of the study**




Source: Oxera.

The study began by consolidating past work evaluating the efficacy of previous and existing policies. This was combined with an extensive economic literature review on what affects energy efficiency take-up by households. As a result, several hypotheses of the reaction of householders to policies were identified, and the strength of evidence supporting these hypotheses was assessed. This process identified the gaps in knowledge that need to be plugged in order to make more policy decisions more confidently. A clear case emerged for gathering more primary evidence, and a survey approach was chosen. The review also identified suggestions for designs for policy and issues to take into account in determining whether intervention is desirable.

To focus the survey work, statistics on the use of energy in the home were examined to reveal the trends and current character of energy efficiency in homes. This showed where the most important savings might come from, and enabled the study to concentrate on those areas with the greatest potential for energy savings.

The survey was designed to gather data to fill gaps in existing knowledge and to allow testing of hypotheses about how people make choices about energy efficiency. In-depth interviews, lasting around 30 minutes each, were carried out with a representative sample of more than 1,000 homeowners, and covered insulation, appliances and lighting. The data collected was processed statistically so that the significant drivers of choice could be identified and the magnitude of their influence estimated precisely. The survey did not cover householders' change in energy-consuming behaviour upon adopting energy efficiency measures, the 'rebound effect' or 'comfort factor', because this has been studied by others before.

The following models were built:

1) owner-occupiers' choice of insulation measures (based on choice modelling and housing stock characteristics, explained further below);

2) (brown and white) appliances (based on choice models and Market Transformation Programme sales projections); and

3) lighting (based on choice models and stock information).

The owner-occupier insulation model represents the character of the UK housing stock and the preferences driving homeowners' decisions. Homeowners respond to policies through the filter of their preferences, and make choices appropriate for their housing stock. The other models work in a similar way, either tracking the stock or purchasing of lighting and appliances.

The models are then used to predict the take-up of energy efficiency measures or goods in response to a range of candidate policies. In this way, they can help to determine how attractive these policies would be, in terms of their carbon savings, feasibility and cost-effectiveness.

This work was carried out by Oxera between April and July 2005 and contributed to Defra's Energy Efficiency Innovation Review (EEIR). Oxera was assisted by Professor Ian Bateman and his team in the School of Economics at the University of East Anglia (on survey design), Taylor Nelson Sofres (TNS) on the survey fieldwork, and the Building Research Establishment (BRE) on the modelling of the effects of Building Regulations, as well as the provision of data on the housing stock (derived from the English Household Condition Survey).

This report is structured as follows.

– Sections 2 and 3 provide a briefing on energy use in the home and past energy efficiency policies.

– Section 4 presents evidence from literature on consumer behaviour in the take-up of energy efficiency measures.

– Section 5 presents evidence collected during this study.

– Section 6 introduces the policy evaluation models developed in this study and analyses the results.

– Section 7 summarises the policy implications from the study.

# 2 Background briefing: energy use in the home

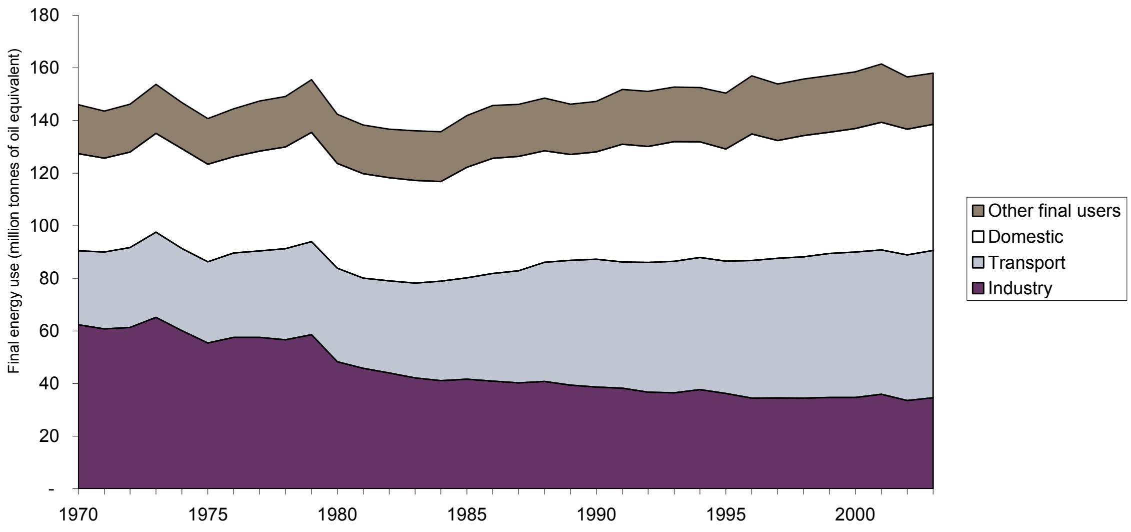
The trends in energy consumption are a starting point for understanding the evolution of domestic energy efficiency over time. This section displays some key characteristics of the domestic energy market. It shows the importance of household energy use in UK greenhouse gas emissions and the dominance of space heating as the driver of demand for energy consumption—hence, the focus later in the study on insulation measures as offering the greatest potential for greenhouse gas emissions savings.

A notable statistic is the greater affordability of energy through time. The cost of energy expressed relative to earnings has fallen by around three-quarters for the lowest earners and even more for higher-income households over the last 30 years. Nevertheless, the energy efficiency of the housing stock, of appliances and of lighting continues to improve, in part as a response to policies. These figures reinforced the need for study of the importance of energy savings as a driver of energy efficiency measures, and suggested that, if householders were motivated at all by energy efficiency savings now, over time that motivation would decline, and that it might already be lower in higher-income groups. In fact, the survey revealed that households are already almost completely indifferent to the financial savings available from energy efficiency, regardless of income group.

## 2.1 Trends in energy consumption

Domestic energy consumption is around one-third of total energy use in the UK, and has been roughly this proportion for several decades, as shown in Figure 2.1. This makes household energy use an important contributor to the UK's greenhouse gas emissions.

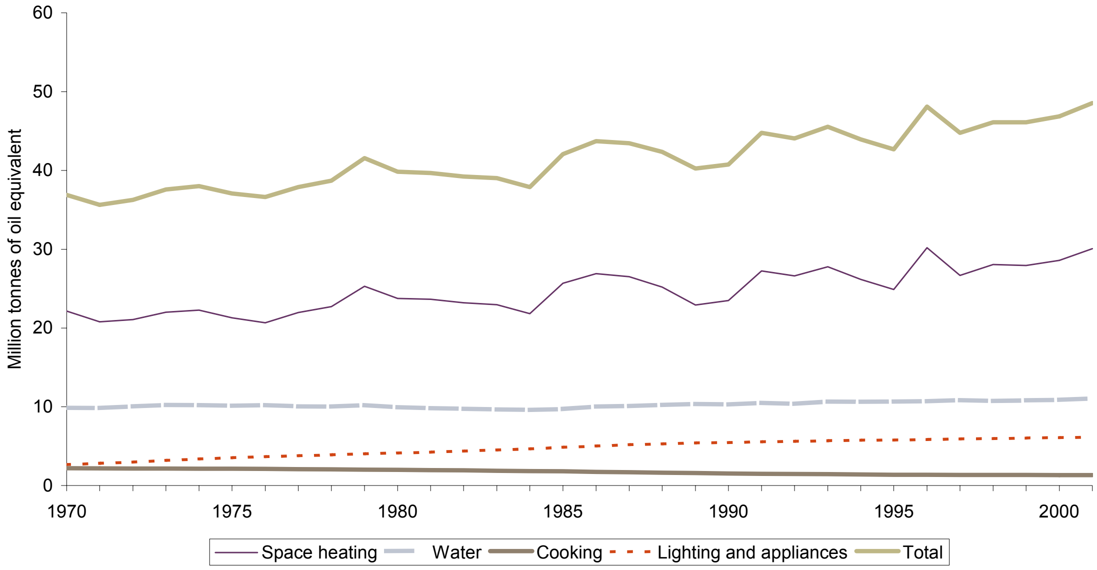
**Figure 2.1 Total energy use in the UK, 1970–2003**




Source: Digest of UK Energy Statistics.

Figure 2.2 below shows the trends in domestic energy use, according to purpose. Space heating is by far the greatest energy use, accounting for between one-half and two-thirds of domestic energy consumption. Water heating takes up approximately half the balance, and lighting and appliances share the remaining 10%. Use of energy in cooking is insignificant.

**Figure 2.2 Trends in domestic energy use, 1970–2001**




Source: BREHOMES, taken from the Domestic Energy Fact file, BRE.

This indicates that, while the consumption of energy for heating water and for cooking has remained steady, its consumption for space heating, lighting and appliances has increased. The trend in energy use for these purposes may reflect rising household income (resulting in higher internal temperatures), and falling real prices of appliances (resulting in more widespread ownership of appliances). Measures to improve the energy efficiency of homes through insulation and boiler efficiency would appear to have the most leverage for achieving the Government's energy reduction targets.

## 2.2 Spending on energy

Spending on energy as a proportion of total household expenditure has fallen steadily over the last 30 years, as incomes (and therefore consumption) have risen and real energy prices have remained fairly static (see Table 2.1).

**Table 2.1 Percentage of total expenditure accounted for by expenditure on fuel, 1970–2002/03**

| Income group | 1970 | 1980 | 1990 | 2000/01 | 2001/02 | 2002/03 |
|---|---|---|---|---|---|---|
| Lowest | 13.0 | 12.0 | 10.8 | 6.8 | 6.0 | 5.7 |
| Low–mid | 7.6 | 7.9 | 6.5 | 4.7 | 4.2 | 4.0 |
| High–mid | 5.9 | 5.5 | 4.1 | 2.9 | 2.8 | 2.8 |
| Highest | 4.6 | 3.6 | 2.9 | 2.0 | 1.9 | 1.9 |

Note: Expenditure relates to fuel and power only, and excludes expenditure on petroleum spirit and diesel.
Source: Extract from DTI (2004), 'Energy Indicators (Social Objectives—Fuel Poverty)'.

While the proportion of total expenditure on fuel is persistently higher in the lowest income group than in all other groups, it is notable that the ratio of the proportion of expenditure between the lowest and highest income groups has declined since 1990.

## 2.3 Energy efficiency trends

The most recent energy projections, published by the DTI in November 2004,[4] show the rates at which energy-intensity reductions have been changing in the residential and other sectors. In comparison, the UK's long-term climate change target of a 60% reduction in emissions by 2050 requires an absolute reduction of around 1.9% per annum across the economy, which equates to a rate of intensity reduction of around 4% per annum. The historical trend for efficiency improvement for the household sector has been around 1% per annum (but a static energy intensity). The Climate Change Programme aims to double this rate in the period up to 2010 (see Table 2.2).[5]

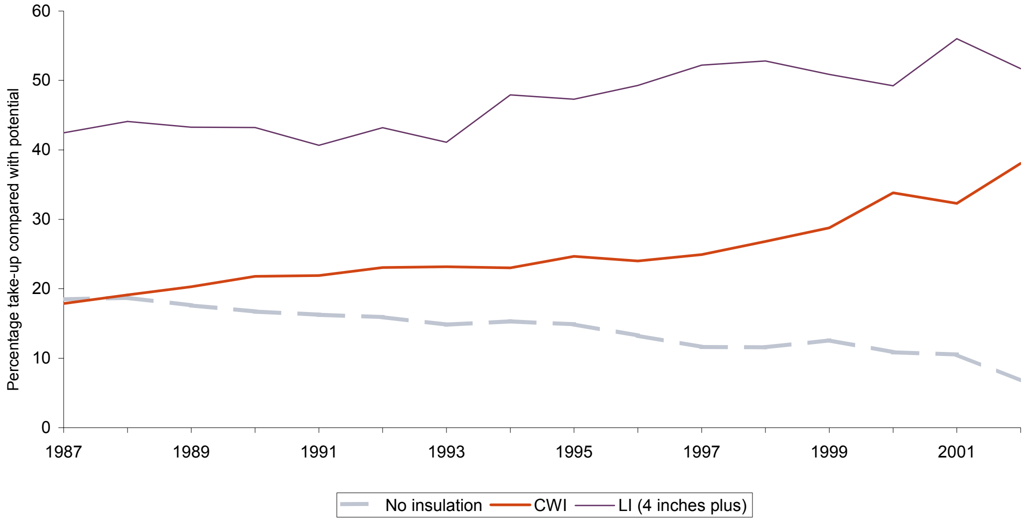
**Table 2.2 DTI historical and projected annual average energy-intensity reductions by sector (%)**

| | Residential[1] | Services | Transport | Industry |
|---|---|---|---|---|
| 1990–95 | 0.81 | 0.14 | 1.09 | 1.45 |
| 1995–2000 | 0.98 | 2.80 | 0.93 | 2.05 |
| 2000–05 | 3.19 | 3.34 | 1.56 | –0.73 |
| 2005–10 | 2.66 | 2.26 | 0.59 | 1.72 |

Note: [1] Energy use per unit of GDP not per household. Other sectors are shown as energy per unit of an index of sector output, and, for transport, GDP.
Source: DTI (2004), 'Updated Emissions Projections: Final Projections to inform the National Allocation Plan (NAP)', November.

Figure 2.3 shows the trend in the proportion of homes with differing types of thermal insulation—by 2002, more than 90% of the housing stock with the potential to install thermal insulation had installed some. It also shows that most homes could be improved further.

**Figure 2.3 Trend in the take-up of insulation measures, 1987–2002**



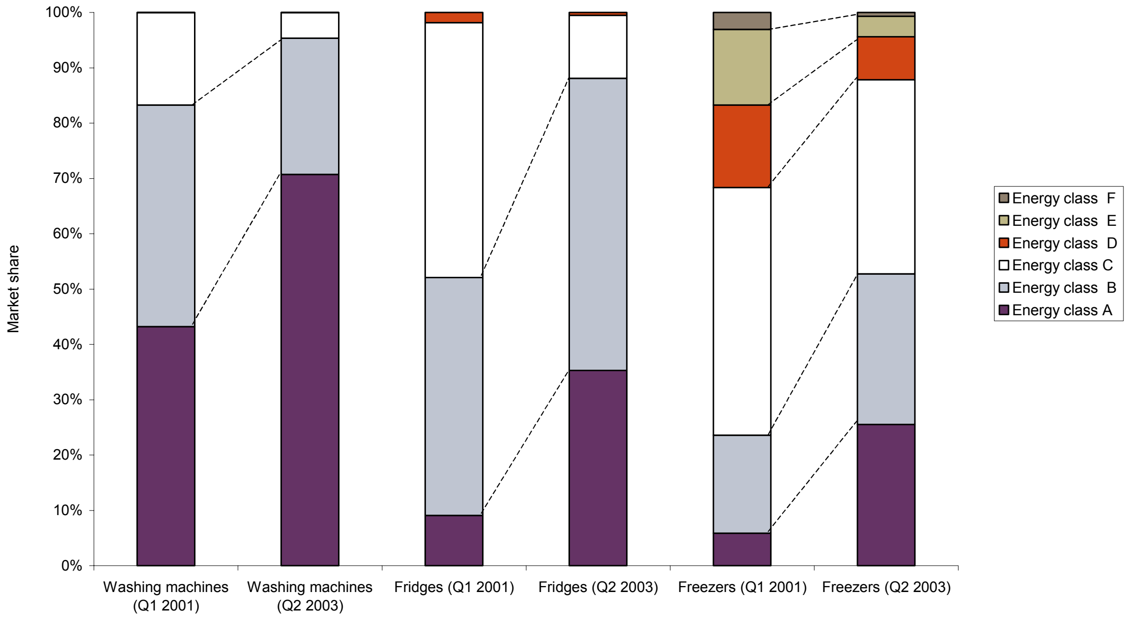

Source: BRE.

[4] DTI (2004), 'Updated Emissions Projections: Final projections to inform the National Allocation Plan (NAP)', November.

[5] Further information on energy trends and the distinction between changes in intensity and efficiency is available from the DTI (2005), 'UK Energy Sector Indicators 2005: A supplement to the Second annual report on the Energy White Paper "Our Energy Future—Creating a Low Carbon Economy"', available at www.dti.gov.uk/energy/inform/energy_indicators/indicators2005.pdf; and DTI (2005), 'Progress on the development of indicators', July, Joint Working Group on Energy and the Environment, available at www.dti.gov.uk/energy/environment/jwgee/ewp_2nd_annual_jwgee_report.pdf.

On appliances, data from market research organisation, GfK, indicates that the market share of appliances with energy ratings of ‘C’ and above has increased significantly in recent years. Figure 2.4 shows the change in the market share of washing machines, fridges and freezers by energy efficiency rating between Q1 2001 and Q2 2003. It illustrates the variation across appliances and the increases over time in the share of sales of more efficient models.

**Figure 2.4 Change in the mix of washing machines, fridges and freezers sold, by energy efficiency rating, Q1 2001–Q4 2003**




Source: GfK data.

The increased proportion of sales of relatively energy-efficient appliances means that the average energy efficiency of the stock of domestic appliances has been rising. However, the energy efficiency of the overall stock of household appliances will be significantly lower than that of the additions/replacements represented above.

# 3 Background briefing: UK energy efficiency policies

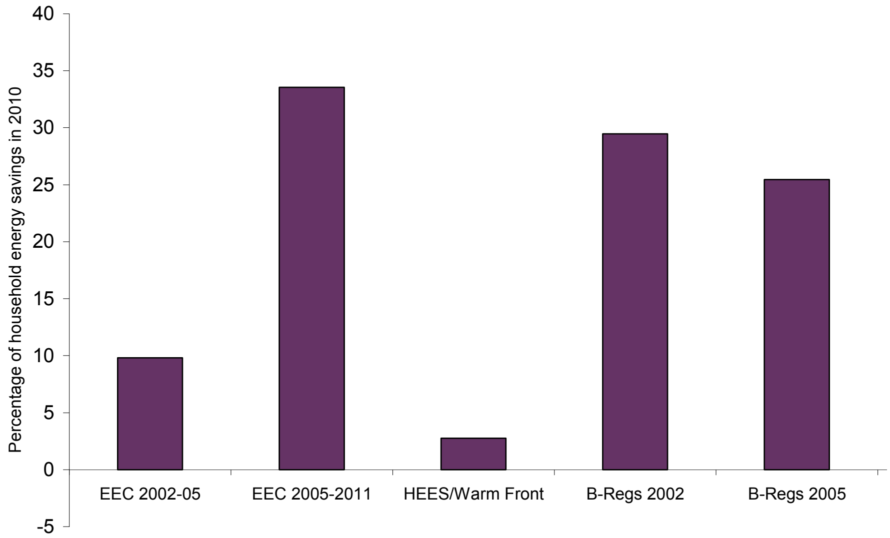
This section reviews a range of UK policies put in place in recent years to increase energy efficiency. Details of EU policies may be found in Appendix 1.

The UK Government has had an involvement in promoting energy efficiency since the mid-1970s and actively since the mid-1980s. The scale of the programmes run through energy suppliers has grown over the last ten years from around £30m per annum to £400m,[6] accompanied by public spending to tackle fuel poverty. Meanwhile, Building Regulations have become progressively tighter and have made an equal contribution to the supplier-led programmes. The focus of effort has been on the largest sources of savings (insulation and heating systems) and the fuel poor.[7] As a consequence, the performance of social housing stock will soon have been almost completely addressed, but there is a large remainder of private housing where further improvements remain. he household energy reduction measures contributing by 2010 are as follows:

- Energy Efficiency Commitment 2002–05 (EEC 2002–05);
- EEC 2005–08 and EEC 2008–11;
- Home Energy Efficiency Scheme/Warm Front;
- Building Regulations 2002;
- Building Regulations 2005;
- product policy and transformation of appliance and lighting markets;
- Community Energy, particularly addressing CHP (CE CHP).

The contribution to household energy reduction of each of these policies by 2010 is shown in Figure 3.1.

**Figure 3.1 Contribution of policies to household energy reductions, 2010**




Source: Defra data, as provided to the DTI for 'Updated Energy Projections 2004'.

[6] Defra (2004), 'The Energy Efficiency Commitment from April 2005: Consultation Proposals', partial regulatory impact assessment, Table 1, May.

[7] The Home Energy Efficiency Scheme addressed the fuel poor in social housing, while Warm Front addresses the same audience in private housing.

## 3.1 Building Regulations

In 2002, the Government introduced amendments to the Building Regulations. The main obligations on builders with respect to energy efficiency in dwellings (Regulations L1) were as follows:

– ‘reasonable provision’ to limit the loss of heat through the fabric of the building, hot water pipes, hot air ducts and hot water vessels;
– provision of energy-efficient space heating and hot water heating systems;
– provision of lighting systems with appropriate lamps, and, in the case of externally fitted lighting systems, sufficient controls, in order to ensure efficient energy use;
– provision of sufficient information for heating and hot water systems to ensure that occupiers can use those systems in an energy-efficient manner.

The 2002 Part L regulations also brought in regulations for replacement windows and boilers, which together are expected by the Government to save more carbon than the new-build measures above.

No monitoring of the Building Regulations 2002 has been carried out to date.[8] Moreover, a recent report by the Energy Saving Trust has raised serious issues concerning the level of compliance with Regulations Part F.[9] The report found that of 99 houses constructed according to 2002 Building Regulation standards, 32% failed to meet the recommended maximum air permeability level. There is also some anecdotal evidence of failure to comply with energy efficiency requirements. This level of non-compliance may be explained by a focus of inspections on the health and safety components of regulations.

A study on compliance with the energy labelling of new homes (ie, Standard Assessment Procedure, or SAP, ratings) found that 49 out of 50 sites visited did not display SAP ratings on unsold properties.[10] Furthermore, among the top five house builders in the UK, 74% of sales negotiators were unable to explain what the SAP is. Other sources have raised similar concerns about compliance.[11]

Following the Energy Performance of Buildings Directive (2002), further regulations are due to take effect in 2005. For example, from April 1st 2005, all boilers installed (ie, in new residential buildings or as replacement boilers) must be condensing boilers with A or B efficiency ratings.

In 2010 and 2015, it is expected that the Buildings Regulations will be updated further. The measures and standards sanctioned in these updates are currently unknown. However, as part of this study, BRE has modelled a series of potential measures (see section 6.7).

## 3.2 Supplier-led measures

This section examines measures in chronological order of their implementation.

[8] Defra (2005), ‘Evaluation of the Government’s Energy Efficiency Policies and Measures’, report by Future Energy Solutions and the Policy Studies Institute.

[9] Brown/Energy Saving Trust (2004), ‘Assessment of Energy Efficiency Impact of Building Regulations Compliance’, report prepared on behalf of BRE.

[10] Devine-Wright, P. and Lomas, K. (2003), ‘Selling the SAP: a Research Study into the Display of Energy Ratings in Private Sector New Homes’, National Energy Services and De Montfort University.

[11] See, for example, Warren, A. (2004), ‘Time is running out for UK buildings MOT’, EIBI, October; and (2004), ‘New homes, yet the same old standards of energy efficiency’, EIBI, January.

### 3.2.1 Energy Efficiency Standards of Performance

Between 1994 and 2000, the Office of Electricity Regulation (Offer), and its successor, the Office of Gas and Electricity Markets (Ofgem), placed obligations on energy suppliers to achieve reductions in energy consumption among domestic consumers. This increased electricity bills initially by around £25m per year, which allowed electricity companies to fund energy efficiency projects, including the installation of energy-efficient light bulbs and insulation.

The energy savings from Energy Efficiency Standards of Performance (EESOP) 1 and 2 have been audited and are summarised in Table 3.1, although it is not clear whether these savings were in excess of business as usual (in contrast with the reporting of savings for EEC). Only part of the costs of these energy-saving investments were borne by public electricity suppliers (PESs). The National Audit Office found that only 20% of the costs of the scheme were carried by customers participating directly in the scheme, with the rest falling on the customers of the suppliers as a whole.

**Table 3.1 Energy savings achieved as a result of the EESOP schemes**

| Scheme | Lifetime discounted accredited energy savings of the measures installed (TWh)[1] | Total cost (£m)[2] | Cost per kWh saved (p/KWh)[3] |
|---|---|---|---|
| EESOP 1 (1994–98) | 6.8 | 133.1 | 1.65 |
| EESOP 2 (1998–2000) | 3.3 | 59.6 | 1.60 |

Note: [1] These are the energy savings attributable to the PESs discounted over the lifetime of the measures installed—in the case of insulation, this may be as long as 40 years. [2] Includes funding from all parties.[3] An approximate figure based on the discounted lifetime savings of measures installed in the first year of the scheme—not all of the savings will be attributed to the PESs.
*Source*: National Audit Office, Energy Saving Trust, and Ofgem.

### 3.2.2 EEC 2002–05 and EEC 2005–08

In 2002, EESOP was transformed into the Energy Efficiency Commitment (EEC), now the principal policy mechanism driving increases in the energy efficiency of existing homes.

Under EEC 2002–05, a total of 62TWh of energy savings (lifetime-discounted fuel-standardised) were projected at a proposed cost of £3.60 per customer per annum for each of gas and electricity (in 2000 prices). EEC 2002–05 allowed electricity and gas suppliers to place surcharges on domestic energy bills (relative to bills in the absence of the EEC) to fund energy efficiency measures. Simultaneously, the companies were obliged to achieve set energy efficiency targets. 50% of their energy savings had to come from Priority Group households (those receiving certain income-related benefits and tax credits), thus helping to deliver an equitable distribution of benefits.

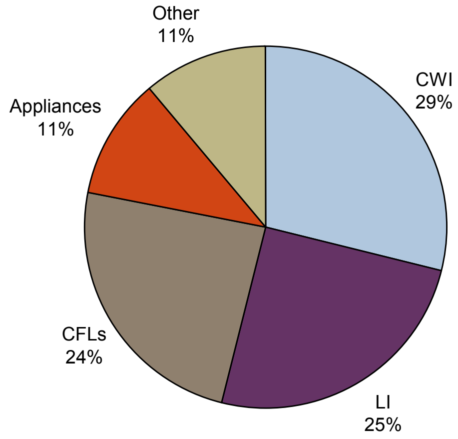
According to Defra, between 2002 and 2004, the overall cost-effectiveness of EEC was a saving of £150/tC.[12] Figure 3.2 below shows the illustrative[13] mix of the main energy-saving measures. The total investment was estimated at £276m, of which £154m was funded through EEC by increases in consumers' electricity and gas bills.[14]

[12] Defra (2004), 'Energy Efficiency: The Government's Plan for Action', p. 21.

[13] The mix of measures undertaken by suppliers may turn out to be different in reality.

[14] Defra (2001), 'Energy Efficiency Commitment 2002–05: Illustrative Mix of Possible Measures', Tables 1 and 2. EEC 2002–05 results are presented in Ofgem (2005), 'A review of the Energy Efficiency Commitment 2002–2005: A report for the Secretary of State for Environment, Food and Rural Affairs', August, www.ofgem.gov.uk/temp/ofgem/cache/cmsattach/12015_18105.pdf.

**Figure 3.2 Energy efficiency savings (illustrative) under the EEC 2002–05**

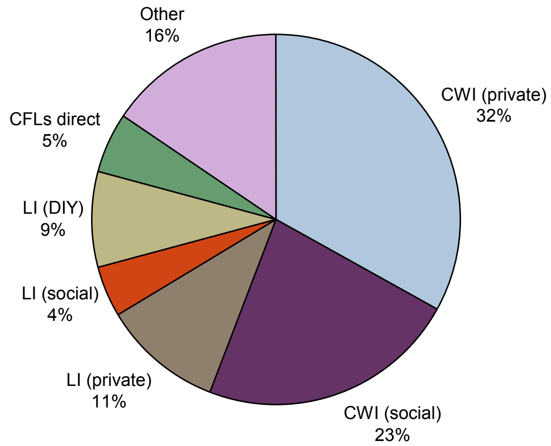



Note: CFLs, compact fluorescent lamps.
Source: Ofgem (2005), 'A Review of the Energy Efficiency Commitment, 2002–2005', August.

By December 2004, energy suppliers had surpassed the overall targets set under EEC 2002–05. Cumulative savings of 70TWh had been achieved, of which 33TWh were in the 'Priority Group' of low-income households. Although, as a proportion of total energy savings, this was below the 50% target, it still surpassed the original target in absolute terms.[15]

EEC 2005–08 has a target of 122TWh[16] in energy efficiency improvements (fuel-standardised, lifetime-discounted equivalent). Figure 3.3 gives a breakdown of the targets under EEC 2005–08, showing an illustrative mix of measures, as developed by Defra.

**Figure 3.3 Breakdown of basis targets (illustrative) under EEC 2005–08**




Source: Defra (2005), 'Energy Efficiency Commitment 2005–08. Background Information on the Illustrative Mix'.

Table 3.2 below provides a comparison of the costs and effectiveness of the two EEC programmes. Any increase in the cost per kWh of energy saved is likely to reflect both the increased scale of EEC 2005–08 compared with EEC 2002–05 and the likelihood that the

[15] Defra (2005), 'Evaluation of the Government's Energy Efficiency Policies and Measures', report by Future Energy Solutions and the Policy Studies Institute.

[16] The 'headline' energy efficiency targets under EEC 2002–05 and EEC 2005–08 cannot be compared directly because the assumptions used to calculate the projected energy efficiency savings differ in terms of both the achievable energy efficiency savings per installation (for a range of measures) and the discount rate used, which was reduced from 6% in the first case to 3.5% in the second.

first measures to be taken up under EEC 2002–05 will have been the cheapest, thereby leaving more expensive measures still to be taken up.

**Table 3.2 Comparison of costs of EEC 2002–05 and EEC 2005–08**

| | EEC 2002–05 illustrative mix[1] | EEC 2005–08 illustrative mix |
|---|---|---|
| Cost per customer (£) | 4.0 | 9.0 |
| Total cost (£m) | 535 | 1,250 |
| Cost-effectiveness (p/kWh) | 0.94 | 1.05 |

Note: [1] The EEC 2002–05 figures cannot be directly compared with the EEC 2005–08 figures, as the units of energy savings have changed. Both sets of figures are in 2004 prices
Source: Energy Saving Trust (2005), 'Energy Saving Commitment 2005–08. Briefing Note', and Defra (2004), 'Comparing the Energy Efficiency Commitment (EEC) 2002–05 with EEC 2005–08'.

## 3.3 Government-led initiatives

### 3.3.1 Home Energy Efficiency Scheme/Warm Front and other initiatives

Operating in parallel with EEC, there is a range of programmes directed specifically at fuel poverty, including the Home Energy Efficiency Scheme (HEES) and Warm Front. The Warm Front grant scheme has been introduced in England only. Initially, it was estimated that these programmes would save between 0.2 and 0.3MtC per annum by 2010. This has since been revised to around 0.3–0.5MtC per annum by 2010.[17]

The number of installations under the Warm Front programme was approximately 60,000 CWI, 70,000 LI and 120,000 others per annum.[18] By 2004, the Government had devoted around £1.2 billion to the HEES, about half of which was spent before 2000.

The Decent Homes programme was set up to ensure that all social homes are warm, dry and have reasonably modern facilities by 2010, thereby saving a further 0.03–0.04MtC per annum.[19] However, there is likely to be considerable overlap with EEC, so these savings may not be net of EEC savings.

### 3.3.2 Energy Matters programme

The Energy Matters programme was set up in June 1999 to encourage awareness of energy conservation in schools, and interest in energy efficiency measures among children and parents. The programme provided training and support for teachers through local 'Energy Educators', as well as educational materials and teaching packs. In particular, the 'Home Energy Resource' teaching pack was designed to fit into the National Curriculum at Key Stages 2 and 3 (7–14-year olds).

## 3.4 Questions arising

The questions now apparent are whether EEC and Warm Front can be extended; what can be achieved through future updates of Building Regulations in 2010 and 2015; and whether to seek further tightening of EU standards on appliances and lighting, or to pursue alternative policies.

[17] New Perspectives and NFO Utilities (2003), 'Energy Matters Home Energy Resource: Its Effects on Energy Efficiency in the Home', draft paper prepared for the Centre for Sustainable Energy.
[18] Defra (2003), 'Warm Front Annual Report, 2003'.
[19] Ibid.

# 4 Evidence review: literature on consumer behaviour

There is a useful branch of economic literature analysing the take-up of energy efficiency measures. It explores theoretical ideas on how consumers make choices and empirical evidence on how energy efficiency investment choices are made. Through this literature, existing data sources were revealed, plausible explanations of consumer behaviour were noted, possible policies identified, and methods for collecting and analysing empirical evidence were found. This work informed the design of the survey and of the policy evaluation models.

## 4.1 The energy efficiency gap

This section reviews the economic literature on the 'energy efficiency gap', which is loosely defined as the divergence between the social optimum and the actual level of investment in energy efficiency. There are two striking features of this literature. First, the energy efficiency gap is not new; it has been defined, discussed, analysed and debated at length for the last three decades.[20] Second, while theories have been proposed to explain why an energy efficiency gap exists, there is little empirical evidence that explicitly favours one theory over another.[21] This is the principal reason for carrying out fieldwork within this study.

The literature on the energy efficiency gap must address the fact that consumers do not appear to invest to a level that would be *privately* optimal. Much of the literature, such as early work by Gates,[22] considers why households or firms do not adopt energy efficiency measures that appear to be in their own best interests. Jaffe & Stavins[23] argue that different definitions of the social optimum are implicitly employed in the literature:

– economists' economic potential—the level of energy efficiency if failures in the market for energy efficiency were eliminated;

– technologists' economic potential—as above, but also eliminating market barriers other than market failure, such as uncertainty;

– hypothetical potential—the level of energy efficiency based on no barriers and perfectly functioning energy markets (not just energy efficiency markets);

– narrow social optimum—based on eliminating barriers only when this passes a cost–benefit analysis;

– true social optimum—as above, but also internalising environmental externalities.

These definitions are illustrated in Figure 4.1 below.

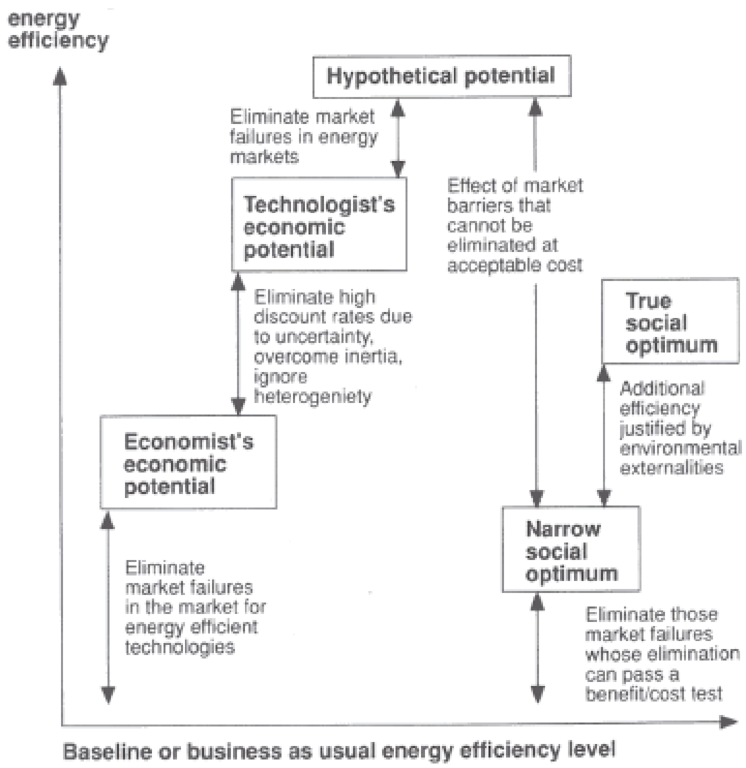
[20] Scheraga, J. D. (1994), 'Energy and the environment. Something new under the sun?', *Energy Policy*, **22**, 798–803.

[21] Huntington, H., Schipper, L. and Sanstad, A. H. (1994), 'Editors' Introduction', *Energy Policy*, **22**, 795–886.

[22] Gates, R. (1983), 'Investing in energy conservation: are homeowners passing up high yields', *Energy Policy*, **11**, 63–71.

[23] Jaffe, A. B. and Stavins R. N. (1994), 'The energy efficiency gap, what does it mean?', *Energy Policy*, **22**, 804–10.

**Figure 4.1 Definitions of the energy efficiency gap**




Source: Jaffe & Stavins (1994).

Based on a comparison between rates of return on a range of energy efficiency investments (thermostat control, weatherstripping and caulking, CWI and LI, etc) and returns on the stock market, Gates (1983) concludes that 'conserving energy may be one of the most profitable actions a homeowner can take'. This paper reached the conclusion, 21 years ago, that:

> barriers exist which inhibit investment in conservation: it is perceived as risky and the cost of obtaining reliable information is high.

Although there are some dissenting voices,[24] the conclusion of DeCanio & Watkins (1998) is that a:

> sizable technical and scholarly literature presents an imposing body of evidence that the typical rate of return available from energy efficiency investments is much higher than the discount rate for projects of comparable risk.[25]

There are four hypotheses for the gap: adverse selection, transaction costs, bounded rationality, high discount rates, as described below.

[24] Ingham, A., Maw, J. W. and Ulph, A. (1991), 'Testing for barriers to energy conservation—an application of a vintage model', *Energy Journal*, **12**, 41–64. The authors are unable to find evidence of significant barriers to energy conservation in the UK manufacturing sector, although they point out the limited nature of the tests they conducted.

[25] DeCanio, S. J. and Watkins, W. E. (1998), 'Investment in energy efficiency: do the characteristics of firms matter?', *Review of Economics and Statistics*, **80**, 95–107; DeCanio, S. J. (1993), 'Barriers within firms to energy-efficient investments', *Energy Policy*, **21**, 906–15.

## 4.2 Hypotheses for the gap

A large body of peer-reviewed literature supports the claim that consumers are poorly informed about the variables relevant to their energy decisions.[26] For instance, one study found that consumers' estimates of the price they paid per kWh of electricity varied by up to an order of magnitude from the actual price. The authors question, however, whether the simple provision of factual information is adequate to enable consumers to make 'substantively rational' decisions.

Given this relative unawareness, it is not surprising that information programmes appear to be an effective policy instrument, as confirmed by various studies.[27] One study in Norway found that shifting from annual to bimonthly meter readings yielded an 8% reduction in energy use. A similar study in Finland yielded a 5% savings. An earlier study found that providing daily feedback on household electricity consumption resulted in a 10.5% reduction in energy use.[28] At the extreme, energy use reduced by 13% when meters indicating the consumption of each appliance were provided to households.[29]

Less detailed information provision is also effective—energy efficiency in home appliances was more responsive to energy prices after energy efficiency product labelling was required.[30] Similarly, an information campaign by the Irish Electricity Supply Board in 1990 (which included leaflets in electricity bills, certifications for appliances, advertisements in DIY journals, etc) led to a 7% reduction in electricity demand.[31]

If providing information to consumers on appliance performance is expensive, problems of **adverse selection** may arise.[32] If it is impossible for consumers to distinguish between high- and low-performance equipment, the market for the high-performance equipment will break down. Energy efficiency labelling schemes may have gone a long way towards solving this problem.

A further aspect of the information problem is tenure—the failure of both rental values and house prices to reflect energy efficiency performance. Hawken et al (1999) argue that adoption of energy efficiency is particularly problematic in rental properties where it is difficult for the landlord to recoup the value of the investment from tenants.[33] Even when energy costs are included in the rent, although landlords now have an incentive to invest, tenants have no incentive at the margin to conserve energy. This is a manifestation of the 'principal–agent' problem in economics.[34] Indeed, using the American Housing Survey and the Residential

[26] Sanstad, A. H. and Howarth, R. B. (1994), '"Normal" markets, market imperfections and energy efficiency', *Energy Policy*, **22**, 811–818; (1995), 'Discount rates and energy efficiency', *Contemporary Economic Policy*, **13**, 101–09.

[27] Kempton, W. and Layne, L. L. (1994), 'The consumer's energy analysis environment', *Energy Policy*, **22**, 857–66.

[28] Studies referred to in Seligman, C., Darley, J. M. and Becker, L. J. (1978), 'Behavioural approaches to residential energy consumption', pp. 231–54, in R. Socolow (ed), *Saving energy in the home: Princeton's experiments at Twin Rivers*, Cambridge MA: Ballinger.

[29] See Kempton and Layne (1994), op. cit.

[30] Newell, R., Jaffe, A. B. and Stavins, R. N. (1999), 'The induced innovation hypothesis and energy-saving technological change', *Quarterly Journal of Economics*, **114**, 941–75.

[31] Dulleck, U. and Kaufmann, S. (2004), 'Do customer information programs reduce household electricity demand?—the Irish program', *Energy Policy*, **32**, 1025–32.

[32] Sanstad and Howarth (1994), op. cit; Akerlof, G. A. (1970), 'The market for "lemons": Quality uncertainty and the market mechanism', *Quarterly Journal of Economics*, **84**, 488–500.

[33] Hawken, P., Lovins, A. B. and Lovins, L. H. (1999), *Natural capitalism: the next industrial revolution*, Earthscan Publications.

[34] DeCanio argues that similar principal–agent problems within firms are stalling investment in energy efficiency—differential incentives between different levels of management prevent profitable energy conservation: DeCanio (1993), op. cit; DeCanio, S. J. (1994), 'Agency and control problems in US corporations: the case of energy-efficient investment projects', *Journal of the Economics of Business*, **1**, 105–24; DeCanio, S. J. (1994), 'Why do profitable energy-saving investment projects languish?', *Journal of General Management*, **20**, 61; DeCanio, S. J. (1998), 'The efficiency paradox: bureaucratic and organizational barriers to profitable energy-saving investments', *Energy Policy*, **26**.

Energy Consumption Survey, Levinson & Niemann (2004) show that when energy costs are included in the rent, tenants set their thermostats between 1 and 3°F higher during the winter, or the equivalent of a 0.5–0.75% increase in energy expenditure.[35] Interestingly, the rent differential between energy-inclusive and metered (ie, non-energy-inclusive) rent agreements is significantly less than the cost of this extra fuel use.

Similar problems apply where homeowners expect to sell their home before the returns from the energy-efficient investment cover the initial outlay. In theory, with full information, the value of these investments should be incorporated into the sale price (or, indeed, rental rates) accordingly. However, information problems are likely to be present. If sellers cannot credibly represent the energy-conserving features of the property to potential buyers, the sale price will not fully reflect efficiency attributes.[36]

**Transaction costs** include the time taken to find, evaluate and apply information about energy-efficient equipment; the costs of negotiating with potential suppliers; the costs of taking on risk when reaching decisions; enforcing agreements; and other costs associated with the process of purchasing and installing the equipment.[37] Howarth & Sanstad (1994) argue that other hidden costs, or 'indivisible private costs'—such as the 'hassle' of having energy-efficient equipment installed—are important and should be distinguished from transaction costs that are measurable and easier to price.[38] Hidden costs might be thought of as direct reductions in utility, rather than costs that have an impact on consumers' finances (and therefore also indirectly on their utility). The rationale for separating these costs from transaction costs might be challenged, but separate budget constraints may apply to financial and time resources.

Calculating the 'optimal' quantity of energy efficiency for a specific household is relatively complex, so the cognitive costs of performing that optimisation are high. As such, many consumers will base their decisions on simple rules of thumb, which reduce cognitive load. This is known as **bounded rationality**.[39] For instance, Kempton & Montgomery (1982) find that even consumers who understand technical energy measurements make systematic errors (underestimates) in quantifying the benefits of energy conservation.[40]

It might therefore be concluded from the above findings that, even if consumers are provided with technically correct information, and are sophisticated enough to understand it, they may still under-invest in energy efficiency. Potentially useful cognitive models of consumer decision-making on energy efficiency are presented by Yates & Aronson (1983), Friedman & Hausker (1988), and Howard & Andersson (1993).[41]

There is evidence that consumers require short pay-back times for energy efficiency investments that may not be due to information failures in the property market, but may instead be due to **high discount rates** (impatience). Individuals appear to have high implicit discount rates (around 20%) in making trade-offs between capital costs and expected

[35] Levinson, A. and Niemann, S. (2004), 'Energy use by apartment tenants when landlords pay for utilities', *Resource and Energy Economics*, **26**, 51–75.

[36] Jaffe, A. B. and Stavins, R. N. (1994), 'Energy efficiency investments and public policy', *Energy Journal*, **15**, 43–65.

[37] Sorrell, S., Schleich, J., Scott, S., O'Malley, E., Trace, F., Boede, U., Ostertag, K. and Radgen, P. (2000), 'Barriers to energy efficiency in public and private organisations', Science and Technology Policy Research.

[38] Howarth, R. B. and Sanstad, A. H. (1994), 'Energy efficiency investments and public policy', *Energy Journal*, **15**, 43–65.

[39] A useful summary of this literature is provided by Sorrell, S. et al (2000), op. cit.

[40] Kempton, W. and Montgomery, L. (1982), 'Folk quantification of energy', *Energy*, **7**, 817–27.

[41] Yates, S. and Aronson, E. (1983), 'A social psychological perspective on energy consumption in residential buildings', *American Psychologist*, April, 435–44. Friedman, L. S. and Hausker, K. (1988), 'Residential energy consumption: models of consumer behaviour and their implications for rate design', *Journal of Consumer Policy*, **11**, 287–313. Howard, R. B. and Andersson, B. (1993), 'Market barriers to energy efficiency', *Energy Economics*, **15**.

operating costs.[42] The implicit discount rate appears to vary inversely with income—richer households appear to behave more patiently. This might be because poorer households frequently pay higher rates of interest on their debt, or may be subject to credit rationing, making it rational to employ very high discount rates.

However, the vast majority of the literature challenges the conclusion that high discount rates are the root of the problem. Metcalf (1994) argues that various factors—in particular, option values—explain why the rates of return required by consumers from energy efficiency investments might exceed market interest rates.[43] Similarly, Hassett & Metcalf (1993) argue that apparently high discount rates arise from the recognition that energy conservation investments involve sunk capital costs with uncertainty about future savings.[44] Their simulations suggest that the appropriate hurdle rate for such an investment is four times the standard rate.

Likewise, van Soest & Bulte (2001) argue that since investment in energy efficiency technologies is partly irreversible, it may be beneficial to postpone investment until newer and better technologies become available.[45] The option value of waiting plays some part in explaining the energy efficiency gap. Similarly, Howarth & Sanstad (1995) argue that high discount rates are masking other effects, but they consider features other than the option value of waiting to be important—namely, asymmetric information, bounded rationality and transaction costs.[46] According to Kooreman (1995), risk is likely to be the source of the problem—if the lifetime of energy-using durables is random, ignoring the randomness biases the estimated discount rates upwards by as much as 35% for risk-neutral consumers.[47]

In sum, the high discount rates required by consumers for energy efficiency investments either reflect real opportunity costs,[48] in which case such discount rates are appropriate, or are symptomatic of other barriers to investment in energy efficiency, in which case the focus should be on these other barriers, not on discount rates.

## 4.3 Summary

The literature review has revealed an ongoing discussion about the reasons why consumers do not install energy efficiency measures, which, on the face of it, appear to be rational, cost-effective investments. The debate is mostly theoretical (rather than evidence-based), but offers a helpful classification into four factors; adverse selection, transaction costs, bounded rationality and high discount rates. The testing of these factors through empirical studies is surprisingly absent. Several authors transfer the findings of studies on discount rates from other areas to energy efficiency, to suggest that it is the root cause, but there is little proof.

The literature provides good arguments why several factors might make households reluctant to adopt energy efficiency measures. They are poor information, transaction costs, and the way in which costs and benefits are weighed up. The evidence gathering, through

[42] Hausman, J. A. (1979), 'Individual discount rates and the purchase and utilization of energy-using durables', *Bell Journal of Economics*, **10**, 33–54.

[43] Metcalf, G. E. (1994), 'Economics and rational conservation policy', *Energy Policy*, **22**, 819–25.

[44] Hassett, K. and Metcalf, G. E. (1993), 'Energy conservation investment: do consumers discount the future correctly?', *Energy Policy*, **21**, 710–16.

[45] van Soest, D. P. and Bulte, E. H. (2001), 'Does the energy efficiency paradox exist? Technological progress and uncertainty', *Environmental and Resource Economics*, **18**, 101–12.

[46] Howarth, R. B. and Sanstad, A. H. (1995), 'Discount rates and energy efficiency', *Contemporary Economic Policy*, **13**, 101–09.

[47] Kooreman, P. (1995), 'Individual discounting and the purchase of durables with random lifetimes', *Economics Letters*, **48**, 29–32.

[48] Sutherland, R. J. (1991), 'Market barriers to energy-efficient investments', *Energy Journal*, **12**, 15–34.

the survey, tried to pin these factors down in a way that enabled take-up behaviour to be modelled. It found evidence against the high discount rate hypothesis in most cases.

# 5 Evidence review: evidence gathered in this study

This section describes the gathering and analysis of evidence in this study, through a survey of homeowners, and the results obtained by it. The survey methodology is first outlined, followed by a summary of the key statistical findings. This covers householders' understanding of energy efficiency and insulation, lighting and appliances, and the factors driving their purchasing behaviour. All the statistics that describe behaviour are contained here and many of the policy-relevant conclusions are reached in the section. A sub-set of the statistical results is then taken forward into the next section, where they are used in the construction of the policy models.

## 5.1 Evidence gathering

To understand more about how consumers make decisions on energy efficiency measures, a survey was designed in conjunction with the School of Economics at the University of East Anglia and fieldwork was commissioned from Taylor Nelson Sofres (TNS). The full version of the survey is presented in Appendix 4.

Having piloted an initial draft survey in 30 households, the final survey, which was completed by 1,069 respondents, assessed the factors affecting their decisions to purchase LI or CWI, fridge-freezers, televisions and light bulbs. The design of the survey ensured that two of the most common techniques associated with the collection of discrete-choice data were used:

– *revealed-preference analysis*—designed to collect information about individuals' decisions when making purchases in relation to their preferences towards energy efficiency and;

– *stated-preference analysis*—designed to collect information about respondents' perception of the relative importance of particular attributes associated with energy-efficient items. Respondents were asked to choose between goods with various attributes, including price and energy consumption.

Statistical analysis on the survey responses was undertaken through the estimation of econometric models.[49] For all energy-efficient items, apart from light bulbs, the econometric models were estimated using a model that maximised the likelihood of a choice of goods, given certain characteristics of the goods under consideration and the individual making the choice (known as maximum likelihood estimation). In this case, a conditional 'logit model' framework was used, which allows estimation in situations where each respondent makes several choices for each stated-preference question they answer.

During estimation of the econometric models, the following factors were identified as having the potential to introduce some level of bias to the results of the modelling.

– *Perception gap*—respondents may not have accurate knowledge of the cost and the associated benefits of an energy-saving measure, such as CWI or LI. As a consequence, respondents may not choose to install either form of insulation as they

[49] The use of econometrics allows the statistical significance of factors influencing the respondent's choice to be tested. For all energy-efficient items, variations on the standard McFadden choice model were employed. These models predict the probability that an individual will purchase an energy-efficient item, considering the attributes of the item and the demographics associated with each respondent, as well as their attitudes towards energy efficiency.

incorrectly perceive the costs to be too high. This may have a disproportionate impact on the response of low-income households.

– *Self-selection bias*—respondents who have already installed either CWI or LI will have a more accurate knowledge of the 'true' costs and benefits. Their previous experience may bias their response, such that they state lower (and more accurate) estimates of costs than the group with no experience (in whom this study is more interested).

– *Hypothetical payment bias*—academic studies have shown that stated-preference analysis may overestimate the probability of take-up, and respondents' actual behaviour may be different to their stated hypothetical behaviour.

The perception gap and hypothetical payment bias are explicitly controlled for in the modelling exercise (see Appendix 6). The main results of the above analysis are presented below.

## 5.2 Analysis: insulation

### 5.2.1 The perception gap

The data was analysed to identify the respondents' knowledge of insulation products, and to identify any 'perception gap'—ie, the difference between the actual cost of installing CWI or LI and respondents' perceptions of this cost.

For the costs of each of CWI and LI, the population was divided into three groups, according to the size of the difference between the perceived cost and the actual cost:

– *pessimistic*: perceived cost is equal to or greater than 150% of the actual cost;
– *informed*: perceived cost is between 50% and 150% of the actual cost;
– *optimistic*: perceived cost is equal to or less than 50% of the actual cost.

For the benefits from CWI and LI, the population was divided along similar lines:

– *optimistic*: perceived benefit is equal to or greater than 150% of the actual benefit.
– *informed*: perceived benefit is between 50% and 150% of the actual benefit.
– *pessimistic*: perceived benefit is equal to or less than 50% of the actual benefit.[50]

Tables 5.1 and 5.2 below show the proportions of the population who are, respectively, pessimistic, informed and optimistic about the costs and benefits of installed LI and CWI. The shaded cells indicate those consumers who are either uninformed or pessimistic about either one of the costs or benefits of LI or CWI.

[50] Representative figures were used for the installation costs and energy savings. The ±50% definition of 'informed' consumers is intended to reflect the range of both estimates.

**Table 5.1 Breakdown of population according to knowledge of the costs and benefits of installing LI (%)**

| | | Benefits | | | | |
|---|---|---|---|---|---|---|
| | | Pessimistic | Informed | Optimistic | Don't know | Sub-total |
| Costs | Pessimistic | 4.7 | 8.9 | 6.9 | 4.7 | **25.2** |
| | Informed | 7.8 | 8.7 | 3.1 | 5.4 | **25.0** |
| | Optimistic | 2.9 | 3.5 | 0.7 | 2.1 | **9.2** |
| | Don't know | 3.5 | 4.1 | 2.1 | 30.8 | **40.5** |
| | Sub-total | **18.9** | **25.2** | **12.8** | **43.0** | **100** |

Source: Oxera calculations.

**Table 5.2 Breakdown of population according to knowledge of the costs and benefits of installing CWI (%)**

| | | Benefits | | | | |
|---|---|---|---|---|---|---|
| | | Pessimistic | Informed | Optimistic | Don't know | Sub-total |
| Costs | Pessimistic | 2.8 | 11.3 | 11.5 | 7.1 | **32.7** |
| | Informed | 3.6 | 6.6 | 3.3 | 3.7 | **17.2** |
| | Optimistic | 0.5 | 1.4 | 0.4 | 1.2 | **3.5** |
| | Don't know | 2.0 | 4.9 | 4.8 | 34.9 | **46.6** |
| | Sub-total | **8.9** | **24.2** | **20.0** | **46.9** | **100** |

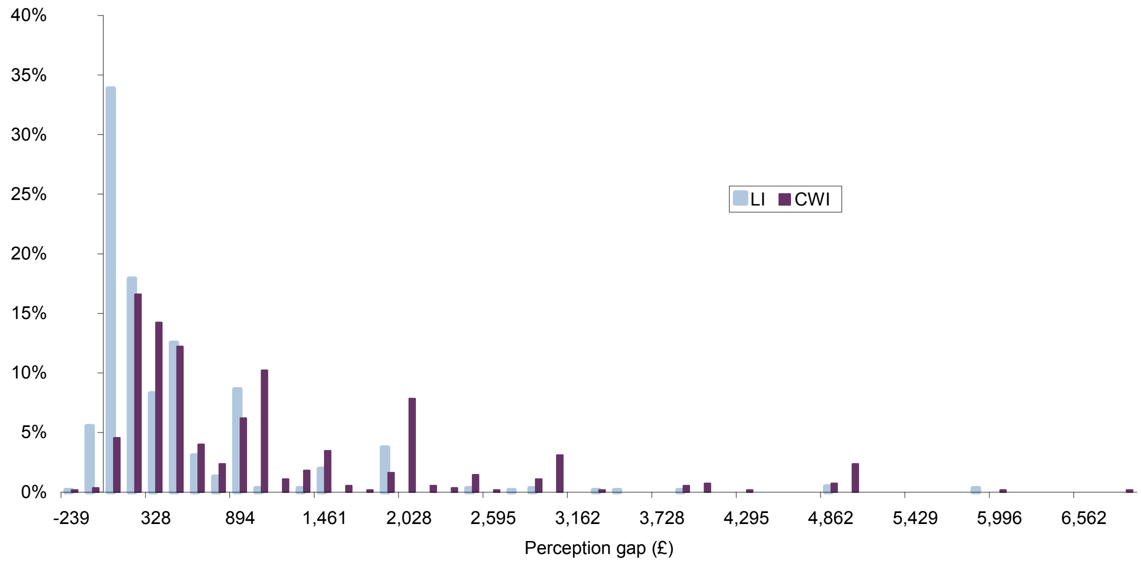
Source: Oxera calculations.

From both these tables, it is apparent that a major factor affecting the ability of consumers to make decisions on the take-up of LI or CWI is a lack of knowledge about the costs and benefits. Looking at the unshaded cells in Table 5.1, only 16% of consumers appear to have sufficiently accurate or optimistic information to enable them to make a *rational* decision on the take-up of LI. The proportion for CWI is only 12%. Between 25% and 50% of the sample 'don't know' and the remainder are mainly pessimistic, particularly about the benefits.

Figure 5.1 shows a graphical representation of the distribution of the perception gap among respondents for LI and CWI. The actual costs of installing insulation measures (in the absence of EEC subsidies) vary between £265 for a flat and £550 for a detached house for CWI and between around £250 for a flat and £360 for LI.[51] However, many people believe the costs to be more than £500 and even £1,000 higher than the actual costs. The figure shows as zero on the horizontal axis those people whose perception of installation costs exactly matches the actual average installation cost, and as £500 those people whose expectation is £500 higher than the actual average. The vertical axis shows the proportion of the sample population at each level of the perception gap.

[51] Energy Saving Trust (2005), 'Domestic Energy Efficiency Primer', February.

**Figure 5.1 Distribution of the perception gap, LI and CWI**




Note: Comparison of perceived retail prices (not controlling for quality of lighting).
Source: Oxera calculations.

### 5.2.2 Discount rates

The discount rates can be estimated as the coefficient on costs, divided by the coefficient on savings. These coefficients appear in the take-up equation that is estimated statistically from the survey responses. The equation explains how likely a respondent is to take up a measure as a function of a number of variables, including the cost of the measure and the annual savings resulting from it. The ratio of the coefficients on these two variables is the rate at which a respondent exchanges costs now for savings later, and is easily converted into a discount rate.

In general, the coefficient on savings was at least an order of magnitude smaller than that on costs. This implies that up-front costs are generally a *much* more important determinant in consumers' decisions to take up LI or CWI than are the benefits. However, it also means that the fraction through which the discount rate is calculated is ill conditioned: small errors in the coefficient on savings are amplified into large errors in the estimated discount factor.

It has only been possible to calculate a discount rate for LI. This is because the coefficient on savings for CWI was not statistically significant (nor influential). For LI, while the coefficient on savings was statistically significant at 5%, its magnitude was small, implying that savings are not particularly influential with respect to the take-up of LI. The discount rate on LI was estimated to be 41%. This is in line with estimates of similar discount factors/internal rates of return in a study on household investment in energy efficiency measures.[52]

### 5.2.3 Disruption

Table 5.3 shows respondents' perceptions of the disruption caused by the installation of LI and CWI, represented by the length of time required for the installation of either of these measures. Most people (represented by the median) have expectations that CWI takes between half and one day to install, and loft insulation a similar length of time (depending on

[52] Hausman (1979), op. cit. The author estimated a discount rate of 20%. See, also, Laquatra, J. (1987), 'Valuation of Household Investment in Energy-Efficient Design', in W. Kempton and M. Neiman (eds), 'Energy Efficiency: Perspectives on Individual Behaviour', American Council for an Energy-efficient Economy.

the amount of unpacking and repacking of the loft, and removal and refitting of flooring), but a sizeable majority have very pessimistic expectations of installation times. No set of actual installation times has been obtained for comparison.

**Table 5.3 Perceived length of time to install loft and cavity wall insulation**

| | LI | CWI |
|---|---|---|
| Mean | 1.41 days | 2.10 days |
| Median | 1 day | 1 day |
| Minimum | 0 days | 0 days |
| Maximum | 20 days | 96 days |
| Percentage of don't knows | 13.38% | 13.38% |

Source: TNS and Oxera calculations.

Furthermore, using the results of the regressions, it has been possible to calculate valuations for the above factors, as shown in Table 5.4.

**Table 5.4 Estimates of the monetary valuations of disruption costs**

| | Value for LI (£) | Value for CWI (£) |
|---|---|---|
| Average disruption cost | 47 | 68 |

Source: Oxera calculations.

### 5.2.4 Accreditation

Following up anecdotal evidence that some consumers might be put off CWI or LI because of mistrust of builders who would install it, the survey tested the effect of installer accreditation on the likelihood of take-up of these measures. Respondents were presented with choices where either the installer was accredited or was not accredited. The respondents made their own interpretation of what accreditation meant. The results were unequivocal. For both measures, installer accreditation is highly influential, as indicated by the implicit value of accreditation, £400 for LI and £580 for CWI. These implicit values show, in monetary terms, the magnitude of the influence of accreditation in the take-up decision.

## 5.3 Analysis: light bulbs

Table 5.5 presents summary statistics on respondents' estimates of the durability, cost and money saved from installing energy-saving light bulbs. It shows that while respondents have a reasonably good grasp of the cost of energy-efficient bulbs, they are less certain about their durability and the money saved (ie, the cost of energy saved) from installing an energy-efficient light bulb. (Note the percentage of 'don't know' responses, and the high estimate of cost savings.)

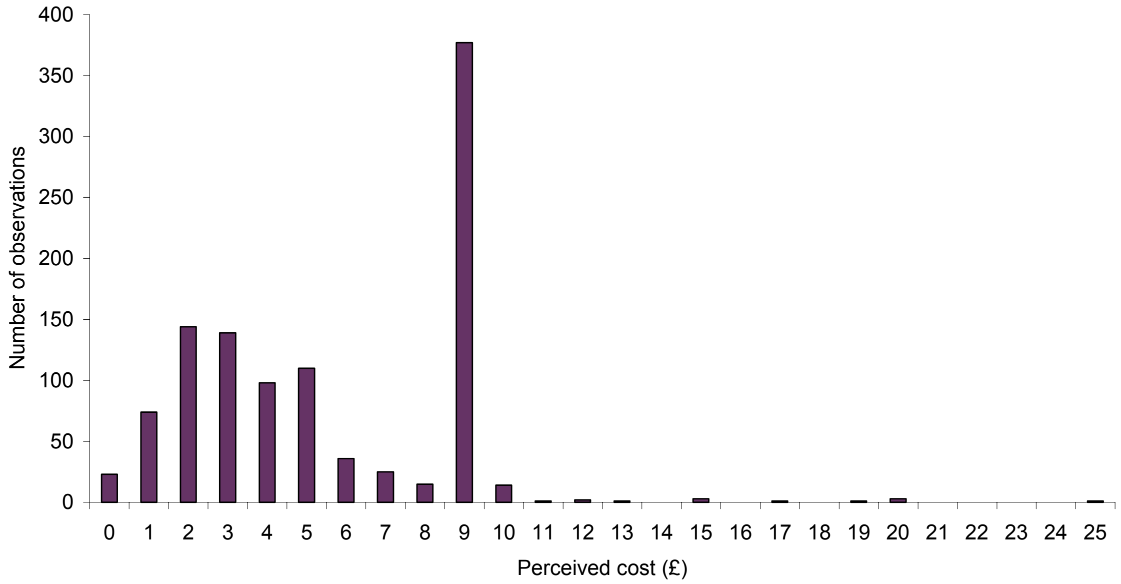
**Table 5.5 Respondents' estimates of the attributes associated with energy-saving light bulbs**

| | Perceived durability of energy-saving light bulb (years) | Perceived cost of energy-saving light bulb (£) | Perceived money saved from energy-saving light bulb over its lifetime (£) |
|---|---|---|---|
| Mean | 3.4 | 5.7 | 15.6 |
| Maximum | 25 | 56 | 110 |
| Minimum | <1 | <1 | 0 |
| % of don't knows | 31% | 0% | 34% |
| Actual | up to 15 | 4–12 | up to 100 |

Note: Midpoints of the bands provided by TNS were assumed in order to calculate the statistics associated with monetary savings from energy-efficient light bulbs.
Source: Oxera calculations.

A histogram of the perceived costs of energy-efficient light bulbs is provided in Figure 5.2 below. While the average perceived cost is £5.65, there is a large spike at £9 per bulb.[53] However, in comparison to consumers' perceptions of the costs of LI and CWI, their perceptions of the costs and benefits of energy-efficient light bulbs are significantly more accurate.

**Figure 5.2 Histogram of perceived costs of energy-efficient light bulbs**




Source: Oxera.

Table 5.6 lists the factors that are statistically significant in determining the likelihood of purchasing an efficient light bulb, according to the magnitude of their influence.

[53] Many bulbs are sold at discounted prices under EEC.

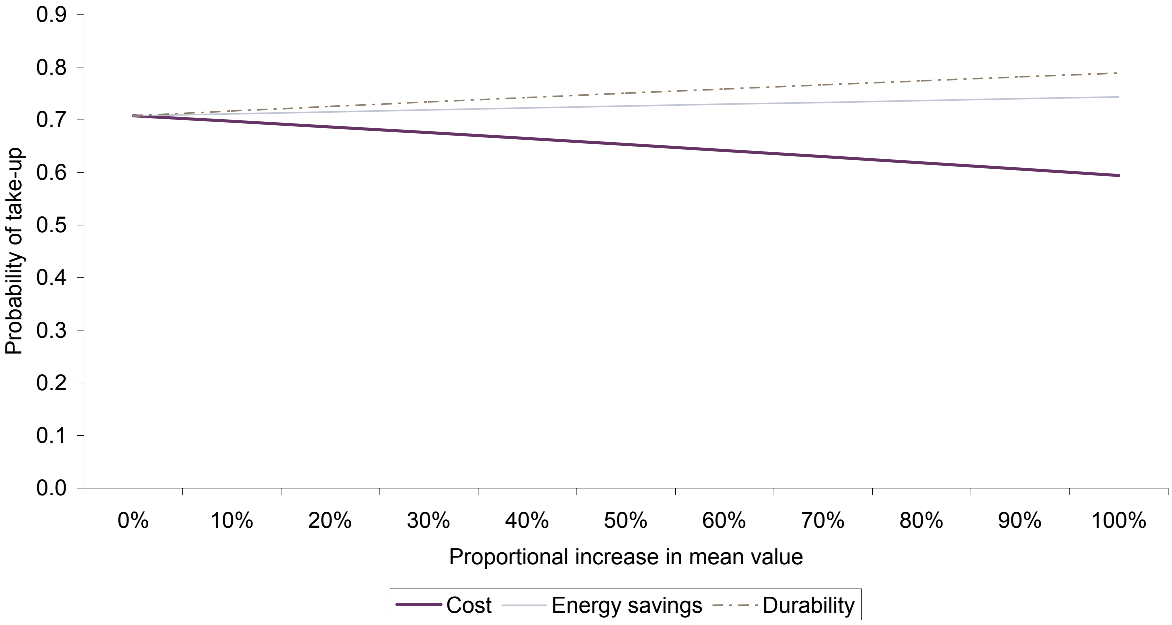
### Table 5.6 Factors influencing the likelihood of purchasing efficient light bulbs

| | Factor |
|---|---|
| Important | Price, attitude to labelling, lifetime |
| Minor | Receipt of advice |
| Very minor/insignificant | Cost savings |

Source: Oxera.

Figure 5.3 below illustrates how sensitive people are to these drivers, showing that eight out of ten households with average perceptions of the cost of an energy-efficient light bulb, the energy savings and durability (represented as 0% in the chart) will already have purchased energy-saving light bulbs. The figure then shows the effect on take-up as these perceptions change. For instance, if the perceived cost of an energy-efficient light bulb is increased by 10%, the probability of households with those perceptions having purchased energy-efficient light bulbs decreases by 1%, from 0.70 to 0.69.

### Figure 5.3 Impact of change away from mean perceived cost, savings and durability on the probability of having an energy-saving light bulb in the home




Note: The linear relationship shown may not hold for the higher proportional increases in mean value shown towards the right-hand side of the chart.
Source: Oxera calculations.

From these figures, the elasticity of demand for light bulbs (with respect to price) has been calculated as –0.11. In other words, for every 1% increase in the price of energy-efficient light bulbs, there would be an 0.11% reduction in demand. This relationship also holds in the opposite direction—ie, for every 1% reduction in price, demand increases by 0.11%. This result indicates that changes in the relative price of energy-efficient light bulbs have only a small effect on the probability of respondents' owning light bulbs.

## 5.4 Analysis: appliances

Table 5.7 shows the relative importance of all statistically significant different drivers of choice for fridge-freezers, televisions and lighting, based on the most general regression (ie, the regression which included all variables as explanators). Further details are available in Appendix 3.

**Table 5.7 Factors influencing the take-up of energy efficiency measures, as derived from statistically significant regression estimates (significant at 5%)**

| | Fridge-freezer | Televisions | Light bulbs |
|---|---|---|---|
| Important | Price, A-rated | Price, recommendations | Price, attitude to labelling, lifetime |
| Minor | Brand, B-rated | Flat screen, cost savings | Receipt of advice |
| Very minor/insignificant | Frost-free, shelving | Brand | Cost savings |

Source: Oxera.

The results show that:

– for *fridge-freezers*, the price of an appliance is a significant factor in consumers' choices. However, the annual value of energy saved by an energy-efficient fridge-freezer does not give energy labels greater influence over choice;

– for *televisions*, the price of the appliance is significant. However, the annual cost of energy consumed has only a weak effect on respondents' choice of television set. Notwithstanding this, brand, and, for purchasers of wide-screen televisions, screen size, are determinants of choice.

An interesting result to emerge from the regression results was the implicit valuation that consumers attached to energy labels, based on the analysis of the results on fridge-freezers. This showed that consumers attached a greater value to A-labelled fridge-freezers than to B-labelled fridge-freezers (with an implicit premium placed on the former estimated at around £30), and to B- rather than C-labelled fridge-freezers (with an implicit premium placed on the former estimated at around £100).

The survey tested the influence on consumers of a simple energy efficiency performance label, which grades performance alphabetically, and one that also states the value of energy savings per annum. The additional information on the value of energy savings was found to have no effect on consumers. This finding is consistent with several hypotheses, including that energy labelling is effective for some reason other than that it allows consumers to identify products that offer energy savings; that consumers correctly infer savings from the alphabetic label alone; and that consumers do not care about the value of energy savings.

# 6 Policy evaluations

A series of models was constructed to assess the potential for energy efficiency gains in the domestic sector as well and the impact of a range of policies on the take-up of energy efficiency measures. These models are outlined below.

The policies to be tested were price discounts, standards (for appliances and lighting), accreditation of installers, the effects of awareness campaigns on insulation measures, and the current and enhanced versions of EEC. For some of these policies, several policy strengths were tested; for example, tougher and more lenient standards, higher and lower levels of price discounts, and more and less effective awareness campaigns.

## 6.1 How the models work

The take-up of insulation was simulated using two separate models, covering owner-occupiers and landlord/tenants respectively.

### 6.1.1 Owner-occupier insulation model

The owner-occupier model is based on a simulation of the likely purchasing decisions of homeowners in relation to insulation measures. At the heart of the model is a representation of a large number of households based on information gathered from the English House Condition Survey 2001, the Labour Force Survey and BRE, as well as information from the Energy Saving Trust on the cost and benefits of insulation measures. Each of these households is described in terms of key characteristics such as age, size and type of house, demographics, heating type and the levels of insulation currently installed. These characteristics were used in combination with the results of the econometric modelling to determine the probability of each household choosing to install either or both of the LI and CWI measures.

The main determinants used in the model to predict the take-up of measures are:

– the perceived cost of the measure;
– the perceived amount of disruption its installation would cause;
– the presence and awareness of any accreditation regime; and
– whether the measure had been recommended to the household.

The effect of different potential policies can be modelled through adjustments to the levels of these factors, for example by reducing the perceived cost of a measure in order to represent rebates to households that install them. The model also allows policies to be applied to specific subsets of the population, such as households that pay stamp duty, or those with mortgages, in order to better target the specific policies.

Each of the households in the model represents approximately 3,500 actual UK households. Therefore, the total take-up of measures, and hence expected carbon savings, are estimated by extrapolating the behaviour of the model households to the UK population.

### 6.1.2 Landlord insulation model

Within the landlord model, properties are divided between socially rented accommodation (ie, local authority-owned and housing association properties) and privately rented accommodation. Due to the difficulty in collecting information on the decisions of landlords with respect to energy efficiency measures, the scope of the landlord model is more limited than that of the owner-occupier model.

In particular in relation to private landlords, the model performs a simple calculation to work out the cost to landlords of installing insulation, and therefore the size of financial incentive necessary to persuade them to adopt it.

### 6.1.3 Appliances

The modelling of appliances addresses two sets of possible Government policies:

- the provision of subsidies to reduce the price of energy-efficient appliances. This covers lighting and fridge-freezers, and is based on econometric evidence derived from the survey in combination with sales projections from the Market Transformation Programme 'WhatIf?' policy simulation tool;
- enhanced minimum product standards, such that only those appliances with efficiency characteristics surpassing a threshold may be sold to consumers. This covers washing machines, freezers, Tumble-driers, fridges, washer-driers, fridge-freezers, televisions, and lighting, and is again based on sales projections from the Market Transformation Programme 'WhatIf?' policy simulation tool.

### 6.1.4 Building Regulations

The modelling of potential energy savings to be achieved through Building Regulations (and the costs associated with this) was undertaken by BRE. The model calculated the effects of the following scenarios:

- *2005 Building Regulations*—simulation of a basket of measures included in the current update to Section L of the Building Regulations;
- *2010 Building Regulations*—a reduction of 25% in the carbon emission rates from space and water heating in new houses, compared with those built under the 2005 regulations;
- *2015 Building Regulations*—a reduction of 25% in the carbon emission rates from space and water heating in new houses, compared with those built under the 2010 regulations; a requirement, beginning as of 2006, for homeowners who undertake extension work to the fabric of their properties to install CWI or LI.

The assumptions and parameters used by BRE in their modelling are included in Appendix 5.

## 6.2 Introduction to results

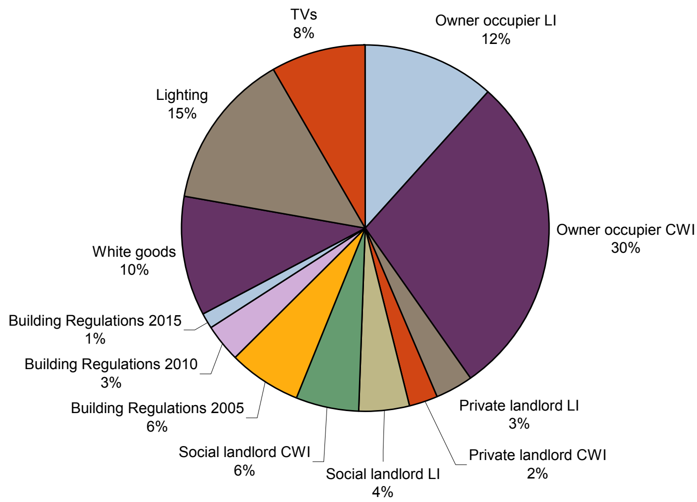
Below are the key results from the modelling of energy efficiency policies. They are set out under the following headings:

- potential for savings;
- insulation measures in owner-occupied properties;
- insulation measures in rented properties;
- lighting and appliances;
- Building Regulations.

## 6.3 Potential for savings

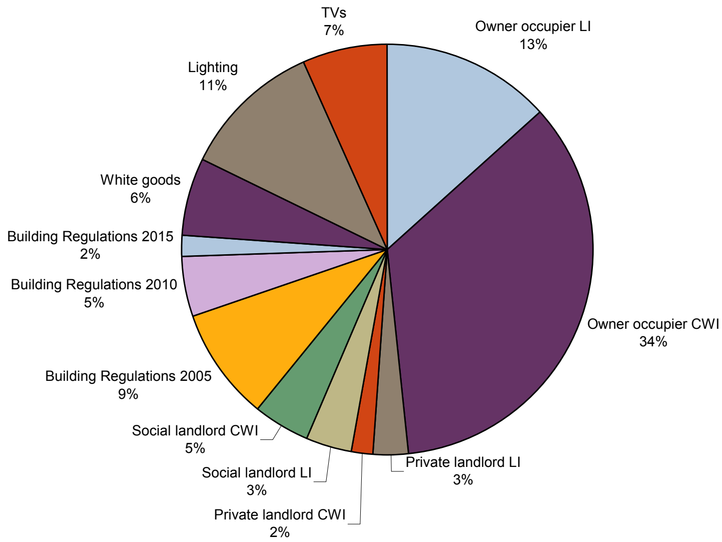
The maximum potential savings from domestic energy efficiency measures in the models are around 6MtC per annum by 2020. The maximum savings are the energy savings if every home in the country were to adopt the measures available to it. The largest components are lighting and CWI in owner-occupied dwellings. Of this total, the models suggest that perhaps 3.5–4MtC per annum is realistically deliverable through policy initiatives. The breakdown of how this can be achieved is shown in Figures 6.1 and 6.2 below.

**Figure 6.1 Share of maximum potential savings by 2020 (totalling 6MtC per annum)**




Source: Oxera.

**Figure 6.2 Share of realistic potential savings by 2020 (totalling 3.5–4MtC per annum)**




Source: Oxera.

Around one-half of savings available by 2020 from these measures is accounted for by insulation of existing dwellings, of which the great majority are owner-occupied. CWI in owner-occupied properties offers just over one-quarter of all available savings. New properties offer little potential savings beyond those already achieved as a result of the 2005 Building Regulations, and for electricity use other than for heating, lighting again gives the greatest potential, with around one-quarter of the potential savings.

### 6.3.1 Additionality of savings from policies

Some caution is needed, however, as there is uncertainty about how much heating and appliance use will change as a result of new lighting technology, changing income, household formation and changing lifestyles. Hence the above estimates are not simply additive to the forecasts of future energy demand and greenhouse gas emissions used within Government and elsewhere.

## 6.4 Insulation measures in owner-occupier properties

Several scenarios of policies to promote the take-up of insulation measures by owner-occupiers were investigated: variations on the current EEC, subsidies to reduce the cost of installation, and an awareness campaign.

### 6.4.1 Potential policies examined

*EEC*—a baseline scenario of the continuation of EEC at its current level was set up to calibrate the model. The calibration was necessary to correct possible biases in the estimates obtained from the survey, as noted in section 5.1 and expanded in Appendix 6.

*Price discount*—this scenario involves a discounted installation cost. It is like the discount provided by the EEC, but the financial payment is not accompanied by the frequency of customer marketing, nor the strength of customer relationship (in terms of ease of contact, for example), nor the experience of customer sales, sales targeting or cross-selling that energy suppliers offer. In effect, it assumes that the delivery channel for the subsidy is not via suppliers, but more probably via a Government agent. The scenario is designed to be compared against the EEC scenario, to show the relative importance of the customer sales vehicle. In setting up the scenario, it has been assumed that the discount is less effective at changing perceptions of insulation costs, benefits and disruption, and that there is lower awareness of the scheme than under EEC (except in the case that a 100% discount were offered, which would be expected to attract widespread media interest and a very high level of awareness).

*Enhanced level of EEC*—in this simple variant on EEC, the level of discount is raised to 75% and levels of recommendations from owners with previous installations are increased accordingly.

*Campaign*—this is a series of scenarios in which central Government carries out a marketing campaign to improve householders' knowledge of the costs and savings from insulation and awareness of discounts that are available. The campaign has a second important effect, which is to increase the frequency with which householders make decisions. To illustrate the potential effectiveness of a campaign, it is assumed that perceptions are completely brought into line with actual costs, savings and levels of disruption. This campaign is carried out in conjunction with either an enhanced EEC or a discount. The two are effectively the same since the media campaign overwhelms the marketing impact of energy suppliers.

In addition to the main scenarios above, variants were tested to show the sensitivity to the following:

– level of underlying take-up (ie, base-case scenario or EEC scenario);
– level of subsidy available to homeowners;
– frequency of decision-making (which represents how often households are made aware of LI and CWI and therefore how often they make a decision on whether to install either of them);
– level of awareness among homeowners of the actual costs of installing LI or CWI;
– level of disruption during installation (measured in days);
– level of recommendation from existing owners of LI and CWI.

### 6.4.2 Results

The results of the scenarios indicate the following.

– The total savings between 2005 and 2010 from insulation, under any scenario, are modest, at around 0.5MtC per annum from EEC.

– Increasing the frequency of decision-taking (ie, presenting householders with an offer and capturing their attention) could be the most effective way to increase take-up. The effect of EEC could be to triple take-up rates, relative to a simple price discount, through the level of engagement with householders.

– Closing the perception gap on installation costs increases take-up by 50% or more.

– Financial incentives tend not to increase take-up substantially. However, scenarios with high levels of subsidy are outside the sample range of the survey, so those results must be treated with caution since they are based on an assumption that the behaviour observed in response to small discounts can be extrapolated to large discounts.

In addition, the modelling indicates diminishing returns per £1 of subsidy spent on both LI and CWI. This effect appears to be strongest for LI. Moreover, subsidies for CWI appear to offer better value for money than subsidies for LI.

### 6.4.3 How much difference could an awareness campaign make to delivery under EEC?

An awareness campaign has the potential to deliver almost the same carbon savings as EEC and Warm Front together. In combination with EEC and Warm Front, an awareness campaign would increase the carbon delivered by EEC by 50%, for the same level of supplier financial contribution per measure installed as under the current EEC targets. This would approximately double the combined financial turnover of EEC and Warm Front because of the larger number of installations being undertaken. An awareness campaign might be cost-effective if the alternative involves increasing the level of subsidy to a higher proportion of the installation cost. The cost of an awareness campaign has not been estimated.

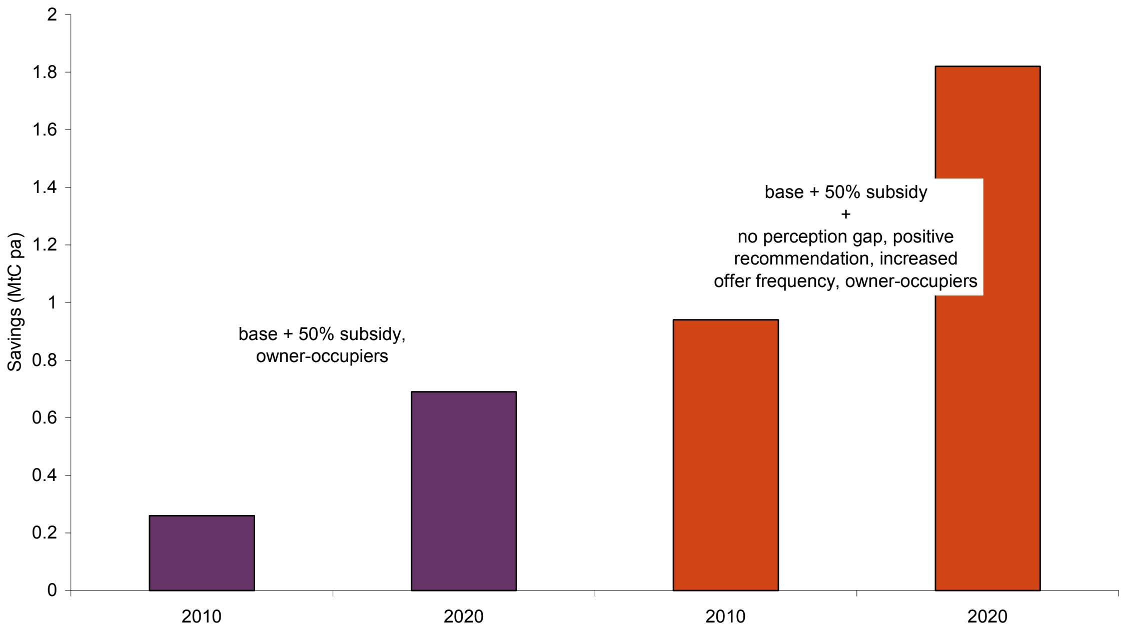
The impact of awareness and recommendations on EEC and on a basic financial incentive is shown in Table 6.1 and Figure 6.3 below respectively, and can be seen to have a significant effect on both, raising take-up levels.

**Table 6.1 Effect of an awareness campaign on EEC**

| | Carbon savings (MtC per annum) | | | Subsidy (£m) | |
|---|---|---|---|---|---|
| | 2010 | 2015 | 2019 | Per annum | Over whole period |
| EEC + Warm Front | 0.73 | 1.23 | 1.55 | 78 | 1,107 |
| Awareness campaign with no subsidy | 0.65 | 1.12 | 1.45 | – | – |
| EEC + awareness campaign | 0.94 | 1.49 | 1.82 | 102 | 1,599 |

Source: Oxera.

**Figure 6.3 Effect of an awareness campaign on a simple discount**

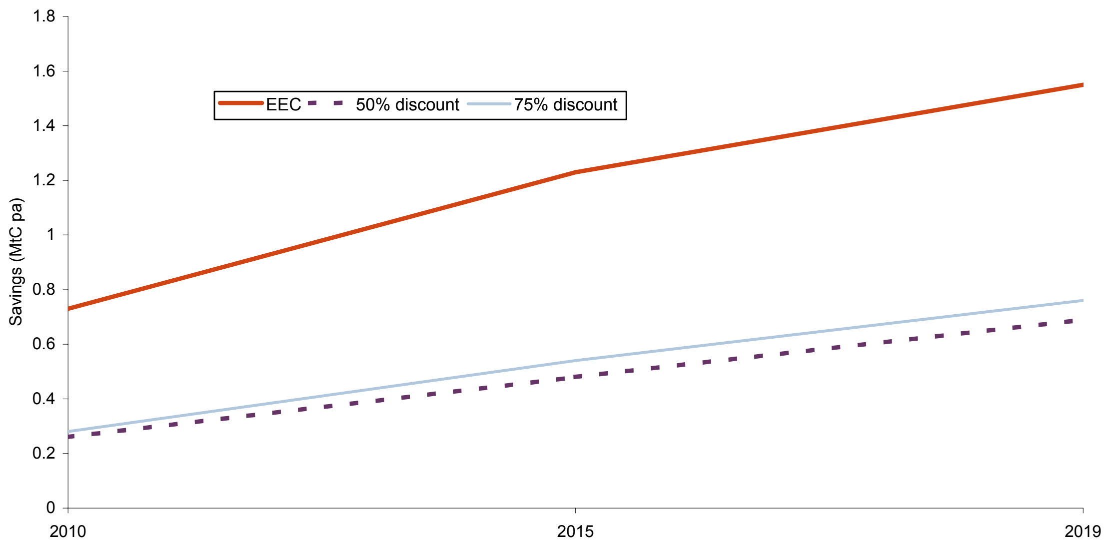



Source: Oxera.

### 6.4.4 How effective is a financial instrument relative to EEC?

EEC can be thought of as a combination of a financial instrument, a lump-sum subsidy for each installation, or a discount on the installation cost, and an awareness campaign. Figure 6.4 and Table 6.2 below show that, compared with a simple discount of equivalent worth, EEC delivers more than twice as much carbon saving, which is consistent with the presence of an awareness effect. Crucially, increasing the size of a bare financial incentive does little to encourage additional take-up, confirming that, within this model, the success of EEC can only be explained through awareness.

**Figure 6.4 Comparison between EEC and a simple discount**




Source: Oxera.

**Table 6.2 Comparison between EEC and a simple discount**

| | Carbon savings (MtC per annum) | | | Subsidy (£m) | |
|---|---|---|---|---|---|
| | 2010 | 2015 | 2019 | Per annum | Over whole period |
| EEC | 0.73 | 1.23 | 1.55 | 78 | 1,107 |
| Simple 50% discount | 0.26 | 0.48 | 0.69 | 22 | 257 |
| Simple 75% discount | 0.28 | 0.54 | 0.76 | 35 | 427 |

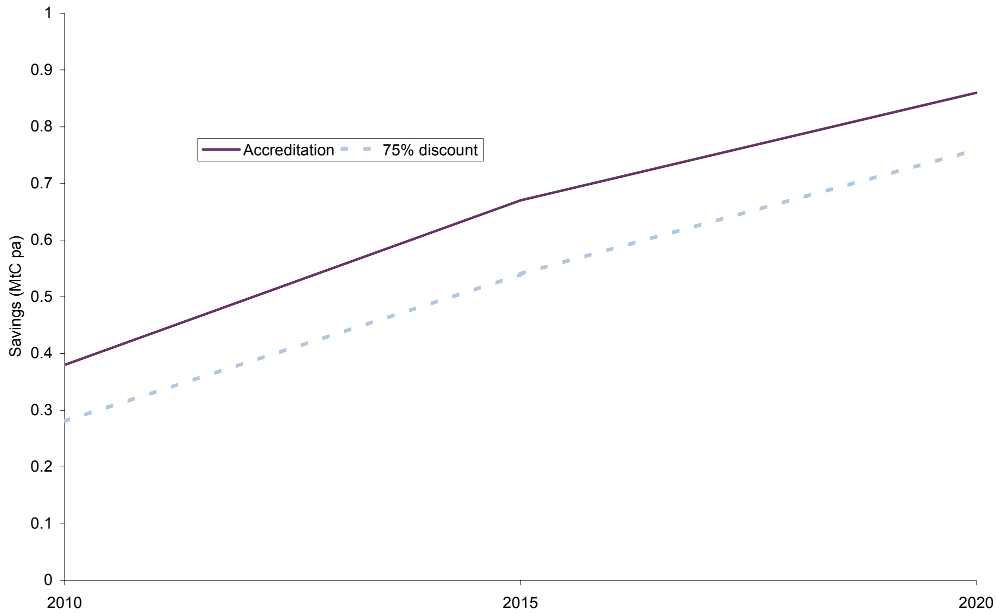
Source: Oxera.

### 6.4.5 How important is accreditation?

The survey showed that accreditation of insulation installers is highly influential in the decision to adopt insulation. The survey did not ask householders whether they were aware of whether such accreditation schemes existed. However, research for the Energy Saving Trust[54] shows that the answer to this question is that only 8% of householders are aware of installer accreditation schemes, even though a high proportion of installers are accredited. Thus, it seems plausible that increasing awareness of existing accreditation schemes could have a great impact on take-up rates. That is, assuming that the accreditation schemes satisfy consumers' concerns about the quality of the installers.

When accreditation is compared with a simple discount, its effect is shown to be equivalent to a discount of over 75%, as seen in Figure 6.5.

**Figure 6.5 Additional savings over base through accreditation compared with 75% discount**




Source: Oxera.

[54] Personal communication, Energy Saving Trust.

### 6.4.6 Findings

Below are the findings for the take-up of insulation measures by owner-occupiers.

– It is only possible to explain how EEC achieves the levels of take-up that it does, given the level of discounts known to be being offered and the level of perceived costs and savings and expected disruption costs, if suppliers are working to increase awareness of insulation measures.

– Marketing by the suppliers could have the effect of making homeowners think about installation more often, reducing the barrier to action by ease of contact with the supplier, improving knowledge of the actual costs and benefits, and making homeowners more aware of the discounts on offer.

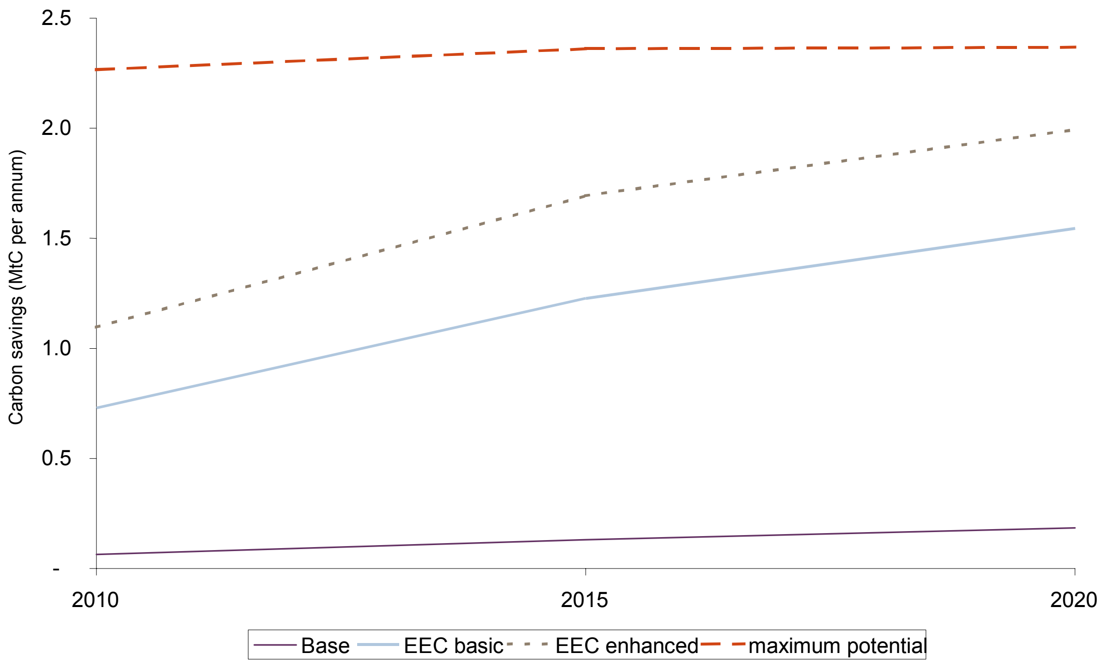
– Any alternative to EEC is likely to be less effective (delivering lower carbon savings), and possibly worse value for money, if it has less effective marketing reach to homeowners and hence a smaller awareness effect.

– Nevertheless, if further awareness-raising activities were carried out, it may be that the carbon savings delivered under EEC could be delivered more cheaply and the rate of carbon savings enhanced. Furthermore, there is likely to be a sub-optimal effort on marketing by the suppliers because of the nature of the competitive environment in which they operate. There is therefore a role for Government in awareness-raising.

– If Government were to decide to enhance its awareness-raising efforts, as part of this it could consider raising the awareness and stature of the accredited installer brand, which has the potential to have a considerable influence on the take-up of CWI.

If the current level of effort under EEC is projected forwards through time, it triggers a slowly diminishing rate of take-up, and captures only about half the available potential savings by 2020. EEC could deliver perhaps 75% of the available savings by 2020 if suppliers increased the discount on offer and their awareness-raising activities, and if Government ran a parallel campaign. These scenarios are labelled ‘EEC basic’ and ‘EEC enhanced’ in Figure 6.6.

**Figure 6.6 Proportion of available savings delivered by EEC and enhanced EEC (carbon saved from LI and CWI versus maximum potential)**




Source: Oxera.

A full set of results is available in Appendix 7.

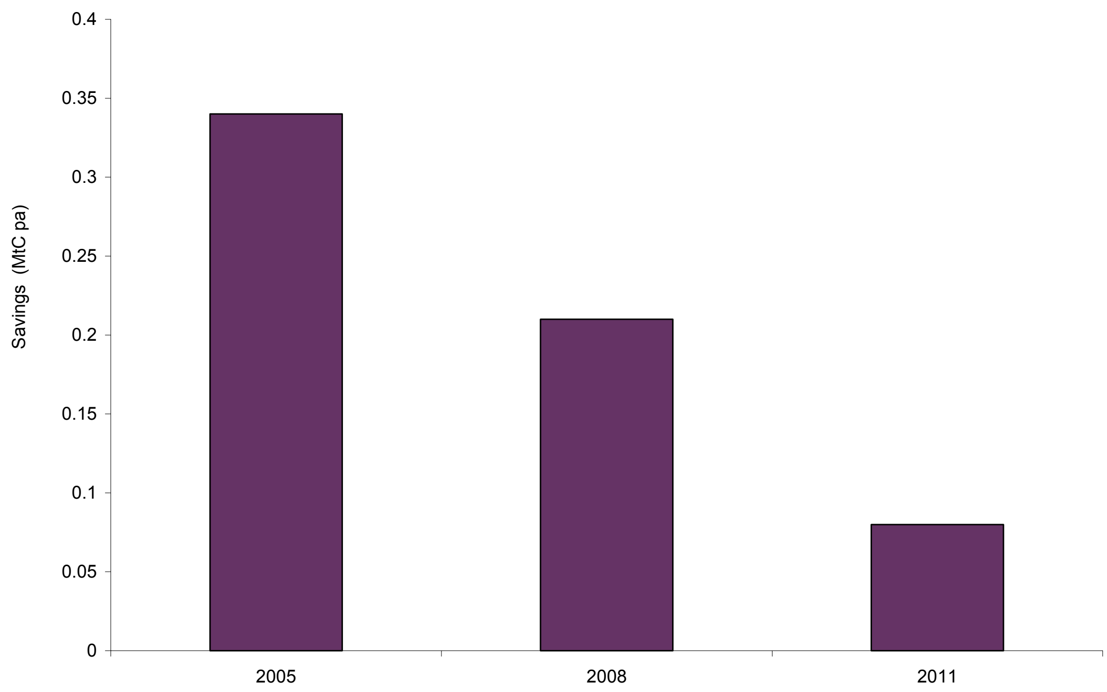
## 6.5 Insulation measures in rented properties

Rented properties are divided into two categories: those with private landlords and those with social landlords (either local authorities or registered social landlords).

The potential for insulation measures, based on English House Condition Survey 2001 data, before EEC and Warm Front were introduced, was around 0.3m virgin lofts, 3.7m loft top-ups and 3.2m CWIs. The lofts are roughly evenly split between social and private landlords, but three-quarters of the available cavity walls are with social landlords. The total savings available were 0.44MtC from lofts and 0.48MtC from cavity walls, at a total installation cost of £1,040m and £840m respectively.[55]

EEC and Warm Front are planned to make a substantial inroad into the potential savings shown above for those living in social rented accommodation. Opportunities for installing both CWI and LI in the social sector are likely to be largely exhausted over the next few years, so the potential for carbon savings through insulation measures, post-EEC 2005–08, is low (see Figure 6.7). It is notable, however, that large numbers of privately rented dwellings will remain unimproved other than through Warm Front. Recognising the market failure between the landlord and tenant, Warm Front demands no landlord contribution.

**Figure 6.7 Cavity wall savings, remaining potential among social landlords**




Source: Oxera calculations.

As discussed previously, probably the only solution for privately rented dwellings is to offer a 100% or greater discount on the installation cost (100% is offered through Warm Front). The estimated cost is around £670m present value to complete all privately rented properties.

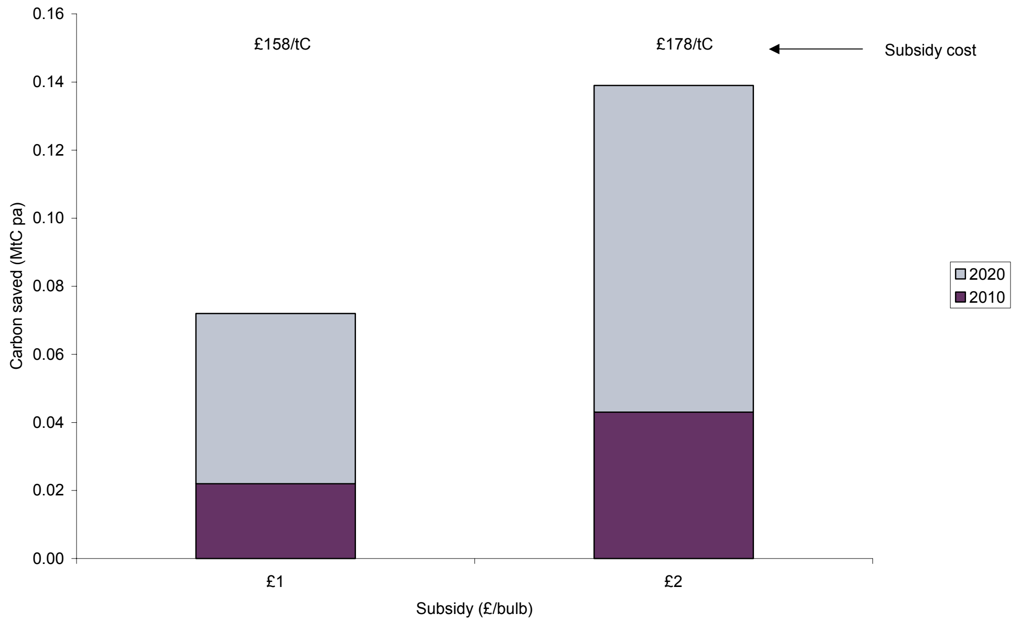
[55] Oxera calculations based on data from BRE and the English Housing Condition Survey.

## 6.6 Lighting and appliances

### 6.6.1 Price discounts

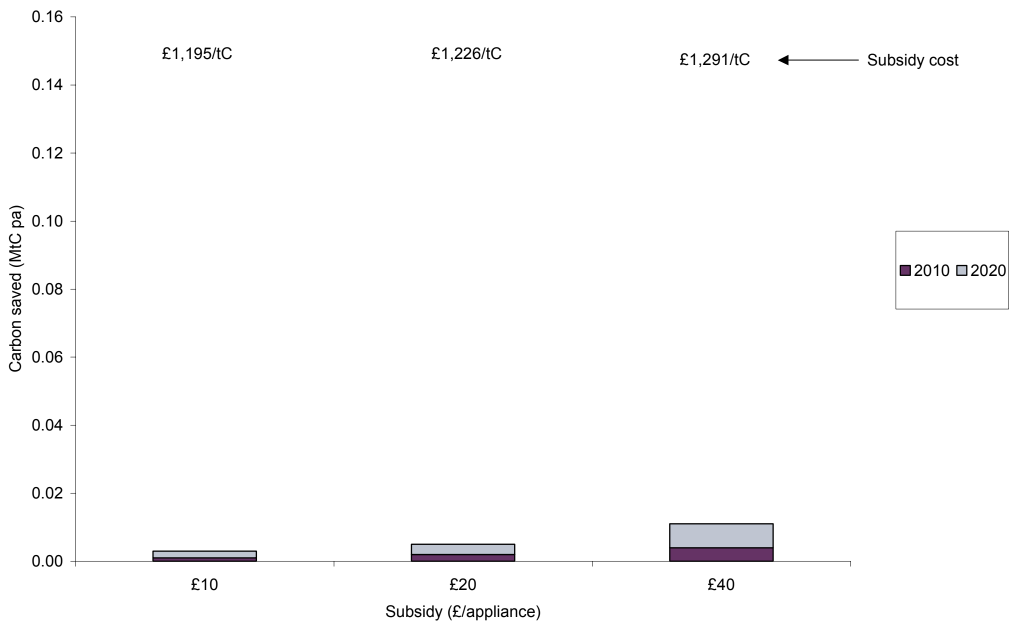
Figures 6.8 and 6.9 show, respectively, the take-up of energy-efficient light bulbs and fridge-freezers in response to a discount. While significant take-up levels can be stimulated through subsidies on energy-efficient products, in the scenarios tested, the level of subsidy per tonne of carbon saved was higher than for LI and CWI.

**Figure 6.8 Carbon savings generated by discounts for efficient lighting, 2020**




Source: Oxera calculations.

**Figure 6.9 Carbon savings generated by discounts for efficient fridges/freezers, 2020**




Source: Oxera calculations.

The total lifetime net benefits of a £1/bulb and £2/bulb discount on the retail prices are £76m and £147m respectively. The lifetime net present benefit per tonne of carbon saved is £72/tC. The total lifetime net benefits of a £10/appliance and £20/appliance discount on the retail prices of cold appliances are £50m and £96m respectively. The lifetime net present benefit per tonne of carbon saved is £50/tC. In both cases the cost-effectiveness figures are high.

However, although the net benefit is high, there is a large transfer payment which occurs because the discount is paid on purchases that would have taken place anyway, as well as those stimulated by the introduction of the discount. For every additional purchase triggered by the discount, the discount is paid on many others. This makes the discount mechanism less attractive.

There is another caveat. The price discount does not have to be very large (in terms of percentage of sales price) before the A-rated goods become equal in cost to inferior goods, or even cheaper; typically a discount of around £50 on cold appliances. At that point, substitution towards efficient appliances could be very large, and the cost-effectiveness of the subsidy might improve sharply, despite the deadweight. This was outside the range of discounts tested in the survey.

### 6.6.2 Product standards

Tighter product standards have the potential to deliver significant energy savings. As a consequence, manufacturers' costs and retail prices are likely to increase, although it is not known by how much. Defra expects that where the tighter standards are announced well in advance so that they can be incorporated into the normal product design cycles, the additional cost will be minimal. Two scenarios are used for white goods energy efficiency standards, as shown in Table 6.3. In these scenarios, the old appliance stock is gradually replaced by new, more efficient stock, hence the savings available by 2020 are higher than by 2010 since more of the stock will have been replaced by 2020

**Table 6.3 Product standard scenarios modelled**

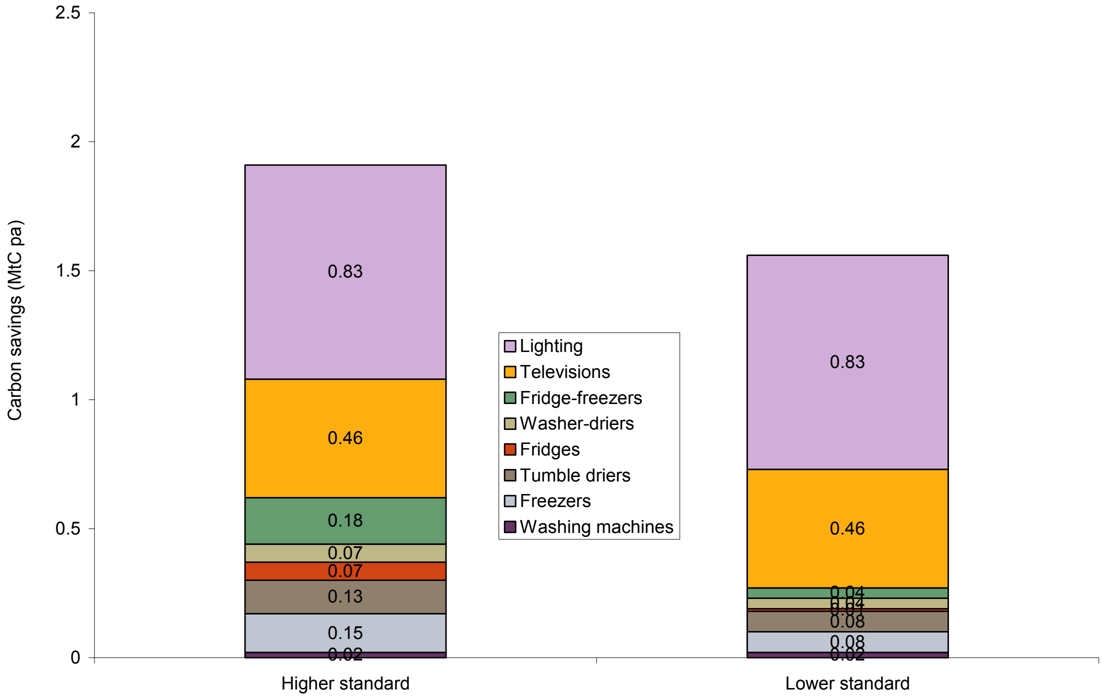
| | Higher standard | Lower standard |
|---|---|---|
| Washing machines | A | See note |
| Freezers (upright) | A++ | A |
| Freezers (chest) | A+ | A |
| Tumble-driers | A | B |
| Fridges | A++ | A |
| Washer-driers | A | B |
| Fridge-freezers | A++ | A |

Note: Under MTP projections, C class fridges drop out of the market over the next two years. Therefore, the minimum de facto standard is projected as being B category fridges after 2008. For this reason, a B category minimum standard has not been modelled.
Source: Oxera.

For lighting, the abolition of incandescent bulbs by 2010, phased in from 2006, was envisaged; and, for televisions, the restriction of sales to cathode ray tube-equivalent energy use by 2010 was envisaged to be phased in from 2006.

A standard based on the highest-performing current model would deliver savings of around 0.62MtC per annum for white goods by 2020 (see Figure 6.10 below). A standard based on A/B class minimum would deliver 0.27MtC per annum for white goods (see Figure 6.11 below). Televisions and lighting would deliver 0.46MtC and 0.83MtC per annum respectively, the same numbers shown in Figure 6.10.

**Figure 6.10 Savings achieved through product standards, white goods set equal to highest current available performance (higher standard) and A/B class (lower standard) (MtC per annum)**




Source: Oxera.

The present-value lifetime benefits of the higher standard total £5.8 billion from white goods, and the lower standard £1.9 billion. Televisions offer benefits of £3.6 billion. The costs of manufacturing appliances to the standards are not known in either case. Lighting, where the manufacturing costs are known, offers benefits net of costs of £9.4 billion.

## 6.7 Building Regulations

Further to the modelling of energy efficiency measures aimed at occupiers of the existing housing stock, BRE modelled the effects of introducing tighter regulations on the standards to which new houses would be required to comply. These measures were modelled as a series of updates to Building Regulations in 2005, 2010 and 2015, coming into force in those years. The measures were applied to the current building projections of the Office of the Deputy Prime Minister for the UK.

These measures took the following forms:

– *2005*—as per part L of the 2005 Building Regulations;
– *2010*—a 25% reduction in carbon emissions from space and water heating, translating into a requirement for the installation of energy-efficient lighting and high levels of insulation in all homes, and addition of solar water heating for oil-heated homes and heat pumps in electrically heated homes;
– *2015*—a further 25% reduction in carbon emissions from space and water heating, translating into a requirement for installation of photovoltaic (PV) cells for gas- and oil-heated homes; and a requirement for additional insulation measures for electrically heated homes and the use of heat pumps.

In parallel, a further scenario was developed modelling the savings that may be achievable by obliging all homeowners who undertake extension work to ensure that LI and CWI is installed in their property, starting from 2006.

The results of this modelling showed the following reductions in annual energy consumption and carbon emissions by 2020:

– *2005 regulations*: reduction in energy consumption of 5.0TWh per annum and a reduction in carbon emissions of 0.33MtC per annum.

– *2010 regulations*: a further reduction in energy consumption of 2.8TWh per annum and a reduction in carbon emissions of 0.17MtC per annum.

– *2015 regulations*: reduction in energy consumption of 1.0TWh per annum and a reduction in carbon emissions of 0.06MtC per annum.

The obligation to ensure that CWI and LI are installed in all properties on which extensions are undertaken is modelled as achieving reductions of 3.8TWh per annum and 0.2MtC per annum, respectively, in 2020.

These reductions in energy consumption (and carbon emissions) through tighter regulations on building standards for new houses rely on an assumption of similar levels of compliance to those in the recent past. If compliance were worse, the actual reductions in energy consumption and carbon emissions would be lower than those shown above.

# 7 Conclusions

## 7.1 How consumers make decisions about energy efficiency

The consensus over several decades has been that poor information, transaction costs, limited effort available for decision-making, and high discount rates explain why people do not adopt energy efficiency measures in the numbers that might be expected on the basis of the simple arithmetic of cost–benefit analysis. It has been suggested that there are significant barriers to take-up because of the cost of finding information; weighing up the options and committing money to an investment that may take several years to recoup; and the effort of contracting with builders and supervising installation.

This study confirms that people’s knowledge of insulation measures is poor, but that information is important, and that this explains in part why take-up of measures is low. The situation for insulation contrasts with that for light bulbs, where people’s knowledge is much better, probably because it is a commodity item. It also confirms that transaction costs play a role, with accreditation of the quality of insulation installers being highly influential in the take-up decision, and that, despite its importance in a decision, people remain poorly informed about the existence of accreditation schemes.

The evidence also sheds light on the high discount rate theory of behaviour. This theory states that future savings are weighted much less in a decision than any up-front costs. There is strong evidence that, rather than a high discount rate being present, people simply do not appear to take into account future savings at all (ie, they have an infinite discount rate). That is, future savings do not feature in their assessment of whether to install insulation or buy an energy-efficient appliance. The exception is light bulbs, where savings have some effect. Over time, if energy costs fall relative to income, as they have done over recent decades, the influence that savings have over purchase decisions may become even weaker.

Even though the financial value of energy savings does not feature in most energy-efficient purchases, there is still demand for insulation and energy efficiency appliances, and they are sensitive to price just as any other normal good would be.

The survey tested the influence on consumers of a simple energy efficiency performance label, which grades performance alphabetically, and one that also states the value of energy savings per annum. The information on the value of energy savings was found to have no additional effect on consumers above a simple alphabetic grading of energy efficiency. This finding might suggest that energy labelling is effective for some reason other than that it allows consumers to identify products that offer energy savings. A possible explanation is that the label is seen as a quality mark. It also might suggest that consumers do not care about energy savings, or that they infer the energy savings from the alphabetic label alone.

## 7.2 How policies work and might be made to work better

There is strong evidence that the policies directed at owner-occupiers via suppliers derive most of their effect through awareness-raising rather than financial inducements. They appear to trigger a decision to take up, or not take up, measures where otherwise no decision would have been taken. At the same time, they probably correct some misunderstanding of the nature of the installation process and the costs or benefits of the measure. A pure financial incentive, which is a potential contender policy to replace EEC, is unlikely to have the same effect on owner-occupiers’ take-up of insulation.

There is a role for Government here. It is evident that installers have not acted collectively to raise awareness of their accreditation scheme, and it is probable, due to the competitive nature of energy supply, that there has been no similar collective action by the suppliers to improve the poor public understanding of energy efficiency measures. The role for Government is thus to act where the market players have not done so, to increase awareness of the measures and the understanding of their costs and what an installation entails, and to help overcome the distrust of suppliers by informing the public about the obligation. This could allow the target number of installations to be achieved by suppliers to be raised substantially, perhaps by 50%, under the EEC, compared with EEC 2 levels.

None of the current policies is effective at stimulating take-up of insulation in the private rented sector. There are compelling reasons why, regulation aside, only strong financial incentives are likely to have any effect, and it is not clear whether regulation could be made feasible. If such incentives are to be effective, they would probably have to create a pay-off for the investment that fully covers the up-front cost and more over a few years.

There is also a role for Government in controlling the standards of efficiency of new buildings and, in cooperation with other EU Member States, appliances. Regulating for standards is an effective way to achieve savings.

## 7.3 How much carbon might be saved

The main opportunity for carbon saving is insulation in owner-occupied homes. Lighting and appliances also represent a large share of the potential savings. By 2020, the potential savings from measures considered in this study (ie, excluding solid wall insulation for example) are around 6MtC per annum, but policies can probably only stimulate savings of around 3.5–4MtC per annum, although some of that figure may already be factored into baseline emissions projections. It has been beyond the scope of this study to determine the future energy intensity trend built into emissions projections.

The gross savings available from policies considered in this study, including business as usual savings, are set out in Table 7.1. These gross savings are not directly comparable with the savings reported by the Interdepartmental Analysts' Group.

**Table 7.1 Effect of enhanced policies on energy efficiency on emissions in 2020**

| | MtC per annum saved in | |
|---|---|---|
| | 2010 | 2020 |
| **Insulation** | | |
| Enhanced EEC 2006–20 with awareness campaign | 1.1 | 2.0 |
| **Appliance standards** | | |
| Maximum tightening of standards | 0.48 | 1.1 |
| **Lighting** | | |
| Phase-out of incandescent bulb sales | 0.42 | 0.8 |
| **Building Regulations** | | |
| 2010 regulations | 0.0 | 0.2 |
| 2015 regulations | 0.0 | 0.1 |
| **Total** | **2.0** | **4.2** |

Note: The 'Enhanced EEC 2006–20 with awareness campaign' policy could not be implemented in the form described in this report. EEC is fixed until 2008, and may continue with a broader eligibility of households and measures than assumed above.
Source: Oxera.

The saving of 4MtC per annum by 2020 can be compared with a starting level of emissions of 39.3MtC per annum in 2005 from the residential sector.[56] This represents an efficiency improvement compound rate of 0.65% per annum. Additional savings, listed below, could take the improvement rate to above 2% per annum.

The savings in Table 7.1 represent only a fraction of the full potential savings available, because they do not include savings from the following:[57]

– improved heating systems—the replacement of existing boilers with high efficiency condensing boilers and alternatives such as micro combined heat and power, and heat pumps, could deliver a further 4MtC in savings;
– insulation of social housing—additional savings of 0.6MtC, see Table A7.13;
– insulation of lower-income private housing—0.3–0.5MtC;
– raising the quality of new properties to the new building standard—savings of around 0.5MtC
– solid wall insulation and possible new technologies could contribute well over 2MtC.

These estimates concern additional savings available from 2006. When comparing these figures with other sources, note that some figures published by Defra, the Energy Saving Trust and others refer to savings available from other dates.

The enhanced EEC scheme shown in Table 7.1 does not map directly onto the current EEC scheme. The figures for 'Enhanced EEC 2006–20 with awareness' relate to owner-occupiers and insulation, which are a subset of all households and a subset of the range of measures likely to be installed under the current EEC schemes. Nevertheless, the figures cover the critical area for possible expansion of EEC beyond 2008, since insulation is already the dominant measure in EEC2 and because private households will become a larger share of the programme as improvements to the social housing stock are completed. Also, since lower-income groups are eligible for 100% subsidies, it is the owner-occupiers who can receive a partial subsidy who constitute the group where barriers and costs are important.

The figure of 1.1MtC per annum for 2010 in Table 7.1 is equivalent to about a 50% increase of the actual EEC2 scheme. This calculation is set out below.

– EEC3 is three instead of five years (2008–11), so the figure must be scaled down to 60% (0.66MtC per annum);
– owner-occupiers not eligible for 100% subsidies represent two-thirds of all owner-occupiers, so the figure must be further scaled down to 66% (0.44MtC per annum);
– the EEC2 'illustrative mix' of measures contains about 0.2MtC per annum gross (ie, including deadweight savings for compatibility with Table 7.1) from insulation;
– the net increase in carbon savings from EEC2 to EEC3, in this subset of households and measures, is 0.24MtC per annum.

This gives an increase of 120% (0.24/0.20) from 'able-to-pay' owner-occupiers, who constitute the majority of the 'Non-Priority Group'. The remainder of this last group are higher-income householders in social housing. However, the carbon saving contribution from all of social housing is expected to remain constant or even decline over the EEC3 period, since most of the potential will have been realised. The overall percentage increase in savings from insulation in the total Non-Priority Group is therefore likely to be lower than the 120%, and the absolute increase could be closer to 0.24MtC per annum.

[56] Defra (2001), '3NC'.

[57] Source: Defra, personal communication.

Whatever the Non-Priority Group saving, it is likely to be matched by that from the Priority Group (as current rules require equal benefits in the two groups), so the maximum overall additional saving over EEC2 could be twice 0.24MtC per annum (ie, almost 0.5MtC per annum).

Finally, the EEC2 illustrative mix has approximately one-third of its total carbon coming from non-insulation measures (eg, lights, appliances, and fuel switching). Again, with diminishing scope, these are unlikely to deliver increased savings in EEC3, and might deliver reduced savings. Once again, therefore, the total additional insulation savings of 0.48MtC per annum may represent the maximum additional savings in total from an expanded EEC3 (ie, around a 70% increase on EEC2). In practice, the increase might be less than this, perhaps around 50% of the total EEC2.

## 7.4 Value for money

All the household energy efficiency measures show net financial savings per tonne of carbon saved except the Building Regulations 2015, which show large net costs (see Table 7.2). Appliances generate the largest net savings, but this may be because the incremental costs of manufacture have been omitted. All the measures except the Building Regulations 2015 pass the cost–benefit test, having costs per tonne of carbon saved that are more positive than £85/tC (the mid-estimate of the current social cost of carbon).

**Table 7.2 Net benefit per tonne of carbon saved**

| | £/tC |
|---|---|
| CWI and LI | 250 |
| Lighting | 50 |
| Appliances | 400–600[1] |
| Building Regulations 2005 | 150 |
| Building Regulations 2010 | 50 |
| Building Regulations 2015 | –430 |

Note: [1] Excludes the incremental costs of manufacture associated with higher energy efficiency.
Source: Oxera calculations.

The corollary of net financial savings per tonne of carbon is large positive net present values from the policies that deliver energy efficiency measures. Table 7.3 below shows the net impact (including carbon benefit in monetary terms) by 2020, and to consumers over the lifetime of the measures. The total benefits amount to around £30 billion, which is split equally between efficient lighting, insulation and appliances.

**Table 7.3 Value of net benefits generated by policies (£m present value)**

| | NPV to 2020 (including value of carbon saved) | Lifetime benefit to consumers |
|---|---|---|
| **Insulation** | | |
| EEC continued to 2020 | 2,103 | 6,351 |
| EEC enhanced to 2020 | 2,362 | 6,979 |
| EEC enhanced to 2020 + campaign | 2,960 | 8,329 |
| Simple 50% discount | 549 | 2,495 |
| Private landlord levy | 341 | 507 |
| **White goods standard** | 3,490 | 6,226 |
| **Television standard** | 2,555 | 3,865 |
| **Lighting standard** | 5,866 | 9,474 |
| **Building Regulations** | | |
| 2005 | 807 | 2,278 |
| 2010 | –300 | 212 |
| 2015 | –840 | –637 |
| Extensions | 214 | 1,063 |

Note: [1] Excludes the incremental costs of manufacture associated with higher energy efficiency.
Source: Oxera calculations.

## 7.5 Costs to the Exchequer

EEC imposes no costs on the Exchequer, whereas a 50% discount on the cost of installation of insulation measures might cost around £700m and a levy on private landlords might net receipts of around £500m. Appliance and lighting discounts cost in the region of £100m–£300m each. Appliance and lighting standards and Building Regulations do not impose costs on the Exchequer, but the costs of enforcement have been omitted from the calculation.

## 7.6 The state of the evidence base

Although this study has generated a substantial amount of new evidence to advance the understanding of energy efficiency, there remain uncertainties over the effectiveness of policies because of incomplete evidence on the following.

- how, and how often, households take a decision on whether to adopt measures, and whether this is associated with periodic events such as moving house or receiving utility bills, or in response to an awareness or marketing campaign;
- how much discount suppliers offer to householders to induce take-up of measures;
- the rebound effect of increasing internal temperatures after installing insulation—comfort-taking;
- the rate of take-up of measures assumed in emissions projection baselines;
- the trend in consumers' decision patterns over periods of a decade or more;
- the behaviour of consumers in the market (through a longitudinal study rather than a survey approach).

# Appendix 1 European policies

### Energy Performance of Buildings Directive (2002/91/EC)

The Energy Performance of Buildings Directive, which is to be incorporated into law by all Member States by 2006, sets out standards in the following areas:

- a common methodology for calculating building energy performance;
- minimum energy performance for new buildings and large conversions of old buildings;
- building certification for energy consumption levels of buildings;
- inspection of boilers and air conditioning systems for energy efficiency.

### Directive concerning common rules for the internal market in electricity (2003/54/EC)

The Electricity Directive sets out requirements for the inclusion of environmental information in consumers' electricity bills:

- bills must include the mix of fuels used in generating an individual consumer's electricity in the preceding year;
- information on the environmental consequences of the fuels used, including $CO_2$ emissions and radioactive waste, can either be included as part of the electricity bill or consumers can be referred to the distributor's website.

In 2005, the provisions of this Directive were passed into UK law.[58] This obliged electricity suppliers to include in, or with, bills the contribution of each source to their overall fuel mix in the year preceding the issuance of a bill.

### Boiler Efficiency Directive (92/42/EEC)

The Boiler Efficiency Directive of 1992 put in place efficiency requirements for standard domestic 'combination' boilers. Minimum efficiency levels were established for full- and part-load operation. In addition, a system was introduced in which the efficiency rating of a boiler could be indicated with a star mark (the higher the efficiency, the greater the number of stars) and with a 'CE' mark to indicate conformity with the Directive.

### Energy Labelling Framework Directive (92/75/EEC)

The Energy Labelling Directive of 1992 set out a framework for standardisation across Member States of the labelling of household appliances according to efficiency and energy consumption. It covered the following:

- fridges, freezers and their combinations;
- washing machines, driers and their combinations;
- dishwashers;
- ovens;
- water heaters and hot water storage appliances;
- lighting sources; and
- air conditioning appliances.

The Directive, which came into force in 1994, made compulsory the provision by dealers of information regarding the energy consumption of the above appliances. Such information was to be attached to the appliances in a clearly visible place. In addition, the provision of technical information underlying the energy consumption data was made compulsory.

[58] The Electricity (Fuel Mix Disclosure) Regulations 2005.

### Directive on Energy Efficiency Requirements for Household Electric Refrigerators, Freezers and Combinations thereof (96/57/EC)

This Directive set maximum allowable levels of electricity consumption according to varying specifications of fridges, freezers and combinations of these appliances. It also set out standard procedures for assessing the electricity consumption of such appliances. As such, manufacturers were obliged to place onto the market only those appliances that conformed to the requirements of the Directive.

An assessment of the effectiveness of the Directive (in combination with the Energy Labelling Directive) was undertaken[59] using data obtained by GfK. The study found that the rate of compliance for fridges increased from around 75% in 1996 to around 90% by 2000. Among other new cold appliances, the rate of compliance increased from around 20–40% in 1996 to around 70–95% by 2000.

Table A1.1 shows the reduction in the energy consumption of a range of cold appliances between 1992 and 1999.

**Table A1.1 Reduction in energy consumption of cold appliances, 1992–Q4 1999**

| | Energy consumption (kWh per annum) | | Reduction in energy consumption |
|---|---|---|---|
| | 1992 | Q4, 1999 | (%) |
| Fridges | 301 | 228 | 24 |
| Fridge-freezers | 627 | 492 | 22 |
| Chest freezers | 458 | 306 | 33 |
| Upright freezers | 460 | 368 | 20 |

Source: Schiellerup (2002).

### Proposed Eco-design of Energy-using Products Directive (92/42/EEC)

This Directive proposes a series of principles and methods through which manufacturers of energy-using products (which include all commercial and domestic electrical and gas-fuelled appliances) would assess and manage the environmental impact over the lifetime of those products. The rationale behind the Directive is that much of the environmental impact of energy-using products is determined at the design stage; consequently, there is scope to reduce impacts by environmentally considerate design.

Provisions are put forward for a methodology for the assessment of the environmental impact, covering energy use, consumption of materials, use of consumables during the lifetime of the product, and ease of recycling. Manufacturers are also obliged to produce technical documentation detailing the results of the environmental assessments carried out in the course of determining the product design.

[59] Schiellerup, P. (2002), 'An Examination of the Effectiveness of the EU Minimum Standard on Cold Appliances: the British Case', *Energy Policy*, **30**, 327–32.

# Appendix 2 Other relevant literature

## A2.1 Policy studies

Policy documents that have been or are likely to be influential in the debate over the direction of future policy are reviewed below.

### 40% House

A recent report by the Environmental Change Institute in Oxford set out a mix of policies that the authors envisage would be required to achieve a 60% reduction in $CO_2$ emissions from the UK residential sector by 2050.[60] This corresponds with the targets set out in the Government's 2003 Energy White Paper (see section 1.1).

The policies put forward include:

– an increased rate of demolition of energy-inefficient houses. This, it is argued, would reduce the overall energy consumption of the housing stock, as energy-inefficient houses would be replaced by more modern and energy-efficient houses;
– refurbishment of remaining homes which are not sufficiently energy-efficient;
– measures to encourage the design and accurate labelling of energy-efficient appliances and goods;
– revision of Building Regulations to specify the installation in new homes of energy-efficient appliances (such as fridges and washing machines);
– the possible introduction of personal carbon allowances which could be traded between consumers;
– a much greater take-up of low- and zero-carbon technologies (LZCs) among households. Examples of LZCs include solar water heating and Stirling micro-CHP units. Notable in the scenario modelled is the high take-up of LZC technologies: by 2050, 72% of homes are projected as having LZC as the main form of heating. This would shift the burden of electricity generation away from central units and towards micro-level domestic generation.

No estimates were given of the cost or feasibility of the measures.

### Recent papers on the link between energy efficiency and fuel poverty/distributional impacts

'Green Taxes and Charges' considers the impact of a range of environmentally based taxes across the earnings spectrum, with particular emphasis on low-income households.[61]

Taxes on carbon emissions were argued to be highly regressive if applied equally across the earnings spectrum. Furthermore, by increasing the effective cost of carbon-based fuels, they would exacerbate problems of fuel poverty in the absence of some compensating (and progressive) benefits to low-income households. However, the design of a suitable benefit scheme was judged to be problematic in terms of its practicality and the precision with which it could compensate low-income households for the imposition of a carbon tax.

[60] Environmental Change Institute (2005), '40% House', University of Oxford.

[61] Ekins, P. and Dresner, S. (2004), 'Green Taxes and Charges: Reducing their Impact on Low-income Households', Joseph Rowntree Foundation.

A research paper by Defra looked at the distributional effects of product charges on a range of energy-inefficient appliances.[62] This indicated that, as a consequence of energy efficiency labelling, relatively cheap appliances and energy-efficient appliances were available on the market. The link between price and energy efficiency was found to be weak or non-existent for most household appliances. As a result, the availability of cheap and relatively efficient (ie, unaffected by product charges) appliances means that the imposition of product charges on inefficient appliances would not be likely to have significant regressive effects—although this could not be ruled out completely.

### Powergen Energy Monitor 2004

The Powergen Energy Monitor 2004 provided a review of policies with respect to energy efficiency, as well as the results of the company's own research among consumers.[63] This research looked at attitudes towards energy efficiency and climate change among householders and small and medium-sized enterprises (SMEs).

Among householders, some of the main results from this survey work were as follows:

– a high awareness of the potential for problems arising from climate change;
– almost half of consumers (49%) had received no advice on energy efficiency, and of those who had, the most common source of information were energy suppliers;
– the most common reasons for not taking up energy efficiency measures were found to be not owning a property (ie, among tenants) and the (perceived) expense of the measures. Other important reasons were that houses were already efficient and a lack of knowledge about energy efficiency measures.

The further area in which the peer-reviewed literature provides useful insights is on the analysis of the effectiveness of different types of policy on the take-up of energy efficiency. Three recommendations on the use of **price instruments** emerge.

– Anderson & Newell (2004) found that firms are 40% more responsive to *initial costs* than to annual savings.[64] In short, the authors concluded that a capital subsidy is a more effective instrument than an increase in energy prices.

– Policy faces a free-rider problem—70% of the participants in a Norwegian programme providing subsidies for investment in energy efficiency were 'free riders' who would have invested in efficiency improvements even in the absence of the programme.[65]

– Allowing energy firms to run the programmes that provide incentives to invest in energy efficiency (thereby reducing the size of their market and profits) seems counterintuitive. Loughran & Kulick (2004) used panel data on 324 utilities between 1989 and 1999 to estimate the impact of the $14.7 billion spent by US utilities to encourage investments in energy efficiency. The authors concluded that demand-side management programmes had a much smaller effect on retail electricity sales than reported by utilities.[66] Similarly, Nichols (1994) questioned whether such programmes are effective, arguing that the

[62] Pittini, M., Collingwood, J., Webb, M. and Danskin, H. (2003), 'Distributional Implications of Product Charges on Energy Inefficient Appliances', Defra.

[63] E.ON and the University of East Anglia (2004), 'Powergen Energy Monitor 2004'.

[64] Anderson, S. T. and Newell, R. G. (2004), 'Information programs for technology adoption: The case of energy efficiency audit', *Resource and Energy Economics*, **26**, 27–50.

[65] Haugland, T. (1996), 'Social benefits of financial investment support in energy conservation policy', *Energy Journal*, **17**, 79–102.

[66] Loughran, D. S. and Kulick, J. (2004), 'Demand-side management and energy efficiency in the United States', *Energy Journal*, **25**, 19–43.

official evaluations always employ discount rates lower than those used by individuals, and do not factor in the cost of agents' time.[67]

## A2.2 Academic studies

Two important empirical studies provide insight into the relevant household characteristics. Brechling & Smith employed data on 7,000 households from the **1986 English House Condition Survey** to model the pattern of take-up of loft insulation, wall insulation and double glazing.[1] The data included physical information on the dwelling, in addition to socio-economic information about the occupants. They found that many of the socio-economic variables (unemployment, age, etc) are not significant determinants of energy efficiency. Although there was a significant positive relationship to household income, the magnitude was small. A larger negative effect was observed if a property is rented—privately rented properties are significantly less likely to invest in energy efficiency. The length of tenure in the property was also significant under some circumstances.

A large effect was found in the type of heating: insulation and double glazing are more likely in households with central heating, possibly because of a possible difference in attitudes and awareness of the household to investments in heating.

Scott replicated the Brechling & Smith study for Ireland using data on 1,200 households from a 1992 **TEAGASC** and **ESRI Consumer Survey**.[1] Measures analysed were loft insulation, hot water cylinder insulation, draught-proofing of windows and doors, insulating curtains, dry lining of walls, low-energy light bulbs and double glazing. Reasons found for not investing in energy efficiency included lack of information, the tenure problem, low rates of return, restricted access to credit, and transaction costs.

**Information instruments** have proved effective policy instruments, and most of the implications from the literature were reported above.[68] Some additional insight are provided by Ball, Ross & Gan (1999), who estimated a diffusion model of energy efficiency take-up using data collected from 705 households in Christ Church, New Zealand.[69] Among those who had already considered adoption of energy efficiency, it was the communication channels, not the perceived attributes, which determined whether take-up occurred. The authors concluded that effort should be directed towards establishing inter-personal communication strategies and increasing the visibility of benefits, rather than relying on mass-media campaigns.

Finally, the literature on **regulation**, in the form of appliance standards, suggests some advantages and disadvantages. Some commentators argue that appliance standards that require consumers to invest at lower discount rates reduce overall economic well-being.[70] Others argue that, given the extent of the informational problems, standards may increase utility by preventing consumers from making inappropriate choices.[71] Greening, Sanstad & McMahon (1997) found that energy performance standards significantly reduced energy consumption without adding much cost, leading to welfare gains for consumers.[72] One further

[67] Nichols, A. L. (1994), 'Demand-side management overcoming market barriers or obscuring real costs?', *Energy Policy*, **22**, 840–47.

[68] See also Sutherland, R. J. (1991), 'Market barriers to energy-efficient investments', *Energy Journal*, **12**, 15–34.

[69] Ball, R., Ross, C. and Gan, C. (1999), 'The diffusion of energy efficiency innovations among residential energy consumers', *New Zealand Economic Papers*, **33**, 115–35.

[70] Sutherland (1991), op. cit.

[71] Moxnes, E. (2004), 'Estimating customer utility of energy efficiency standards for refrigerators', *Journal of Economic Psychology*, **25**, 707–24.

[72] Greening, L. A., Sanstad, A. H. and McMahon, J. E. (1997), 'Effects of appliance standards on product price and attributes: An hedonic pricing model', *Journal of Regulatory Economics*, **11**, 181–94.

benefit of standards emerges from a more sophisticated understanding of the supplier market. If suppliers discriminate according to price, minimum standards can restrict the inefficient use of energy intensity to segment consumers.[73]

## Inter-departmental Analysts Group

Table A2.1 presents forecasts of potential energy efficiency savings (in MtC) from the Inter-departmental Analysts Group in 2002. The definitions in the table are: technical potential, all commercially available energy efficiency technologies; economic potential, a sub-set of the technical potential that passes a cost-effectiveness condition. The carbon savings are not restricted to a 2010 time period and have been adjusted on the basis of judgements made by the Inter-departmental Analysts Group.

**Table A2.1 Energy efficiency: technical potential versus economical potential in the domestic sector**

| | Technical potential | | Economic potential | |
|---|---|---|---|---|
| | (MtC) | (TWh) | (MtC) | (TWh) |
| **With economic potential** | | | | |
| Condensing boilers | 5.3 | 102 | 5.3 | 102 |
| Energy-efficient appliances | 3.6 | 31 | 3.6 | 31 |
| CWI | 2.6 | 50 | 2.6 | 50 |
| LI | 1.4 | 27 | 1.4 | 27 |
| Energy-efficient lighting | 1.1 | 9 | 1.1 | 9 |
| Controls | 0.4 | 3 | 0.4 | 3 |
| Hot water cylinder insulation | 0.3 | 6 | 0.3 | 6 |
| Micro-CHP | 4.5 | 87 | 0.2 | 87 |
| **Without economic potential** | | | | |
| Solid wall insulation | 2.8 | 54 | – | – |
| Double glazing (+ low emissivity) | 1.7 | 33 | – | – |
| Draught-proofing | 0.3 | 6 | – | – |
| Solar water heating | 1.6 | 31 | – | – |
| Ground source heat pump | 5.3 | 102 | – | – |
| High-performance glazing | 1.2 | 23 | – | – |
| **Total** | **32.1** | **564** | **14.9** | **315** |

Source: Performance and Innovation Unit (PIU), and Inter-departmental Analysts Group (2002), 'Long-term Reductions in Greenhouse Gas Emissions in the UK', February.

[73] Fischer, C. (2005), 'On the importance of the supply side in demand-side management', *Energy Economics*, **27**, 165–80.

# Appendix 3 Survey design

This appendix explores the adopted econometric approach in greater detail. It presents the results from the estimation of the econometric models and discusses the method employed to estimate respondents' implied discount rates.

The survey was designed to ensure that all respondents answered the questions on LI and CWI, as well as the questions on energy-saving light bulbs. With respect to appliances, 40% of the overall sample was asked about their choices with respect to televisions, while the remaining 60% of respondents were asked about their choices with respect to fridge-freezers.

A fifth of respondents were interviewed as part of a couple, with the interviewers recording whether one respondent from the couple was more dominant than the other. For each individual respondent, data on their demographics and attitudes towards energy efficiency were obtained, in order to complement the analysis of the factors affecting respondents' decisions to purchase energy-efficient items.

– Demographic data included variables such as household income, age, educational and employment status, and the age and type of dwelling.
– Attitudinal questions included the importance attached by the respondents to reducing the amount of energy use, views on the environment as well as their awareness of the availability of grants to cover the full cost of insulation, lighting and other energy-efficient items.

However, due to high levels of variation among responses to the questionnaire, it was not always possible to take account of differences in demographic and attitudinal characteristics.

### Analysis on choice of goods

To assess the factors influencing respondents' decisions to purchase LI and CWI, televisions and fridge-freezers, consumers were asked to choose between models with a range of characteristics (known as stated-preference analysis, as described in section 5.1). Respondents were asked to choose between items depending on hypothetical attributes (see Table A3.1).

**Table A3.1 Hypothetical attributes**

| Capital goods | Televisions | Fridge-freezers |
|---|---|---|
| Cost of the investment | Price | Price |
| Money saved each year as a result of the insulation | Cost of energy used each year | Energy efficiency rating |
| Official accreditation of the installer | Brand | Brand |
| Days of disruption to the home during the installation process | Screen size | Whether the fridge-freezer is frost-free |
| Recommendations from family and friends | Recommendations from family and friends | Proportion of the fridge-freezer allocated to the fridge and freezer segments |
| | Type of screen (flat or non-flat widescreen or LCD) | Number of shelves |

Source: Oxera.

For the capital goods analysis, respondents were asked to choose between installing either LI or CWI, installing both, or neither, based on the hypothetical attributes reported in the above table.

Stated-preference techniques were also used to assess the factors influencing respondents' decisions to purchase a television, where individuals were asked to choose between four hypothetical televisions with varying characteristics. For the fridge-freezer analysis, respondents were asked to choose between two hypothetical fridge-freezers, with information regarding one of the main attributes—the energy efficiency rating—varying across the sample. For the first half of the sample, information on the EU's energy rating was provided, while for the remainder of the sample, information on the rating was supplemented with data on the annual running cost of the fridge-freezer.

Revealed-preference questions were designed to assess the relationship between the likelihood of a respondent having an energy-saving light bulb in their home and their estimates of the durability, cost and lifetime savings associated with energy-saving light bulbs. Due to limitations on the practical length of a questionnaire, stated-preference questions on lighting were not included.

During estimation of the econometric models, the analysis has taken into account problems arising from the non-independence of observations, correlations between choice alternatives and the potential for various segments of the sample to value the attributes differently. For example, high-income households may be less sensitive to the cost of energy-efficient items compared with low-income households. To examine preferences and taste variation across market segments, the respondents' socio-economic characteristics were included in the modelling through the following two approaches:

– data was grouped into market segments and separate logit models were estimated with identical specifications for each segment, with tests undertaken to ascertain whether the estimated coefficients were the same across segments;[74] and

– dummy variables were created for each segment and the attribute to be examined, such as household income, was interacted with each dummy variable.

### Respondents' implied discount rates

To examine how respondents' value the money saved from installing LI or CWI relative to the upfront cost of the installation, discount rates were imputed from the logit models for each section of the sample, with segments based on demographic characteristics, such as household income.

The discount rates were estimated according to the method adopted by Sills, Pattanayak and Whittington (2004).[75] Equation A3.1 below illustrates a simplified standard conditional logit model (with the parameters defined below), which was estimated in order to assess respondents' decisions to purchase LI or CWI.

$$P_i = \alpha + \beta_1 \text{ cost} + \beta_2 \text{ benefit} + \text{other attributes} \qquad \text{Equation A3.1}$$

[74] In order to facilitate the construction of the take-up models, this approach was adopted instead of interacting a dummy with the variable of interest.

[75] Sills, E. O., Pattanayak, S. K. and Whittington, D. (2004), 'Water supply coverage and cost-recovery in Kathmandu: Understanding the role of time preferences and credit constraints', RTI International, Research Triangular Park, North Carolina State University.

| Parameter | Definition |
|---|---|
| $P_i$ | Probability of installing LI or CWI |
| $\alpha$ | Alternate-specific constant, which reflects the respondents' inherent bias towards installing either LI or CWI |
| $\beta_1$ | Coefficient to be estimated, which is associated with the cost of the insulation |
| cost | Cost of installing the insulation |
| $\beta_2$ | Coefficient to be estimated, which is associated with the money to be saved as a result of installing the insulation |
| benefit | Money saved from installing the insulation |
| other attributes | Other attributes associated with LI or CWI, such as recommendations from family and friends |

Estimation of discount rates was based upon the assumption that the marginal disutility of the cost of the installation equals the marginal utility of the net present value of the benefits. This assumption is captured through Equation A3.2, with the parameters defined thereafter.

$$-(\partial U / \partial C) = \partial U / \partial(NPV_{benefit}) = \partial U / \partial(Benefit / r) \qquad \text{Equation A3.2}$$

| Parameter | Mathematical definition | Economic interpretation |
|---|---|---|
| $-(\partial U / \partial C)$ | The negative of the first derivative of utility with respect to cost | The marginal disutility of the cost of installing either LI or CWI |
| $\partial U / \partial(NPV_{benefit})$ | The first derivative of utility with respect to the net present value of the benefits | The marginal utility of the benefits, in terms of money saved in the future, as a result of installing either LI or CWI |
| $\partial U / \partial(Benefit / r)$ | The first derivative of utility with respect to the benefits, which are discounted at the discount rate (r) | The marginal utility of the benefits, which are discounted at the discount rate (r), as a result of installing either LI or CWI |

This implies that the negative of the estimated coefficient associated with the cost of the installation ($-\beta_1$) equals the estimated coefficient associated with the benefits from the installation ($\beta_2$) multiplied by the discount rate (r), as illustrated in Equation A3.3.

$$-\beta_1 = \beta_2 \times r \qquad \text{Equation A3.3}$$

From Equation A3.3, the discount rate is estimated to be equal to the value, shown by Equation A3.4, which assumes a constant exponential discount rate.

$$r = (-\beta_1/\beta_2) \qquad \text{Equation A3.4}$$

## Results

Tables A3.2 to A3.5 below present the results from the stated- and revealed-preference analysis. A general-to-specific approach has been followed, with those right-hand side variables, which are not statistically significant at the 5% level, excluded from the model.

### Table A3.2 Results of the estimation of the conditional logit model for capital goods

| Parameter | Coefficient | Robust standard error |
|---|---|---|
| **Low income (less than £12,000)** | | |
| Upfront cost of LI | –0.003 | 0.000 |
| Upfront cost of CWI | –0.002 | 0.000 |
| Disruption associated with installing LI | –0.245 | 0.064 |
| Positive recommendation by friends or family for LI | 0.390 | 0.138 |
| Very positive recommendation by friends or family for LI | 0.633 | 0.138 |
| Positive recommendation by friends or family for CWI | 0.772 | 0.140 |
| Very positive recommendation by friends or family for CWI | 0.805 | 0.152 |
| Constant for LI | 0.482 | 0.183 |
| Constant for CWI | –0.452 | 0.158 |
| **Medium income (between £12,000 and £30,000)** | | |
| Upfront cost of LI | –0.003 | 0.000 |
| Upfront cost of CWI | –0.003 | 0.000 |
| Disruption associated with installing LI | –0.229 | 0.047 |
| Positive recommendation by friends or family for LI | –0.176 | 0.044 |
| Very positive recommendation by friends or family for LI | 0.272 | 0.120 |
| Positive recommendation by friends or family for CWI | 0.769 | 0.122 |
| Very positive recommendation by friends or family for CWI | 0.824 | 0.139 |
| Constant for LI | 0.978 | 0.120 |
| Constant for CWI | 0.902 | 0.115 |
| Upfront cost of LI | 0.164 | 0.138 |
| Upfront cost of CWI | 0.021 | 0.124 |
| **High income (over £30,000)** | | |
| Upfront cost of LI | –0.004 | 0.000 |
| Upfront cost of CWI | –0.003 | 0.000 |
| Disruption associated with installing LI | –0.231 | 0.049 |
| Positive recommendation by friends or family for LI | 0.440 | 0.122 |
| Very positive recommendation by friends or family for LI | 1.069 | 0.148 |
| Positive recommendation by friends or family for CWI | 1.304 | 0.139 |
| Very positive recommendation by friends or family for CWI | 1.205 | 0.114 |
| Constant for LI | 1.135 | 0.120 |
| Constant for CWI | 0.279 | 0.140 |
| Upfront cost of LI | –0.203 | 0.104 |

Source: Oxera calculations.

### Table A3.3 Results of the estimation of the conditional logit model for fridge-freezers

| Parameter | Coefficient | Robust standard error |
|---|---|---|
| Price | –0.007 | 0.005 |
| Energy efficiency rating A (highest rating) | 1.408 | 0.102 |
| Energy efficiency rating B | 1.179 | 0.092 |
| Energy efficiency rating C (lowest rating) | 0.427 | 0.083 |
| Frost-free relative to the base of non-frost-free | 0.642 | 0.057 |
| Proportion fridge/freezer: 1/3 freezer relative to 1/2 freezer | –0.305 | 0.062 |

Source: Oxera calculations.

### Table A3.4 Results of the estimation of the conditional logit model for televisions

| Parameter | Coefficient | Robust standard error |
|---|---|---|
| Price | –0.002 | 0.000 |
| Cost of energy used each year | –0.012 | 0.005 |
| Phillips brand relative to the base (Panasonic) | –0.201 | 0.066 |
| Toshiba brand relative to the base (Panasonic) | –0.158 | 0.060 |
| Flat widescreen interacted with screen size | 0.008 | 0.002 |
| Very positive recommendation by family or friends | 0.433 | 0.055 |
| Positive recommendation by family or friends | 0.709 | 0.060 |

Source: Oxera calculations.

### Table A3.5 Results of the estimation of the logit model for light bulbs

| Parameter | Coefficient | Standard error |
|---|---|---|
| Respondents' estimate of the price of an energy-saving light bulb | –0.089 | 0.025 |
| Respondents' estimate of the monetary savings over the lifetime of one energy-saving light bulb | 0.012 | 0.006 |
| Respondents' estimate of the durability of an energy-saving light bulb | 0.128 | 0.039 |
| Constant | 0.772 | 0.175 |

Note: As each respondent only made one choice, the standard error does not need to be corrected.
Source: Oxera calculations.

# Appendix 4 Survey text

VERSION A - CAPITAL GOODS (INSULATION) AND TVs (400 SAMPLE)
VERSION B - CAPITAL GOODS (INSULATION) AND FRIDGE\FRIDGEFREEZER (600 SAMPLE)

Hello, my name is .. from TNS and I'm conducting a survey of people's opinions about an issue to do with improving your home. This research is funded by you, the taxpayer, and not by any private companies. The survey takes about 20 minutes, all answers are confidential and I'm not trying to sell anything and your answers will not be passed on to any other firms.

Q.a Before I start can I just ask if you own your current home or if you are renting it?

01: own home
02: renting
03: other
04: DK
05: Refused

(Continue interview if code 01, others close interview)

Q.b INTERVIEWER: CHOOSE RESPONDENT TYPE

01: Individual male respondent
02: Individual female respondent
03: Male and female couple answering jointly
04: Other (please specify)

**SECTION A: INVENTORY OF CAPITAL GOODS (Ask all)**

I am going to begin by asking you a few questions about your home.

Q.1 What sort of home do you live in?

01: Flat or apartment
02: Detached house
03: Semi-detached house
04: Terraced house (mid terrace)
05: End of terrace house.
06: Other (please specify)
07: DK
08: Refused

Q.2 How many bedrooms are there in your house?

Q.3 Approximately when was your home built?

01: Newly built (2000 to present)
02: 1980s to 2000
03: Post-war to late 1970's
04: Pre-war 20th Century
05: Victorian or earlier
06: DK \ unsure
07: Refused

(If code 06, ask Q.3a. Others go to Q.4)

Q.3a If you are unsure then you can indicate two or more of these age ranges.

01: Newly built (2000 to present)
02: 1980s to 2000
03: Post-war to late 1970's
04: Pre-war 20th Century
05: Victorian or earlier
06: DK \ unsure
07: Refused

Q.4 How long have you been living in this house?

Q.5 What is your best estimate of how many more years you would expect to live in this house before moving house?

Please tell me which of the following responses best describes whether your house has or intends to get this item.

Q.6a Loft Insulation, by which I mean matting or other material in the loft space to reduce heat loss through the roof.

Which category number best describes your house regarding this item?

01: 1 - Yes, the item was already fitted when we purchased this house
02: 2 - Yes, we have fitted or added to it since purchasing this house
03: 3 - Not sure
04: 4 - No, this item cannot be fitted in this house
05: 5 - No, but I am considering purchasing it
06: 6 - No, and I am not considering purchasing it

Q.6b Cavity Wall Insulation, where insulating material is inserted into the cavities between the inner and outer walls of brickwork that make up the outside of your property

Which category number best describes your house regarding this item?

01: 1 - Yes, the item was already fitted when we purchased this house
02: 2 - Yes, we have fitted or added to it since purchasing this house
03: 3 - Not sure
04: 4 - No, this item cannot be fitted in this house
05: 5 - No, but I am considering purchasing it
06: 6 - No, and I am not considering purchasing it

**SECTION B: PERCEPTIONS OF CAPITAL GOODS (Ask all)**

Now think about a house of similar size and number of bedrooms to your own. In this house both loft insulation nor cavity wall insulation could be installed.

Q.7 I want to find out how much you think each item might cost to install in a house like that.

Q.7a Loft insulation
Q.7b Cavity wall insulation

What is your best estimate of what it might cost to install <7a or 7b>?

Which of the following best describes your confidence in the estimate you have given?

01: I am extremely certain. The true figure should only be a few pounds different from my estimate.
02: I am fairly certain. The true figure should be within £100 of my estimate.
03: I am fairly unsure. The true figure could easily be several hundred pounds different to my estimate.
04: I am very unsure. The true figure could be over a thousand pounds different to my estimate.
05: Don’t know.

Thank you. I now want to repeat that exercise for the <RANDOMLY INSERT the one out of Q7a, Q7b NOT ASKED PREVIOUSLY>. Again what is your best estimate of what it might cost to install.

And which of the following best describes your confidence in the estimate you have given?

01: I am extremely certain. The true figure should only be a few pounds different from my estimate.
02: I am fairly certain. The true figure should be within £100 of my estimate.
03: I am fairly unsure. The true figure could easily be several hundred pounds different to my estimate.
04: I am very unsure. The true figure could be over a thousand pounds different to my estimate.
05: Don't know.

Q.8 I would like you to consider the entire process prior to the installation of any of these items. This includes obtaining information about the items, time spent obtaining quotes and choosing suppliers, and any related inconvenience.

Using the following responses, please tell me your assessment of the amount of inconvenience you would expect prior to installation in obtaining..

..Loft Insulation
..Cavity wall insulation

01: 1 - A great deal of inconvenience
02: 2 - Considerable inconvenience
03: 3 - A little inconvenience
04: 4 - No inconvenience
05: DK

Q.9 How long do you think it would take installers to fully install each of these items?
Please answer to the nearest half day.

..Loft insulation
..Cavity wall insulation

Q.10 For each of the features we have discussed please tell me to what extent you agree with the following….

..Loft insulation
..Cavity wall insulation

: …Most suppliers would carry out the work to the agreed timetable.

01: Strongly agree
02: Somewhat agree
03: Neither agree nor disagree
04: Somewhat disagree
05: Strongly disagree
06: DK

Q. For each of the features we have discussed please tell me to what extent you agree with the following….

..Loft insulation
..Cavity wall insulation

…Most suppliers would carry out the work to my satisfaction.

01: Strongly agree
02: Somewhat agree
03: Neither agree nor disagree
04: Somewhat disagree
05: Strongly disagree
06: DK

Q.11 Now the items we have discussed have a number of different benefits. One of these may be that they save you money in terms of reduced energy bills each year.

Q.11a loft insulation
Q.11b cavity wall insulation

Please give me your best estimate of the amount that <RANDOMLY INSERT ONE OF Q11a or Q11b > might save you over the course of a year.

Which of the following best describes your confidence in the estimate you have given?

01: I am extremely certain. The true figure should only be a few pounds different from my estimate.
02: I am fairly certain. The true figure should be within £100 of my estimate.
03: I am fairly unsure. The true figure could easily be several hundred pounds different to my estimate.
04: I am very unsure. The true figure could be over a thousand pounds different to my estimate.
05: DK

Now I would like to repeat that exercise for < INSERT ONE OF Q11a, Q11b, NOT MENTIONED PREVIOUSLY>. Please give me your best estimate of the amount that <INSERT NAME OF 2ND ITEM> might save you over the course of a year.

Which of the following best describes your confidence in the estimate you have given?

01: I am extremely certain. The true figure should only be a few pounds different from my estimate.
02: I am fairly certain. The true figure should be within £100 of my estimate.
03: I am fairly unsure. The true figure could easily be several hundred pounds different to my estimate.
04: I am very unsure. The true figure could be over a thousand pounds different to my estimate.
05: Don't know.

Q.12 Installing these energy saving features might affect the selling price of a house. Using the following responses, I want you to tell me the extent to which you feel the presence of each of these features alters the selling price of a house, compared to the cost of that feature.

..Loft insulation
..Cavity wall insulation

The presence of this feature..

01: Increases house price by more than the cost of the feature
02: Increases house price by about the cost of the feature
03: Increases house price by less than the cost of the feature
04: Does not increase house price
05: Don't know.

Q.13 Suppose you were considering moving house. Please tell me how important the presence of each feature would be to your decision to buy a particular house?

..Loft insulation
..Cavity wall insulation

..Importance to the decision to buy a particular house

01: Essential
02: Fairly important
03: Fairly unimportant
04: Completely unimportant
05: DK

**SECTION C: STATED PREFERENCE QUESTIONS FOR CAPITAL GOODS (Ask all)**

In the following questions please imagine that you are moving to a house which is similar in size, and has the same number of bedrooms as the one you are living in now. This house has neither loft insulation nor cavity wall insulation although they could both be installed.

Q.14 If you had just moved to such a house how many years do you think it would be before you moved again?

The following questions concern whether you would install types of insulation in the first year after moving into that house. The questions ask you to choose between not installing either Loft Insulation or Cavity Wall Insulation, or installing one, or the other, or installing both.

Now lots of different companies offer these features, but the options they offer differ in a number of ways. Also your attitude to these investments may differ depending on how long you intend to stay in this new house, who recommends the scheme to you and so on.

To reflect this I am going to present you with a number of options to choose between. Now I am going to start off with an introductory example, just to illustrate how the subsequent choice questions work.

So, to illustrate this consider the following description of a Loft Insulation option.

Loft Insulation
Recommendation from family or friends?: No experience of it
Days of installation work \ disruption to your house: One day
Installer: Not officially approved
Cost of investment (£): £200
Money saved each year (£ per annum): £60

Here the first row indicates that neither friends nor family have experience of this item and so cannot give you either a positive or negative recommendation regarding fitting loft insulation.

The next row tells you that purchasing Loft Insulation results in about one day of disruption for your household including preparation time, time that installers are working at your house and tidying up afterwards.

The third row shows that the installer is not officially approved.

The fourth row tells you that, in this example, the cost of loft insulation is £200, while the final row tells you that it will save you £60 per year.

To let you indicate whether or not you would undertake this investment, in the following table we compare the option of not purchasing this feature, which we label Option A, with the alternative of undertaking the Loft Insulation, which we label Option B.

Now we add in Cavity Wall Insulation. Here you can see that the cost is £400, the savings are £80 per year, it takes two days to install through an approved fitter and you have had a positive recommendation from friends or family.

Loft Insulation: Cavity Wall Insulation
Recommendation from family or friends?: No experience of it: Positive reports
Days of installation work \ disruption to your house: One day: Two days
Installer: Not officially approved: Officially approved
Cost of investment (£): £200: £400
Money saved each year (£ per annum): £60: £80

Now the next few questions ask you to look at tables like this. In each table various details of the options change. All you have to do is tell us about your preferences regarding these options.

We will use the illustrative example you have seen so far to practice how you make choices, although this one is just for practice.

Here you have the same options as before and all you have to do is to choose what you feel would be best for you during the first year after moving into that house.

Loft Insulation: Cavity Wall Insulation
Recommendation from family or friends?: No experience of it: Positive reports
Days of installation work \ disruption to your house: One day: Two days

Installer: Not officially approved: Officially approved
Cost of investment (£): £200: £400
Money saved each year (£ per annum): £60: £80
Choice: Purchase loft insulation: Purchase cavity wall insulation
(Blank cell): Don't purchase loft insulation: Don't purchase cavity wall insulation

You can see that for each type of insulation you have a choice – you can choose to purchase it or you can choose not to purchase it. So you can choose to purchase both Loft Insulation and Cavity Wall Insulation, or you can purchase one or the other, or you can choose not to purchase either.

Do you have any questions before I ask you to make the first choice?

Q.15a OK, please look again at the options and tell me if you would purchase loft insulation.

01: Purchase loft insulation
02: Don't purchase loft insulation
03: DK

Q15b. And now please look at the options once more and tell me if you would purchase cavity wall insulation
01: Purchase cavity wall insulation
02: Don't cavity wall insulation
03: DK

Q.16

OK, that concludes the introductory example. I am now going to ask you to make some choices 'for real', that is I want you to think about the options I present and answer as if you really were considering investing your own money in purchasing them during the first year after moving into that house. Remember that in all the choices, this house currently has neither loft insulation nor cavity wall insulation although they could both be installed.

Q.16 Here is the first choice question.

Q16a.
01: Purchase loft insulation
02: Don't purchase loft insulation
03: DK

Q16b.
01: Purchase cavity wall insulation
02: Don't cavity wall insulation
03: DK

(7 more questions - all the same format as Q.16, using random options 1-16 from spreadsheet but not repeating any of the options if already asked)

Q.24 Now there may be other factors to consider when deciding whether to fit either type of insulation. I am going to read out a list of possible factors, please use the following responses to tell me how important each one is.

..Price
..Advice from the local council
..Advice from energy suppliers
..Advice from the Energy Saving Trust
..Whether there is an official list of approved installers
..Wanting to be energy-efficient
..Recommendations from family or friends

01: Not at all important
02: Not particularly important
03: Quite important

04: Very important
05: DK

Q.25 To conclude this section, if you were to purchase Loft Insulation, how likely is it that you or a partner in the household would undertake its installation rather than getting an installer to do this work.

01: I\we certainly would undertake the installation
02: I\we probably would undertake the installation
03: I\we probably would not undertake the installation
04: I\we certainly would not undertake the installation
05: DK

**SECTION D - INVENTORY FOR APPLIANCES (ask all)**

I am now going to ask some questions regarding the everyday electrical appliances that you have in your home.

Q.27 Does your home have any of the following?

01: Separate Fridge
02: Separate Freezer
03: Combined Fridge\Freezer
04: TV
05: None
06: DK

**SECTION E1: STATED PREFERENCE QUESTIONS FOR TVs**
(Ask all version A respondents excluding those who do not code 06 at Q.27)

In the following questions, imagine that your main television needs replacing. Each question presents you with a choice between four televisions, each described through a variety of features

Blank cell: Television 1: Television 2: Television 3: Television 4
Brand (make): Sony: Toshiba: Panasonic: Philips
Screen size (inches): 24: 32: 28: 24
Recommendation from family or friends?: No experience: Positive: Very positive
reports: Negative reports
Price (£): £249: £699: £399: £999
Cost of energy used per year: £10: £15: £25: £10
Type: Non-flat widescreen: Flat widescreen: Flat widescreen: LCD:

The first row shows the make. The second row shows you the size of the screen.

The third row shows whether friends or family have recommended this TV to you. Next its price is given. The price includes all delivery charges and installation speakers and a stand. Then we show you the average running cost of the TV in one year. The last row tells you the type of television.

Widescreen TVs have a cathode ray tube like traditional TVs, but have a similar shape to a cinema screen. Non-flat screens have curved edges, again like traditional TVs, whereas flat screens minimize screen distortion. LCD TVs do not have tubes and are slim enough to be hung on a wall.

Q.28 Now, considering the various features of these four TVs, which would you choose?

01: Television 1
02: Television 2
03: Television 3
04: Television 4
05: DK

OK, that concludes the introductory example. I am now going to ask you to make some choices 'for real', that is I want you to think about the options I present and answer as if you really were considering investing your own money in purchasing them.

Here is the first choice question.

Q.29 Which would you choose?

01: Television 1
02: Television 2
03: Television 3
04: Television 4
05: DK

Q.30
Q.31
Q.32
Q.33
Q.34
Q.35
Q.36

(same format as Q.29, using random selection 1-16 from "TV 01.xls" but not repeating any of the 1-16 options already asked)

Q.37 I am going to read out a wider list of factors which may or may not be important to you when buying a new TV. Please use the following responses to tell me how important each factor is.

..Price
..Brand (make)
..Ensuring it uses the latest technology
..Appearance, look and style
..Energy efficiency
..Recommendations from family or friends
..The shop you buy it from
..Advice from point of sale staff

01: Not at all important
02: Not particularly important
03: Quite important
04: Very important
05: DK

(Go to SECTION F)

**SECTION E2: STATED PREFERENCE QUESTIONS FOR FRIDGES AND FRIDGE\FREEZERS**

(Ask all version B respondents as long as code 03 or 04 at Q.27)
(those who code 03 at Q.27 skip to section E2FF: FRIDGEFREEZER)
(ask those who code 04 and not 03 at Q.27):

Q.38 If your fridge needed replacing do you think you would purchase another fridge or a fridge-freezer?

01: Fridge (go to section E2F: FRIDGE)
02: Fridge-freezer (go to section E2FF: FRIDGEFREEZER)
03: DK (go to section E2F: FRIDGE)

**SECTION: E2F.FRIDGE**

THE SAMPLE IS RANDOMLY DIVIDED INTO TWO EQUAL PARTS. THE ENERGY EFFICIENCY OF THE FRIDGE BEING DESCRIBED IN TWO WAYS:

E2.FRIDGE-VERSION 1: HERE WE JUST USE THE EU ENERGY RATING INFORMATION GIVEN OUT WITH ALL FRIDGES SOLD IN UK SHOPS (Order 1)

E2.FRIDGE-VERSION 2: HERE WE AGAIN USE THE EU ENERGY RATING INFORMATION GIVEN OUT WITH ALL FRIDGES SOLD IN UK SHOPS - BUT NOW THIS IS SUPPLEMENTED BY TELLING THE RESPONDENT WHAT THE ANNUAL RUNNING COST WILL BE FOR DIFFERENT RATINGS. (Order 2)

(Need to record whether order 1 or order 2 answered)

**E2.FRIDGE-VERSION 1: (order 1)**

In the following questions, imagine that your present fridge needs replacing and you are planning to buy a new fridge of a similar size. Each question presents you with a choice between two fridges, with each being described through a variety of features. An illustration is given in this introductory example

Blank cell: Fridge 1: Fridge 2
Brand (make): Bosch: Zanussi
Does it have castors or rollers?: Yes: No
Has it got an ice box?: Yes: No
Price (£): £199: £169
Energy-efficient rating (A=highest, G=lowest): B: C
Automatic defrost?: No: Yes

The first of these is the manufacturer of the fridge.

Next there is whether the fridge has castors or rollers which can make it easier to move the fridge for cleaning.

The third row tells you whether the fridge has an ice-box or not.

Next its price is given. Then we tell you the energy efficiency rating which you will see in shops as the scale shown in this picture where A is the highest level of efficiency and G is the lowest.

The last row of the table tells whether the fridge defrosts automatically or not.

Q.39 Now, considering the various features of these two fridges, which would you choose?

01: Fridge 1
02: Fridge 2
03: DK

OK, that concludes the introductory example. I am now going to ask you to make some choices 'for real', that is I want you to think about the options I present and answer as if you really were considering investing your own money in purchasing them.

Q.40 Which would you choose?

01: Fridge 1
02: Fridge 2
03: DK

Q.41
Q.42
Q.43
Q.44
Q.45
Q.46
Q.47

**E2.FRIDGE-VERSION 2: (order 2)**

In the following questions, imagine that your present fridge needs replacing and you are planning to buy a new fridge of a similar size. Each question presents you with a choice between two fridges, with each being described through a variety of features. An illustration is given in this introductory example

Blank cell: Fridge 1: Fridge 2
Brand (make): Bosch: Zanussi
Does it have castors or rollers?: Yes: No
Has it got an ice box?: Yes: No
Price (£): £199: £169
Energy-efficient rating (A=highest, G=lowest) (and running costs each year):
B (£28): C (£41)
Automatic defrost?: No: Yes

The first of these is the manufacturer of the fridge.

Next there is whether the fridge has castors or rollers which can make it easier to move the fridge for cleaning.

The third row tells you whether the fridge has an ice-box or not.

Next its price is given. Then we tell you the energy efficiency rating which you will see in shops as the scale shown in this picture, where A is the highest level of efficiency and G is the lowest. Looking back at the table, notice that under each rating it shows the running cost each year for each fridge.

Q.48 Now, considering the various features of these two fridges, which would
you choose?

01: Fridge 1
02: Fridge 2
03: DK

OK, that concludes the introductory example. I am now going to ask you to make some choices 'for real', that is I want you to think about the options I present and answer as if you really were considering investing your own money in purchasing them.

Here is the first choice question.

Q.49 Which would you choose?

01: Fridge 1
02: Fridge 2
03: DK

Q.50
Q.51
Q.52
Q.53
Q.54
Q.55
Q.56

Q.57 I am going to read out a wider list of factors which may or may not be important to you when buying a new fridge. Please use the following responses to tell me how important each factor is.

..Price
..Brand (make)
..Ensuring it uses the latest technology
..Appearance, look and style
..Energy efficiency
..Recommendations from family or friends
..The shop you buy it from
..Advice from point of sale staff

01: Not at all important
02: Not particularly important
03: Quite important
04: Very important
05: DK

**SECTION E2FF: FRIDGEFREEZER**

(SCRIPTER - PLEASE NOTE THE FOLLOWING:THERE ARE TWO VERSIONS OF THE QUESTIONS ASKED IN THIS SUBSECTION - split the sample equally into two random groups - order 1 and order 2)

THE SAMPLE IS RANDOMLY DIVIDED INTO TWO EQUAL PARTS. THE ENERGY EFFICIENCY OF THE FRIDGEFREEZER BEING DESCRIBED IN TWO WAYS:

E2.FRIDGEFREEZER-VERSION 1: HERE WE JUST USE THE EU ENERGY RATING INFORMATION GIVEN OUT WITH ALL FRIDGEFREEZERS SOLD IN UK SHOPS (order 1)

E2.FRIDGEFREEZER-VERSION 2: HERE WE AGAIN USE THE EU ENERGY RATING INFORMATION GIVEN OUT WITH ALL FRIDGEFREEZERS SOLD IN UK SHOPS - BUT NOW THIS IS SUPPLEMENTED BY TELLING THE RESPONDENT WHAT THE ANNUAL RUNNING COST WILL BE FOR DIFFERENT RATINGS (order 2)

**E2.FRIDGEFREEZER-VERSION 1: (order 1)**

SHOW SCREEN
In the following questions, imagine that your present fridge-freezer needs replacing and you are planning to buy a new one of a similar size. Each question presents you with a choice between two fridge-freezers, with each being described through a variety of features. An illustration is given in this introductory example

Blank cell: Fridge-freezer 1: Fridge-freezer 2
Brand (make): Bosch: Zanussi
Frost free: Yes: No
Proportion fridge \ proportion freezer: Half Fridge, Half Freezer: Two-thirds Fridge, One-third Freezer
Price (£): £349: £299
Energy efficiency rating (A = highest, G=lowest): B: C
Number of Shelves in fridge: 2:3

The first row is the manufacturer of the fridge-freezer.

The next row tells you whether the freezer is frost-free – meaning that there is no build up frost, so no need to defrost.

The third row tells you the proportion which is fridge and the proportion which is freezer.

Next its price is given. Then we tell you the energy efficiency rating which you will see in shops as the scale shown in this picture (SHOW SHOWCARD B), where A is the highest level of efficiency and G is the lowest.

The last row of the table tells you how many shelves there are in the fridge section of the fridge-freezer.

Q.58 Now, considering the various features of these two fridge-freezers, which would you choose?

01: Fridge-freezer 1
02: Fridge-freezer 2
03: DK

OK, that concludes the introductory example. I am now going to ask you to make some choices 'for real', that is I want you to think about the options I present and answer as if you really were considering investing your own money in purchasing them.

Q.59 Which would you choose?

01: Fridge-freezer 1
02: Fridge-freezer 2
03: DK

Q.60
Q.61
Q.62
Q.63
Q.64
Q.65
Q.66

**E2.FRIDGEFREEZER-VERSION 2: (order 2)**

In the following questions, imagine that your present fridge-freezer needs replacing and you are planning to buy a new one of a similar size. Each question presents you with a choice between two fridge-freezers, with each being described through a variety of features. An illustration is given in this introductory example

Blank cell: Fridge-freezer 1: Fridge-freezer 2
Brand (make): Bosch: Zanussi
Frost free: Yes: No
Proportion fridge \ proportion freezer: Half Fridge, Half Freezer: Two-thirds Fridge, One-third Freezer
Price (£): £349: £299
Energy efficiency rating (A = highest, G=lowest) (and running costs each year): B (£29): C (£42)
Number of shelves in fridge: 2:3

The first row is the manufacturer of the fridge-freezer.

The next row tells you whether the freezer is frost-free – meaning that there is no build up frost, so no need to defrost.

The third row tells you the proportion which is fridge and the proportion which is freezer.

Next its price is given. Then we tell you the energy efficiency rating which you will see in shops as the scale shown in this picture, where A is the highest level of efficiency and G is the lowest. Looking back at the table, notice that under each rating it shows the running cost each year for each fridge-freezer.

The last row tells you how many shelves there are in the fridge section of the fridge-freezer.

Q.67 Now, considering the various features of these two fridge-freezers, which would you choose?

01: Fridge-freezer 1
02: Fridge-freezer 2
03: DK

OK, that concludes the introductory example. I am now going to ask you to make some choices 'for real', that is I want you to think about the options I present and answer as if you really were considering investing your own money in purchasing them.

Q.68 Which would you choose?

01: Fridge-freezer 1
02: Fridge-freezer 2
03: DK

Q.69

Q.70
Q.71
Q.72
Q.73
Q.74
Q.75

Q.76 I am going to read out a wider list of factors which may or may not be important to you when buying a new fridge-freezer. Please use the following responses to tell me how important each factor is.

..Price
..Brand (make)
..Ensuring it uses the latest technology
..Appearance, look and style
..Energy efficiency
..Recommendations from family or friends
..The shop you buy it from
..Advice from point of sale staff

01: Not at all important
02: Not particularly important
03: Quite important
04: Very important
05: DK

**SECTION F: QUESTIONS ABOUT LIGHT BULBS**

I now want to ask about a different issue.

Q.77 Do you have any energy saving light bulbs in your house?

01: Yes (continue with Q.78)
02: No (skip next two questions, go to Q.80)
03: DK (skip to Section G)

Q.78 How many energy saving light bulbs do you have in your house?

Q.79 What were the reasons why you bought energy saving light bulbs?

01: Because they save money
02: Because they save energy
03: Because they are good for the environment
04: Because they reduce the number of times I have to change light bulbs
05: Last longer\more reliable
06: Other (write in)

Q.80 What were the reasons why you have not bought any of these?

01: Cost\ Too expensive
02: I do not know (enough) about them
03: I do not believe they give the claimed energy savings
04: I do not believe they last as long as claimed
05: They do not fit my lamps
06: They give a strange\poorer light
07: They take too long to turn on
08: Never thought about buying them
09: Do not know where they are sold
10: They are not sold in the stores I visit
11: I do not like how the bulbs look
12: Other (write in)

Q.81 What is your best estimate of how long an energy saving light bulb lasts in typical use?

Q.82 And what is your best estimate of what it costs to buy one energy saving light bulb?

Q.83 What is your best estimate of the money one energy saving light bulb might save you over its lifetime?

01: They don't save money
02: Less than £5
03: £5 to £10
04: £10 to £25
05: £25 to £50
06: £50 to £75
07: £75 to £100
08: Over £100
DK

**SECTION G: ATTITUDE QUESTIONS (Ask all)**

I'm now going to ask you some attitude questions.

Q.84 I think reducing the amount of energy our household uses is important.

01: Strongly Agree
02: Agree
03: Neither Agree nor disagree
04: Disagree
05: Strongly Disagree
06: DK

Q.85 When we purchase appliances we always check energy efficiency information for each item we consider.

01: Strongly Agree
02: Agree
03: Neither Agree nor disagree
04: Disagree
05: Strongly Disagree
06: DK

Q.87 How often do you typically pay for your electricity?

01: Annually
02: Quarterly
03: Monthly
04: Weekly
05: When it runs out
06: Other (type in)

Q.88 What is your best estimate of how much you pay for electric

Q.89 Using the following scale, please tell me how certain you are about the accuracy of that last answer?

01: Extremely certain
02: Fairly certain
03: Fairly unsure
04: Extremely unsure
05: DK

Q.90 Looking at this list, have you ever used any of these sources of information to get any advice on energy efficiency?

01: Family and\or friends

02: Energy suppliers
03: Shops
04: Council
05: Citizens Advice Bureau
06: Energy Saving Trust
07: Internet
08: Magazines and newspapers
09: Other (write in)
10: None
11: DK

Q.91 In your opinion, what are the reasons why some people purchase energy-efficient items for their homes?

01: Because they save money
02: Because they save energy
03: Because they make the house warmer
04: Because they are good for the environment
05: To be good citizens\play their part
06: Last longer\more reliable
07: Other (write in)
08: DK

Q.92 And again, in your opinion, what are the reasons why some people do not purchase energy-efficient items for their homes?

01: Cost\ Too expensive
02: Lack of knowledge
03: These items do not give the claimed energy savings
04: These items do not last as long as claimed
05: These items are not as good in other respects as conventional products
06: Not readily available
07: Cannot trust companies selling these items
08: Cannot trust companies installing these items
09: Other (write in)
10: DK

**SECTION H: HOUSEHOLD CHARACTERISTICS (ask all)**

To finish off, I just have a few more questions about you and your household. Please remember that all of these answers are completely confidential.

Q.100 Could you tell me your post code?

Q.101 Which of these educational levels have you completed?

01: Primary School (up to 10 yrs)
02: Secondary School (up to 16 yrs)
03: Upper Secondary School (up to 18 yrs)
04: University degree or equivalent
05: Professional qualification
06: Other
07: None
08: DK
09: Refused

(Ask male and female couple answering jointly, i.e. code 03 at Q.b)
Q.101b Which of these educational levels have you completed?

01: Primary School (up to 10 yrs)
02: Secondary School (up to 16 yrs)
03: Upper Secondary School (up to 18 yrs)
04: University degree or equivalent

05: Professional qualification
06: Other
07: None
08: DK
09: Refused

Ask for female respondent
Q.101c Which of these educational levels have you completed?

01: Primary School (up to 10 yrs)
02: Secondary School (up to 16 yrs)
03: Upper Secondary School (up to 18 yrs)
04: University degree or equivalent
05: Professional qualification
06: Other
07: None
08: DK
09: Refused

(Ask all except male and female couple answering jointly, i.e. code 03 at Q.b)
Q.102 Which of these statements best describes your current employment status?

01: Self-employed
02: Employed full-time
03: Employed part-time
04: Student
05: Unemployed
06: Looking after the home full-time
07: Retired
08: Unable to work due to sickness or disability
09: Other (write in)
10: DK
11: Refused

(Ask male and female couple answering jointly, i.e. code 03 at Q.b)
Ask for male respondent
Q.102b Which of these statements best describes your current employment status?

01: Self-employed
02: Employed full-time
03: Employed part-time
04: Student
05: Unemployed
06: Looking after the home full-time
07: Retired
08: Unable to work due to sickness or disability
09: Other (write in)
10: DK
11: Refused

INTERVIEWER: Ask for female respondent
Q.102c Which of these statements best describes your current employment status?

01: Self-employed
02: Employed full-time
03: Employed part-time
04: Student
05: Unemployed
06: Looking after the home full-time
07: Retired
08: Unable to work due to sickness or disability
09: Other (write in)
10: DK

11: Refused

(Ask all except male and female couple answering jointly, i.e. code 03 at Q.b)
Q.103 Can you tell me your age?

(Ask male and female couple answering jointly, i.e. code 03 at Q.b)
INTERVIEWER: Ask male respondent
Q.103b Can you tell me your age?

INTERVIEWER: Ask female respondent
Q.103c Can you tell me your age?

WRITE IN YEARS
Refused - estimate age

Q.104 How many people in your household are..

a) Aged 18 or younger?

b) Aged over 18?

Q.105 People organise their household finances in different ways. Which of the methods comes closest to the way yours is organised?

01: FEMALE looks after the household money except for MALE's personal spending money
02: MALE looks after the household's money except for FEMALE's personal spending money
03: FEMALE is given a housekeeping allowance. MALE looks after the rest of the money
04: MALE is given a housekeeping allowance. FEMALE looks after the rest of the money
05: We share and manage our finances jointly
06: We share and manage some of our finances jointly. Both of us keep some personal spending money
07: We keep our finances completely separate
08: Other (please specify)
09: DK
10: Refused

Q.106 Looking at this card could you tell me which letter best approximates your total household income before tax?

01: A - Up to £6,000 per year \ Up to £500 per month
02: B - £6,001 to £12,000 per year \ £501 - £1,000 per month
03: C - £12,001 - £18,000 per year \ £1,001 - £1,500 per month
04: D - £18,001 - £24,000 per year \ £1,501 - £2,000 per month
05: E - £24,001 - £30,000 per year \ £2,001 - £2,500 per month
06: F - £30,001 - £36,000 per year \ £2,501 - £3,000 per month
07: G - £36,001 - £42,000 per year \ £3,001 - £3,500 per month
08: H - £42,001 - £48,000 per year \ £3,501 - £4,000 per month
09: I - Over £48,000 per year \ Over £4,000 per month
10: DK
11: Refused

Q.107 Looking at the following, please tell me the extent to which you agree or disagree with the following statement..

..After paying for essentials I\we have plenty of money for savings or spending on other things.

01: Strongly agree
02: Somewhat agree
03: Neither agree nor disagree
04: Somewhat disagree
05: Strongly disagree
06: DK
07: Refused

Q.108 Does anybody in your household claim any of the following benefits?

01: Income-based Job Seekers Allowance
02: Income Support
03: Housing Benefit
04: Council Tax Benefit
05: Disabled Persons Tax Credit
06: Industrial Injuries Disablement Benefit
07: War Disablement Pension
08: Attendance Allowance
09: Child Tax Credit
10: Working Families Tax Credit
11: Working Tax Credit
12: None
13: DK
14: Refused

Q.109 Were you aware that you may be eligible for grants to cover the full cost of insulation, lighting and other energy-efficient items?

01: Yes
02: No
03: DK

That was the last of my questions. This survey will continue for several weeks. At the end of that time there is a possibility that my supervisor might have some follow up questions about which he would like to call you. Could you please give me a telephone number where you can be contacted and your first name. This will be kept strictly confidential and will not be given to anyone else.

RECORD TELEPHONE NUMBER INCLUDING AREA CODE

RECORD FIRST NAME OF RESPONDENT(S)

That's the end of the interview!
Thank you very much for your time and help, it is very much appreciated!

**SECTION J. INTERVIEWER'S EVALUATION**

INTERVIEWER: THIS SECTION IS TO BE COMPLETED AFTER THE INTERVIEW. IT IS A CHANCE FOR YOU TO GIVE FEEDBACK ON HOW THE INTERVIEW WENT, IF THERE WERE ANY PROBLEMS UNDERSTANDING ETC

Q.200 How well did the respondents understand what they were asked to do in the choice questions? (e.g. choosing between two fridges, TVs, insulation)

01: Understood completely
02: Understood a great deal
03: Understood somewhat
04: Understood a little
05: Did not understand very much
06: Did not understand at all
07: Other (write in)

Q.201 Property type
01: Flat in multiple occupancy building
02: Terrace
03: End terrace
04: Semi-detached
05: Detached
06: Bungalow
07: Other (write in)

Q.202 Overall, who dominated the discussion of the choices and other answers?

01: Female totally dominated
02: Female was the more dominant
03: About equal
04: Male was the more dominant
05: Male totally dominated
06: DK

Q.203 Please add any other comments you feel would help us regarding this interview

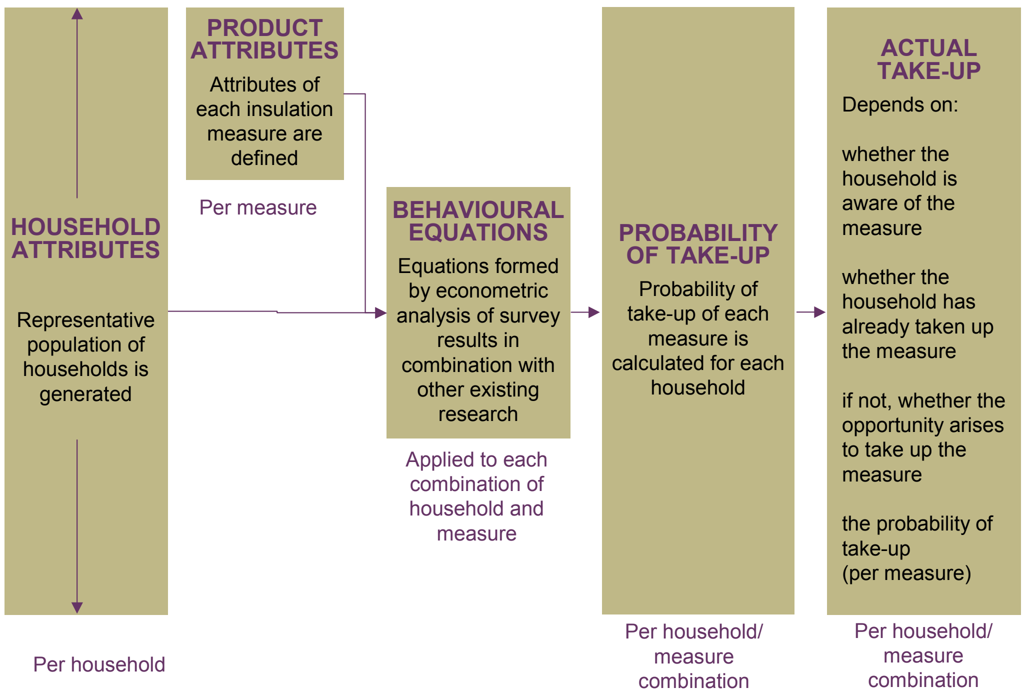
# Appendix 5 Description of the policy evaluation models

## A5.1 Owner-occupier insulation model

The owner-occupier segment of the domestic housing market forms a significant proportion of UK households. Therefore, understanding the impact of energy efficiency policies on this group is one of the more important aspects of assessing the overall policy package.

The approach Oxera has taken to represent the owner-occupier sector is to model the impact of energy-efficient policies at an individual household level. Five thousand 'pseudo' households have been created within the model and their behaviour with regard to the take-up of CWI and LI has been estimated based on the attributes of the household, the attributes of the insulation measures and a set of behavioural equations. Figure A5.1 provides a schematic representation of the approach.

**Figure A5.1 Outline of modelling approach**




Source: Oxera.

Each of the households used in the model has been characterised according to the attributes set out in Table A5.1 below. The 'model' households have been created such that the distribution of household attributes is, as far as possible, representative of the actual distribution of these attributes across the UK. These distributions were based on data from the 2001 English House Condition Survey, the Labour Force Survey and the BRE.[76]

[76] The approach implicitly assumes that the attributes of English households are representative of the UK as a whole.

**Table A5.1 Household attributes**

| Attribute | Attribute levels |
|---|---|
| House type | Flat or apartment, detached, semi-detached, mid-terrace, end terrace, other |
| Age of building | Pre-1945, 1945–1980, 1980– |
| Number of bedrooms | 1, 2, 3, 4+ |
| Type of heating | Gas central heating, oil central heating, electric heating, solid fuel, other |
| LI | None, <50mm, 50mm–100mm, fully installed |
| CWI | Not installed, already installed, unable to be installed |
| Mortgage status | Has mortgage/ does not have mortgage |
| Stamp duty | Liable /not liable for stamp duty |
| Expected tenure | The length of time before household expected to move house |
| Age of household head | <30, 30–65, >65 |
| Household income | <£12k, £12k–£30k, £30k–£48k, >£48k |

Source: Oxera.

The behaviour of each of the 'pseudo' households with respect to the take-up of insulation measures has been modelled using a set of behavioural equations derived from the econometric analysis of the survey results. This analysis identified that the most significant factors in predicting a household's take-up of an insulation measure were:

– the perceived cost of installing the measure;
– the amount of disruption its installation would cause;
– the presence of any accreditation regime;
– whether the measure had been recommended to the household.

By applying appropriate estimates of these factors for each household and each insulation measure, it is possible to estimate the probability of the household choosing to install no measures; LI only; CWI only; or both CWI and LI.

The model runs on an annual basis, with households being faced at regular intervals with a decision whether to install insulation measures. Each time that a household chooses to install a measure, their CWI or LI status is updated in the model, thereby keeping track of the remaining insulation opportunities available. As each 'pseudo' household represents approximately 3,500 real-world households, the take-up volumes estimated by the model can be extrapolated to give an estimate of the total take-up and expected energy savings across the UK.

### A5.1.1 Key parameters and modelling energy efficiency policies

The key drivers on take-up of insulation measures within the model are the factors represented in the behavioural equations and the assumed frequency with which households consider whether to install measures.

Data from the Energy Saving Trust has been used to estimate the installation costs of each measure in each of the different house types. However, as the householder's decision is based on their perceived costs rather than the actual cost, the model uses a cost adjuster, based on the analysis described in section 5, to account for the gap between a household's perception of costs and actual installation costs. This 'perception gap' can be scaled in order to model the effect of policies that seek to increase consumer awareness of energy efficiency measures.

Other ways in which the impact of energy efficiency measures is represented within the model are by adjusting the perceived cost of measures to simulate the effect of rebates on the installation of measures. These rebates can be applied either across all households that pay council tax, for example, or to households that have moved house and would pay stamp duty. Non-fiscal policies can also be represented in the model, such as the effect of increasing householder confidence in the quality of installation (via publicising the installer accreditation programme), or improving the perception of insulation measures (modelled through the recommendation variables).

No empirical evidence was available on the values that some of the parameters should take. This made it necessary to calibrate the model against an existing base case. The base case was the rate of take-up of measures expected under the EEC during 2005–08, and was made available to Oxera by Defra, from Defra's previous discussions with suppliers. A sub-set of the model parameters was adjusted until the model reproduced this base level of take-up. The assumed level of price discounting was kept close to the levels believed to be offered by suppliers, but the relative level between CWI and LI was manipulated to achieve the correct balance of take-up between CWI and LI. The overall rate of take-up was further matched to expectations by adjusting the frequency with which householders were confronted with the decision whether to take up measures, their awareness of the subsidies available, and the level of recommendation from acquaintances. Consequently, the model is best used as a tool for exploring the sensitivity of take-up rates to changes in the parameters relative to the base case.

## A5.2 Building Regulations model

BRE estimated the potential carbon savings and costs associated with compliance with the future Building Regulations updates expected in 2005, 2010 and 2015. Savings were calculated for each year from 2006 to 2020, broken down by fuel type (gas, electricity and oil). The method and assumptions used are described below.

### A5.2.1 Overview of method

As a baseline, carbon emissions for 2002 compliant dwellings were calculated for five dwelling types and three fuel types; hence 15 dwellings were modelled.

For 2005 regulations, the same 15 dwelling types were modelled, but this time using the improved fabric insulation and heating system efficiencies associated with the tougher standard.

For 2010, full carbon emissions calculations for space and water heating were not undertaken. Rather, it was assumed that carbon emission rates for each of the 15 dwelling types meeting the improved standard will be required to be 25% lower than those for 2005. Similarly, for 2015, it was assumed that carbon emissions from dwellings will be 25% lower than in 2010.

Estimates of the number of new dwellings of each of the 15 types in future years were based on projections by the Office of the Deputy Prime Minister. By multiplying the number of homes built each year by the carbon saving per home compared with 2002, the total carbon saving due to the Building Regulations was calculated for each year.

The marginal costs associated with complying with each building regulation standard were calculated. The costs for the 2005 regulations were based on improvements in thermal resistance compared with the 2002 regulations.

Later buildings regulations were modelled on a least-cost combination of technologies, using the following hierarchy:

– improve insulation and conventional heating system (eg, more efficient boiler);

– increase proportion of low-energy lighting;
– add solar water heating;
– if electric heating, replace conventional heating with heat pump;
– add PV.

Once the features had been derived for each of the dwelling types and set of Building Regulations, the cost of compliance compared with 2002 regulations was calculated.

### A5.2.2 Details of assumptions used

To calculate carbon emissions for each dwelling type adhering to 2002 regulations, target thermal performance levels were assumed for the main components of a house, as shown in Table A5.2.

**Table A5.2 Assumed initial thermal performance levels for Building Regulations 2002**

| | | | U-values assumed ($W/m^2K$) | | | |
|---|---|---|---|---|---|---|
| Heating fuel | Dwelling type | Heating efficiency assumed (%) | Wall | Roof[1] | Floor | Window[2] |
| Gas | | | | | | |
| | Detached | 78 | 0.35 | 0.33 | 0.25 | 2.0 |
| | Semi-detached | 78 | 0.35 | 0.21 | 0.25 | 2.0 |
| | Terraced | 78 | 0.36 | 0.35 | 0.25 | 2.0 |
| | Bungalow | 78 | 0.35 | 0.22 | 0.25 | 2.0 |
| | Flat[3] | 78 | 0.7 | 0.35 | – | 2.0 |
| Electricity | | | | | | |
| | Detached | 100 | 0.35 | 0.33 | 0.25 | 2.0 |
| | Semi-detached | 100 | 0.35 | 0.21 | 0.25 | 2.0 |
| | Terraced | 100 | 0.36 | 0.35 | 0.25 | 2.0 |
| | Bungalow | 100 | 0.35 | 0.22 | 0.25 | 2.0 |
| | Flat | 100 | 0.7 | 0.35 | – | 2.0 |
| Oil | | | | | | |
| | Detached | 85 | 0.35 | 0.33 | 0.25 | 2.0 |
| | Semi-detached | 85 | 0.35 | 0.21 | 0.25 | 2.0 |
| | Terraced | 85 | 0.36 | 0.35 | 0.25 | 2.0 |
| | Bungalow | 85 | 0.35 | 0.22 | 0.25 | 2.0 |
| | Flat | 85 | 0.7 | 0.35 | – | 2.0 |

Notes: [1] Thickness of loft insulation assumed to be the easiest factor to vary in practice, up to the lowest acceptable U-value of 0.35. [2] Lowest acceptable U-value of glazing with non-metal frames is 2.0. [3] Flat assumed to be on top floor because this has an energy requirement midway between mid- and ground-floor flat, so is most representative, and hence has no floor U-value.
Source: BRE.

A proprietary model, BREDEM-12, was then used to calculate the energy consumption and carbon emissions of each dwelling. Note that SAP was not used to estimate energy and carbon emissions because it does not consider all aspects of domestic energy use.

For the 2005 regulations, the (draft) SAP 2005 methodology was used to derive likely U-values and heating efficiencies required for compliance with the expected Target Carbon Emission Rate (TCER). Again, U-values were chosen, as listed in Table A5.3 below, to satisfy the overall target, and the energy consumption and carbon emissions of each dwelling type were modelled using BREDEM.

**Table A5.3 Assumed target thermal performance levels for Building Regulations 2005**

| Heating fuel | Dwelling type | Heating efficiency assumed (%) | U-values assumed ($W/m^2K$) | | | |
|---|---|---|---|---|---|---|
| | | | Wall | Roof | Floor | Window |
| **Gas** | | | | | | |
| | Detached | 86 | 0.35 | 0.16 | 0.25 | 1.8 |
| | Semi-detached | 86 | 0.35 | 0.15 | 0.2 | 1.8 |
| | Terraced | 86 | 0.35 | 0.14 | 0.25 | 1.8 |
| | Bungalow | 86 | 0.35 | 0.16 | 0.25 | 1.8 |
| | Flat[1] | 86 | 0.35 | 0.25 | – | 2.2 |
| **Electricity** | | | | | | |
| | Detached | 100 | 0.2 | 0.13 | 0.2 | 1.8 |
| | Semi-detached | 100 | 0.2 | 0.1 | 0.2 | 1.8 |
| | Terraced | 100 | 0.27 | 0.13 | 0.22 | 1.8 |
| | Bungalow | 100 | 0.27 | 0.13 | 0.22 | 1.8 |
| | Flat | 100 | 0.2 | 0.2 | – | 1.8 |
| **Oil** | | | | | | |
| | Detached | 90.3 | 0.22 | 0.14 | 0.2 | 1.8 |
| | Semi-detached | 91.1 | 0.2 | 0.1 | 0.2 | 1.8 |
| | Terraced | 91 | 0.2 | 0.16 | 0.2 | 1.8 |
| | Bungalow | 90.6 | 0.23 | 0.13 | 0.2 | 1.8 |
| | Flat | 89.9 | 0.35 | 0.2 | – | 1.8 |

Notes: As for Table A5.2 [1] Even with every characteristic set to the lowest acceptable value, the gas-heated flat still slightly exceeded the TCER.
Source: BRE.

As stated earlier, full energy and carbon calculations were not required for the 2010 and 2015 regulations. Carbon emissions for space and water heating were estimated for each of the 15 dwelling types by scaling the 2005 values using a factor of 0.75 for 2010 and 0.5625 (= 0.75 squared) for 2015.

The costs of compliance for 2005 compared with 2002 were calculated using unit costs for changing U-values. These unit costs were published in part L of the 2005 consultation document. No additional cost was assumed for higher boiler efficiencies used for 2005 dwellings. This was justified by BRE on the grounds that the costs of these boilers will fall as production volumes rise.

For 2010 and 2015, the SAP 2005 method was used to find the measures necessary to meet the carbon targets. In most cases, measures in addition to insulation improvements were needed.[77] By increasing the proportion of low-energy lighting to 100% (in addition to

[77] Using extremely low U-values (wall = 0.15, roof = 0.1, floor = 0.1, window = 1.2) and the best possible heating efficiencies currently achievable according to SEDBUK, along with a very low air-infiltration rate (Q50 = 3), the carbon savings over the 2005 TCER were, for a semi-detached house, gas = 23%, electricity = 17%, oil = 15%.

assuming very high levels of insulation), gas-heated homes can achieve the target. Electrically heated homes will be able to comply by using heat pump systems, while oil-heated dwellings will require solar water heating.

Table A5.4 below shows the assumed compliance methods for each set of future Building Regulations, along with their associated costs.

## Table A5.4 Assumed compliance methods for future Building Regulations

| | Fabric cost per dwelling (£) | | | Special heating system required | | | Heating system cost per dwelling (£) | | | Total cost per dwelling (£) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2005 | 2010 | 2015 | 2005 | 2010 | 2015 | 2005 | 2010 | 2015 | 2005 | 2010 | 2015 |
| **Gas** | | | | | | | | | | | | |
| Detached | 80 | 217 | 275 | None | None | Small PV | 0 | 0 | 1,750 | 80 | 217 | 2,025 |
| Semi-detached | 71 | 208 | 257 | None | None | Small PV | 0 | 0 | 1,750 | 71 | 208 | 2,007 |
| Terrace | 52 | 149 | 185 | None | None | Small PV | 0 | 0 | 1,750 | 52 | 149 | 1,935 |
| Bungalow | 49 | 137 | 172 | None | None | Small PV | 0 | 0 | 1,750 | 49 | 137 | 1,922 |
| Flat | 32 | 86 | 111 | None | None | Small PV | 0 | 0 | 1,750 | 32 | 86 | 1,861 |
| **Electricity** | | | | | | | | | | | | |
| Detached | 80 | 217 | 275 | None | Heat pump | Heat pump | 0 | 1,400 | 1,400 | 80 | 1,617 | 1,675 |
| Semi-detached | 71 | 208 | 257 | None | Heat pump | Heat pump | 0 | 1,400 | 1,400 | 71 | 1,608 | 1,657 |
| Terrace | 52 | 149 | 185 | None | Heat pump | Heat pump | 0 | 1,400 | 1,400 | 52 | 1,549 | 1,585 |
| Bungalow | 49 | 137 | 172 | None | Heat pump | Heat pump | 0 | 1,400 | 1,400 | 49 | 1,537 | 1,572 |
| Flat | 32 | 86 | 111 | None | Solar water heating | Heat pump | 0 | 1,237.5 | 1,400 | 32 | 1,324 | 1,511 |
| **Oil** | | | | | | | | | | | | |
| Detached | 80 | 217 | 275 | None | Small PV | Large PV | 0 | 1,750 | 2,625 | 80 | 1,967 | 2,900 |
| Semi-detached | 71 | 208 | 257 | None | Small PV | Large PV | 0 | 1,750 | 2,625 | 71 | 1,958 | 2,882 |
| Terrace | 52 | 149 | 185 | None | Small PV | Large PV | 0 | 1,750 | 2,625 | 52 | 1,899 | 2,810 |
| Bungalow | 49 | 137 | 172 | None | Small PV | Large PV | 0 | 1,750 | 2,625 | 49 | 1,887 | 2,797 |
| Flat | 32 | 86 | 111 | None | Small PV | Large PV | 0 | 1,750 | 2,625 | 32 | 1,836 | 2,736 |

Source: BRE.

The decision to deploy solar water heating, heat pump, and PV rather than other technologies was somewhat arbitrary and taken primarily because the SAP procedures for micro-CHP [78] and micro-wind are not yet available. It was assumed that, where renewables are needed, gas- and oil-heated homes first install solar water heating, and, in one case, where that is insufficient, PV. In electrically heated homes, it is assumed that the first choice is solar water heating, and the second, an electric heat pump heating system (which is estimated to be slightly more expensive than solar water heating). This is sufficient to meet the regulations in all cases for 2010 and 2015.

An alternative (not explored) is that gas- and oil-heated dwellings choose electric heat pump systems instead of PV. It was assumed that the costs of solar water heating, PV and electric heat pumps might halve in response to demand stimulated by tighter buildings regulations, but this is very uncertain.

[78] There is also the issue that if the carbon intensity of electricity falls by the planned 10% per decade, it will not be long before the current carbon benefits of micro-CHP are nullified.

# Appendix 6 Policy model calibration and policy interactions

Given that a range of policies is already in place to improve energy efficiency in the UK, it is important to understand the interaction between these and any future (additional) policies to be introduced. The main existing policies are EEC and Warm Front, both of which promote the installation of a wide range of energy efficiency measures in the domestic sector.

This section explains how the existing and future policies may interact, and sets out how this has been handled in the modelling process.

## A6.1 Effects of EEC and Warm Front

Under EEC, domestic energy suppliers are set targets, under which they must achieve levels of energy efficiency improvements among their domestic customers. They promote subsidies to consumers undertaking energy efficiency measures. These subsidies are likely to be funded through all consumers' energy bills, leading to a redistributive effect from all consumers to those consumers who receive any form of subsidy through EEC.

Further to this, the Government provides direct grants to householders through the Warm Front programme, which concentrates on low-income/vulnerable households in order to contribute to eliminating fuel poverty. As this does not involve specific targets in energy efficiency improvements, the way in which Warm Front interacts with future policies is not as complex as EEC. The remainder of this section concentrates on EEC.

The cost of EEC comprises two elements:

– *the cost of the energy efficiency measures installed*—which is independent of the incentives put in place by energy suppliers, and depends only on the measures actually taken up. It is met by a combination of subsidies to consumers and direct contributions from consumers towards the installation of energy efficiency measures (ie, when subsidies cover less than the full cost of installation);

– *the cost incurred by electricity and gas suppliers* in connection with the administration and marketing of EEC-related subsidies to consumers.

A redistributive effect occurs: in effect, a transfer is set up under which all consumers of energy contribute to subsidies for those who choose to take up energy efficiency measures under EEC (half of whom, by energy saved, will belong to a low-income 'priority group').

It is then necessary to make assumptions on how energy suppliers will meet their EEC targets. This itself depends on the level of price discrimination (see below) that energy suppliers are able to bring to bear when assigning subsidies to consumers. In this respect, there are three 'pure' outcomes, as outlined below, although the reality is likely to be some combination of these.

– *Energy suppliers are perfectly informed about their consumers*. They are able to reach all consumers and know how much each consumer requires as a subsidy in order to be induced to take up an energy efficiency measure. Consequently, suppliers provide subsidies only to those with the greatest propensity to take up energy efficiency measures.

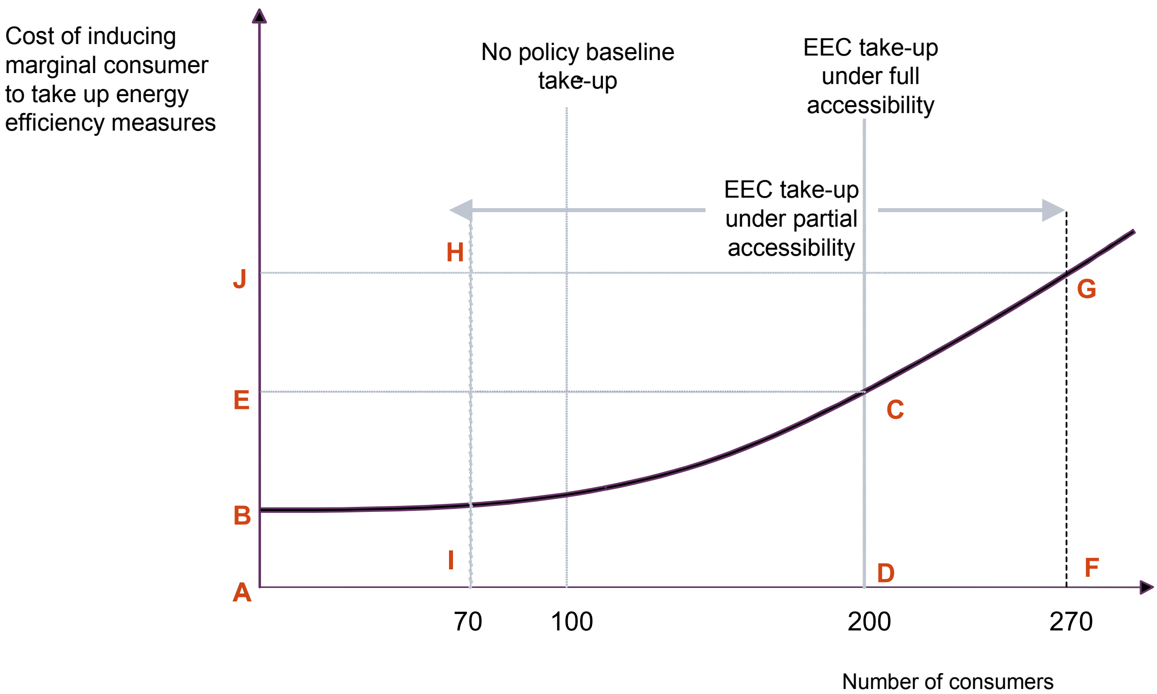
– *Energy suppliers are able to reach all of their consumers* (ie, they can make all of their consumers aware of the subsidies available under EEC), but are unable to tell how much subsidy each individual consumer requires in order to be induced to take up energy efficiency measures. A single level of subsidy is made available to all consumers which corresponds with the required subsidy of the marginal energy efficiency user at the target level of energy efficiency saving.

– *Energy suppliers are unable to reach all of their consumers* (ie, some consumers will not take up the available subsidies) and are also unable to tell how much subsidy each individual consumer requires in order to be induced to take up energy efficiency measures. This forces suppliers to move up the supply curve (see Figure A6.1) and therefore to provide a higher level of subsidy, which corresponds with the required subsidy of the marginal accessible energy efficiency user at the target level of energy efficiency saving.

These outcomes are illustrated in Figure A6.1, which shows a cost curve for the implementation of energy efficiency measures. The consumers with the greatest propensity to take up energy efficiency measures are represented on the left of the graph—they require the lowest level of subsidy, as represented by the curve, in order to be induced to take up energy efficiency measures. As the available level of subsidy increases, so the number of consumers who are induced to take up energy efficiency measures will also increase.

For simplicity, the graph assumes a 'no policy' level of take-up of 100 consumers and an EEC target of 200 consumers.

**Figure A6.1 Three estimates of supplier subsidies required to meet the EEC targets**




– In the case in which suppliers can reach all consumers and can exercise perfect price discrimination, the cost to those suppliers consists of their administration and marketing costs, plus the area under the curve described by ABCD.

– If suppliers can still reach all consumers, yet cannot price-discriminate, then in order to reach the target of 200, all consumers will have to be offered the same level of subsidy, corresponding to the length AE. The cost to suppliers then consists of their administration and marketing costs, plus the rectangle described by the ADCE.

– If suppliers cannot reach all consumers, and cannot price-discriminate, they will need to move further up the cost curve (ie, targeting consumers who require a greater level of subsidy in order to be induced to take up energy efficiency measures). Assuming that 70 consumers cannot be reached by suppliers (ie, they are 'missed' by the subsidies available under EEC), the level of subsidy required will correspond to the length AJ. An *upper-bound* estimate of the cost to suppliers of meeting their EEC targets then consists of their administration and marketing costs, plus the rectangle FGHI.

## A6.2 Interaction between future policies and EEC/Warm Front

The modelling of future policies relative to EEC/Warm Front revolves around the extent to which those policies act within the range of measures possible under EEC/Warm Front (and, by implication, on the extent to which they act outside of the measures possible under EEC/Warm Front). In the analysis below, the range of future policies is unlikely to be restricted to Government-funded subsidies, and is likely to include measures, such as product regulations, energy market interventions and information campaigns.

If a future policy works through the same policy drivers as used by suppliers to reach their EEC targets, two outcomes may occur:

– the cost to suppliers of meeting their EEC targets is reduced (in part, shifting the ultimate burden of EEC from energy consumers to taxpayers). This would occur either through a reduction in the EEC subsidy required, or by making additional consumers aware of EEC;

– additional consumers who are unaware of the incentives made available under EEC are induced to take up energy efficiency measures.

Furthermore, there could be policy measures which influence a different set of drivers to those used by suppliers. These could also have an effect on the cost of achieving the EEC targets by encouraging certain consumers to seek out EEC subsidies. Examples of such policy measures are as follows.

– Policies which solve the market failure associated with the take-up of energy efficiency measures by landlords (as a result of tenants not taking into account the energy efficiency of dwellings in their decision-making) will increase the number of landlords willing to take up energy efficiency measures, many of whom may take advantage of subsidies available under EEC (if they are allowed to do so).

– Policies such as lump-sum payments, which reduce the budget constraints of low-income households (even if lump-sum payments are available under EEC), will increase the number of low-income households that would consider taking up energy efficiency measures, most likely through EEC.

## A6.3 Approach to modelling interactions

To take into account the interaction between EEC/Warm Front and future policies, model runs for the capital goods (LI and CWI) models were calibrated against a 'business as usual' level of installations (representing the number of installation which would have taken place in the absence of any policies to promote energy efficiency measures), as well as the number of installations that are predicted by Defra to occur under EEC and Warm Front.

The owner-occupier model was calibrated against the expected rate of installation of measures in the absence of all policies and in the presence of current policies (EEC and Warm Front). Table A6.1 shows the total number of installations expected to be made under current policy initiatives between 2006 and future dates, and their causation.

**Table A6.1 Installations in owner-occupied dwellings to be completed in base case and under EEC**

| | 2006–08 (two years) LI | 2006–08 (two years) CWI | 2006–11 (five years) LI | 2006–11 (five years) CWI |
|---|---|---|---|---|
| Business as usual | 197,333 | 80,000 | 493,333 | 200,000 |
| EEC | 760,000 | 660,000 | 2,185,000 | 2,510,000 |
| Warm Front | 133,333 | 80,000 | 333,333 | 200,000 |
| Proportion of Warm Front counted within EEC (%) | 5[1] | 72 | 5[1] | 72 |
| Total | 1,084,000 | 762,400 | 2,995,000 | 2,766,000 |

Note: [1] It is assumed that 5% of Warm Front LI installations are included within EEC.
Source: Personal communication, Defra.

### A6.3.1 Calibration against business as usual (baseline)

The parameters controlling the level of take-up in the model were set to generate levels of take-up in the business-as-usual scenario consistent with Defra's assumed baseline in Table A6.1. This involves 500,000 LI installations per annum and 200,000 CWI installations per annum over the period 2006–11. To generate this baseline, it has been assumed that:

- the perceived installation costs and benefits and the expected level of disruption are in line with those recorded in the survey;
- there are no discounts or subsidies available;
- there is an underlying level of positive recommendation whereby every installation generates about five positive recommendations—in this case, 3% of households receive a positive recommendation for LI and 1% for CWI.

Having made these assumptions, the baseline level of installations is generated when the frequency of taking an installation decision is set at 0.08 times per annum (roughly the frequency of changing occupancy—ie, once every 12.5 years), and the constant term on the take-up equations is adjusted to reduce the probability of take-up by around one-half for LI and slightly under one-half for CWI. The adjustment of the constant term reflects 'yea saying' bias in the survey, whereby respondents are more inclined to say that they would purchase insulation in response to a hypothetical question in a survey than they would in real life. Having set the adjustment for the constant term in the calibration of the baseline, this adjustment is kept identical in all other scenarios.

### A6.3.2 Calibration against EEC

The parameters were adjusted to generate the expected numbers of installations made during 2006–11 in the presence of EEC and other policies: 3m for LI and 2.8m for CWI for owner-occupiers. The following assumptions were made.

- The expected disruption cost was left in line with that recorded in the survey for LI (because people have a good understanding of what the installation involves), but the expected disruption cost of CWI was reduced to one day.

- The expected installation costs and benefits were brought 50% towards actuals from the surveyed results for LI and 80% for CWI, to reflect greater reliance on EEC marketing information for installation of CWI than LI, a large proportion of which (perhaps 30% of LI) is self-installed. The perception gap was not closed entirely for CWI to allow for customer mistrust of the quoted discount.

- A discount of 40% and 60% was applied to the installation costs of LI and CWI respectively, within 10% of the level of discounts reported as offered by energy suppliers under EEC.

- Awareness of EEC was set at 100% of all households for CWI and 50% for LI. These levels were chosen to reflect the high likelihood that households considering a CWI installation would have access to price information incorporating an EEC discount. For LI, the awareness was set at 50% since a high proportion of installations are DIY, although these may also benefit from an EEC discount. This adjustment is necessary to prevent over-installation of LI by the model, and may reflect the fact that LI installations are a mixture of DIY and professional installation, and the purchase decisions for each are made in different ways.

- The recommendation levels were scaled relative to the baseline in proportion with the number of installations under this scenario.

Having made this set of assumptions, the frequency of decision was set at 0.4 times per annum to deliver the required annual installation rate. This is much higher than in the baseline. It implies that marketing activities undertaken by suppliers cause householders to consider insulation more often that they would otherwise do.

# Appendix 7 Modelling results

## A7.1 LI and CWI

The tables below have been prepared according to guidance for the Climate Change Programme Review appraisals, issued by the Inter-Departmental Analysts Group. The tables broadly follow the Treasury's Green Book procedures except that the distributional impact to firms assumes that firms bear all the costs (including any taxes), and the distributional impact to consumers assumes that consumers bear all costs (including any taxes) and benefit by the social cost of carbon, where 'ancillary effects' are included in the calculation (indicated in the tables). The unit cost of carbon saved is calculated from the discounted lifetime costs and discounted lifetime benefits. In all cases, energy saved is delivered energy, and the heat replacement effect of lighting is taken into account.

**Table A7.1 Savings from policies for owner-occupied and private households**

| | Energy saved per year (TWh) | | | Carbon saved per year (MtC) | | | Impact on annual average carbon |
|---|---|---|---|---|---|---|---|
| | 2010 | 2015 | 2020 | 2010 | 2015 | 2020 | 2008–12 |
| EEC continued to 2020 | 13 | 22 | 28 | 0.73 | 1.23 | 1.55 | 0.71 |
| EEC enhanced to 2020 | 15 | 24 | 30 | 0.83 | 1.36 | 1.69 | 0.81 |
| EEC enhanced to 2020 + campaign | 15 | 30 | 36 | 1.10 | 1.69 | 1.99 | 1.08 |
| Simple 50% discount | 5 | 9 | 12 | 0.26 | 0.48 | 0.69 | 0.26 |
| Private landlord levy | 1.88 | 3.76 | 3.76 | 0.10 | 0.15 | 0.15 | 0.10 |

Source: Oxera calculations.

**Table A7.2 Present value calculations from policies for owner-occupied and private landlord households (£m)**

| | NPV | NPV | NPV | NPV | NPV | NPV | NPV/tonne carbon |
|---|---|---|---|---|---|---|---|
| | 2010 | 2010 | 2020 | 2020 | Lifetime | Lifetime | Lifetime |
| Ancillary effects | Without | With | Without | With | Without | With | Without |
| EEC continued to 2020 | –632 | –451 | 1,123 | 2,103 | 6,351 | 8,900 | 258 |
| EEC enhanced to 2020 | –744 | –536 | 1,268 | 2,362 | 6,979 | 9,787 | 257 |
| EEC enhanced to 2020 + campaign | –1,133 | –850 | 1,582 | 2,960 | 8,329 | 11,732 | 252 |
| Simple 50% discount | –325 | –262 | 163 | 549 | 2,495 | 3,580 | 239 |
| Private landlord levy | –93 | –68 | 194 | 341 | 982 | 1,352 | 275 |

Source: Oxera calculations.

**Table A7.3 Distributional impacts of policies for owner-occupied and private landlord households (£m)**

| | Without ancillary effects | | | With ancillary effects | | |
|---|---|---|---|---|---|---|
| | Exchequer | Firm | Consumer | Exchequer | Firm | Consumer |
| EEC continued to 2020 | – | 1,336 | 6,351 | – | 1,336 | 8,900 |
| EEC enhanced to 2020 | – | 2,249 | 6,979 | – | 2,249 | 9,787 |
| EEC enhanced to 2020 + campaign | – | 2,848 | 8,329 | – | 2,848 | 11,732 |
| Simple 50% discount | –670 | – | 2,495 | –670 | – | 3,580 |
| Private landlord levy | 474 | 804 | 507 | 474 | 804 | 877 |

Source: Oxera calculations.

## A7.2 Appliances

### A7.2.1 Fiscal measures

**Table A7.4 Savings from fiscal measures on lighting and fridge-freezers**

| | Energy saved per year (TWh) | | | Carbon saved per year (MtC) | | | Impact on annual average carbon |
|---|---|---|---|---|---|---|---|
| | 2010 | 2015 | 2020 | 2010 | 2015 | 2020 | 2008–12 |
| **Lighting** | | | | | | | |
| £1/bulb | 0.045 | 0.092 | 0.143 | 0.022 | 0.046 | 0.072 | 0.023 |
| £2/bulb | 0.086 | 0.178 | 0.276 | 0.043 | 0.090 | 0.139 | 0.044 |
| **Fridge-freezers** | | | | | | | |
| £10/appliance | 0.009 | 0.018 | 0.023 | 0.001 | 0.002 | 0.003 | 0.001 |
| £20/appliance | 0.018 | 0.037 | 0.046 | 0.002 | 0.004 | 0.005 | 0.002 |
| £40/appliance | 0.036 | 0.074 | 0.092 | 0.004 | 0.009 | 0.011 | 0.004 |

Source: Oxera calculations.

**Table A7.5 Present value calculations from fiscal measures on lighting and fridge-freezers (£m)**

| | NPV | NPV | NPV | NPV | NPV | NPV | NPV/tonne carbon |
|---|---|---|---|---|---|---|---|
| | 2010 | 2010 | 2020 | 2020 | Lifetime | Lifetime | Lifetime |
| Ancillary effects | Without | With | Without | With | Without | With | Without |
| **Lighting** | | | | | | | |
| £1/bulb | 14 | 19 | 37 | 74 | 50 | 113 | 47 |
| £2/bulb | 26 | 37 | 71 | 144 | 96 | 219 | 47 |
| **Fridge-freezers** | | | | | | | |
| £10/appliance | 1.9 | 2.1 | 12 | 14 | 23 | 26 | 399 |
| £20/appliance | 3.8 | 4.2 | 24 | 27 | 45 | 52 | 399 |
| £40/appliance | 7.6 | 8.6 | 49 | 55 | 92 | 105 | 399 |

Source: Oxera calculations.

**Table A7.6 Distributional impacts of fiscal measures on lighting and fridge-freezers (£m)**

| | Without ancillary effects | | | With ancillary effects | | |
|---|---|---|---|---|---|---|
| | Exchequer | Firms | Consumers | Exchequer | Firms | Consumers |
| **Lighting** | | | | | | |
| £1/bulb | –158 | 0.0 | 163 | –158 | 0.0 | 226 |
| £2/bulb | –365 | 0.0 | 425 | –365 | 0.0 | 548 |
| **Fridge-freezers** | | | | | | |
| £10/appliance | –68 | 0.0 | 90 | –68 | 0.0 | 93 |
| £20/appliance | –139 | 0.0 | 185 | –139 | 0.0 | 191 |
| £40/appliance | –296 | 0.0 | 388 | –296 | 0.0 | 401 |

Source: Oxera calculations.

### A7.2.2 Minimum standards

**Table A7.7 Savings from minimum standards on white goods**

| | Energy saved per year (TWh) | | | Carbon saved per year (MtC) | | | Impact on annual average carbon |
|---|---|---|---|---|---|---|---|
| | 2010 | 2015 | 2020 | 2010 | 2015 | 2020 | 2008–12 |
| **Top label min. standard** | | | | | | | |
| Washing machines | 0.10 | 0.17 | 0.17 | 0.01 | 0.02 | 0.02 | 0.01 |
| Freezers | 0.54 | 1.03 | 1.28 | 0.06 | 0.12 | 0.15 | 0.06 |
| Tumble-driers | 0.59 | 1.08 | 1.12 | 0.07 | 0.13 | 0.13 | 0.07 |
| Fridges | 0.34 | 0.64 | 0.61 | 0.04 | 0.08 | 0.07 | 0.04 |
| Washer-driers | 0.23 | 0.46 | 0.61 | 0.03 | 0.05 | 0.07 | 0.03 |
| Fridge-freezers | 0.68 | 1.33 | 1.56 | 0.08 | 0.16 | 0.18 | 0.08 |
| **A/B-class min. standard** | | | | | | | |
| Washing machines | | as | above | | | | |
| Freezers | 0.28 | 0.52 | 0.65 | 0.03 | 0.06 | 0.08 | 0.03 |
| Tumble-driers | 0.28 | 0.52 | 0.65 | 0.03 | 0.06 | 0.08 | 0.03 |
| Fridges | 0.08 | 0.12 | 0.09 | 0.01 | 0.01 | 0.01 | 0.01 |
| Washer-driers | 0.12 | 0.24 | 0.32 | 0.01 | 0.03 | 0.04 | 0.01 |
| Fridge-freezers | 0.16 | 0.30 | 0.34 | 0.02 | 0.03 | 0.04 | 0.02 |
| **TVs and lighting** | | | | | | | |
| TVs | 1.59 | 3.76 | 3.88 | 0.19 | 0.44 | 0.46 | 0.19 |
| Lighting | 0.82 | 1.65 | 1.65 | 0.42 | 0.83 | 0.83 | 0.48 |

Source: Oxera calculations, based on sales projections from Market Transformation Programme.

**Table A7.8 Present value calculations from minimum standards on white goods (£m)**

| Ancillary effects | NPV 2010 Without | NPV 2010 With | NPV 2020 Without | NPV 2020 With | NPV Lifetime Without | NPV Lifetime With | NPV/tonne carbon Lifetime Without |
|---|---|---|---|---|---|---|---|
| **Top label min. standard** | | | | | | | |
| Washing machines | 24 | 27 | 114 | 129 | 176 | 200 | 433 |
| Freezers | 119 | 135 | 690 | 785 | 1,339 | 1,528 | 391 |
| Tumble-driers | 126 | 142 | 695 | 790 | 1,104 | 1,259 | 428 |
| Fridges | 77 | 87 | 395 | 449 | 640 | 730 | 423 |
| Washer-driers | 49 | 55 | 311 | 353 | 615 | 702 | 391 |
| Fridge-freezers | 151 | 168 | 876 | 984 | 1,604 | 1,807 | 402 |
| **A/B-class min. standard** | | | | | | | |
| Washing machines | | | as | above | | | |
| Freezers | 65 | 73 | 355 | 404 | 691 | 789 | 389 |
| Tumble-driers | 26 | 29 | 309 | 352 | 493 | 563 | 549 |
| Fridges | 19 | 21 | 76 | 86 | 113 | 128 | 645 |
| Washer-driers | 26 | 29 | 163 | 186 | 324 | 369 | 391 |
| Fridge-freezers | 36 | 40 | 197 | 222 | 354 | 399 | 405 |
| **TVs and lighting** | | | | | | | |
| TVs | 261 | 264 | 2,245 | 2,555 | 3,389 | 3,865 | 433 |
| Lighting | –426 | –415.5 | 5,794 | 5,866 | 9,099 | 9,474 | 610 |

Source: Oxera calculations, based on sales projections from Market Transformation Programme.

### Table A7.9 Distributional impacts of minimum standards on white goods (£m)

| | Without ancillary effects | | | With ancillary effects | | |
|---|---|---|---|---|---|---|
| | Exchequer | Firms | Consumers | Exchequer | Firms | Consumers |
| **Top label min. standard** | | | | | | |
| Washing machines | 0 | 0 | 176 | – | – | 200 |
| Freezers | 0 | 0 | 1,339 | – | – | 1,528 |
| Tumble-driers | 0 | 0 | 1,104 | – | – | 1,259 |
| Fridges | 0 | 0 | 640 | – | – | 730 |
| Washer-driers | 0 | 0 | 615 | – | – | 702 |
| Fridge-freezers | 0 | 0 | 1,604 | – | – | 1,807 |
| **A/B-class min. standard** | | | | | | |
| Washing machines | | | | | | |
| Freezers | 0 | 0 | 691 | – | – | 789 |
| Tumble-driers | 0 | 0 | 493 | – | – | 563 |
| Fridges | 0 | 0 | 113 | – | – | 128 |
| Washer-driers | 0 | 0 | 324 | – | – | 369 |
| Fridge-freezers | 0 | 0 | 354 | – | – | 399 |
| **TVs and lighting** | | | | | | |
| TVs | 0 | 0 | 3,389 | – | – | 3,865 |
| Lighting | 0 | 0 | 9,099 | – | – | 9,474 |

Source: Oxera calculations, based on sales projections from Market Transformation Programme.

## A7.3 Building Regulations

**Table A7.10 Savings from Building Regulations 2005, 2010, 2015 and house extension obligation**

| | Energy saved per year (TWh) | | | Carbon saved per year (MtC) | | | Impact on annual average carbon |
|---|---|---|---|---|---|---|---|
| | 2010 | 2015 | 2020 | 2010 | 2015 | 2020 | 2008–12 |
| **2005** | | | | | | | |
| Low | 1.4 | 2.8 | 4.1 | 0.1 | 0.2 | 0.3 | 0.1 |
| Mid | 1.7 | 3.4 | 5.0 | 0.1 | 0.2 | 0.3 | 0.1 |
| High | 2.0 | 4.0 | 5.9 | 0.1 | 0.3 | 0.4 | 0.1 |
| **2010** | | | | | | | |
| Low | | 1.1 | 2.3 | | 0.1 | 0.1 | 0.0 |
| Mid | | 1.4 | 2.8 | | 0.1 | 0.2 | 0.0 |
| High | | 1.6 | 3.3 | | 0.1 | 0.2 | 0.0 |
| **2015** | | | | | | | |
| Low | | | 0.9 | | | 0.1 | |
| Mid | | | 1.0 | | | 0.1 | |
| High | | | 1.2 | | | 0.1 | |
| **House extension obligation** | 1.3 | 2.5 | 3.8 | 0.1 | 0.1 | 0.2 | 0.1 |

Source: Oxera calculations, based on modelling work undertaken by BRE.

### Table A7.11 Present value calculations from Building Regulations 2005, 2010, 2015 and house extension obligation (£m)

| Ancillary effects | NPV 2010 Without | NPV 2010 With | NPV 2020 Without | NPV 2020 With | NPV Lifetime Without | NPV Lifetime With | NPV/tonne carbon Lifetime Without |
|---|---|---|---|---|---|---|---|
| **2005** | | | | | | | |
| Low | 47 | 69 | 498 | 644 | 1,856 | 2,576 | 144 |
| Mid | 69 | 96 | 629 | 807 | 2,278 | 3,153 | 145 |
| High | 90 | 122 | 760 | 969 | 2,700 | 3,729 | 146 |
| **2010** | | | | | | | |
| Low | | | –404 | –354 | 67 | 319 | 19 |
| Mid | | | –361 | –300 | 212 | 517 | 48 |
| High | | | –317 | –246 | 356 | 644 | 69 |
| **2015** | | | | | | | |
| Low | | | –861 | –851 | –684 | –598 | –559 |
| Mid | | | –852 | –840 | –637 | –534 | –429 |
| High | | | –844 | –830 | –591 | –469 | –338 |
| **House extension obligation** | –64 | –47 | 94 | 214 | 1,063 | 1,466 | 100 |

Source: Oxera calculations, based on modelling work undertaken by BRE.

### Table A7.12 Distributional impacts of Building Regulations 2005, 2010, 2015 and house extension obligation (£m)

| | Without ancillary effects | | | With ancillary effects | | |
|---|---|---|---|---|---|---|
| | Exchequer | Firms | Consumers | Exchequer | Firms | Consumers |
| **2005** | | | | | | |
| Low | – | –113 | 1,856 | – | –113 | 2,576 |
| Mid | – | –113 | 2,278 | – | –113 | 3,153 |
| High | – | –113 | 2,700 | – | –113 | 3,729 |
| **2010** | | | | | | |
| Low | – | –607 | 67 | – | –607 | 319 |
| Mid | – | –607 | 212 | – | –607 | 517 |
| High | – | –607 | 356 | – | –607 | 716 |
| **2015** | | | | | | |
| Low | – | –900 | –684 | – | –900 | –598 |
| Mid | – | –900 | –637 | – | –900 | –534 |
| High | – | –900 | –591 | – | –900 | –469 |
| **House extension obligation** | – | –335 | 1,063 | – | –335 | 1,466 |

Source: Oxera calculations, based on modelling work undertaken by BRE.

## A7.4 Miscellaneous

### Table A7.13 Maximum potential and realistic deliverable savings by 2020

| | Maximum potential MtC per annum | Realistic scenario | Realistic potential MtC per annum |
|---|---|---|---|
| Owner-occupier LI | 0.7 | EEC + campaign | 0.5 |
| Owner-occupier CWI | 1.7 | EEC + campaign | 1.3 |
| Private landlord LI | 0.2 | 50–80% | 0.1 |
| Private landlord CWI | 0.14 | 50–80% | 0.07–0.11 |
| Social landlord LI | 0.26 | 50–80% | 0.13–0.21 |
| Social landlord CWI | 0.34 | 50–80% | 0.17–0.27 |
| Building Regulations 2005 | 0.38 | Mid | 0.19–0.3 |
| Building Regulations 2010 | 0.2 | Mid | 0.1–0.16 |
| Building Regulations 2015 | 0.08 | Mid | 0.04–0.06 |
| White goods | 0.62 | 30–40% | 0.23 |
| Lighting | 0.83 | 50% | 0.42 |
| TVs | 0.5 | 50–80% | 0.25–0.4 |
| **Total** | **6.0** | | **3.5–4.0** |

Note: The 50–80% ranges are arbitrary, but illustrative of the range of take-up of remaining measures that might be achievable.
Source: Oxera.

# Appendix 8 Selection of policies

During the Energy Efficiency Innovation Review, a long list of potential policies was drawn up, which was then whittled down, through discussion, to the shortlist of candidate policies that is the focus of this report. This appendix records the long list and the arguments and evidence that led to the shortlist.

The long list is shown in Table A8.1. It contains a wide range of instruments, from command and control through to economic instruments and voluntary agreements. In some cases a potential legislative mechanism by which the policy could operate is identified; in other cases, it is not, pending further discussion.

**Table A8.1 Long list of candidate policies**

| Instrument | Descriptions | Possible mechanism |
|---|---|---|
| Payment on moving house, buy side | Rebate on energy efficiency measures installed within a period of moving house | Stamp Duty |
| Payment on moving house, sell side | Rebate on houses that have efficiency installed at point of sale, based on Home Condition Report | |
| Annual rebate | Rebate upon presentation of receipts showing installation of efficiency measures | Council Tax, business taxation or personal taxation for landlords |
| Lower mortgage rates | | Mortgage interest tax relief |
| Reduced energy-efficient appliance prices | | VAT, EEC |
| Increased energy-inefficient appliance price | | VAT, EEC |
| Payment to private landlord | Payment upon presentation of receipts showing installation of CWI, LI, thermostats or lighting | Business taxation, personal taxation |
| Payment to registered social landlord | Payment upon presentation of receipts showing installation of CWI, LI, thermostats or lighting | |
| Payment to owner-occupiers | Payment upon presentation of receipts showing installation of CWI, LI, thermostats or lighting | Council Tax, personal taxation |
| Energy price increase | Increase in fuel and power prices | VAT |
| Planning gain adjustment | Lower planning gain for developments adhering to a code for sustainable development | Planning authorities |
| Supplier carbon cap and trade | Tradeable carbon limit per household imposed on energy suppliers | |
| Household cap and trade | As above | |

| Instrument | Descriptions | Possible mechanism |
|---|---|---|
| White certificate trading | Any legal entities can generate energy efficiency savings and sell them into ECC | EEC |
| Product standards | Increase coverage and level of standards dictating minimum energy efficiency performance | European agreement |
| Manufacturer fleet average | As above, but setting average standard for a manufacturer's sales instead of a minimum for any individual appliance | European agreement |
| Building Regulations | Tightening of 2005 Building Regulations | Building Regulations revisions 2010 and 2015 |
| Tradeable obligation for new buildings | Obligation on developers to build a certain proportion of their output to a higher standard | Local authorities |
| Tradeable obligations for appliances | As for manufacturer fleet average, but tradeable between manufacturers | |
| Home Condition Report | A report prepared for the property's sale stating current energy efficiency performance and recommended measures | |
| Condition of sale | Require installation of cost-effective measures to be carried out upon change of occupancy or major modifications | |
| Code for sustainable building | Publication and awareness of the code, followed up by voluntary take-up | |
| Demolition | Demolish old housing stock that is difficult to refurbish | |
| Consumption feedback | Energy suppliers give comparison of domestic bill with previous bill and benchmark | |
| Engagement programmes | Information, advice, education, community action programmes encouraging the take-up of energy efficiency measures and the reduced use of energy | |

Source: Defra EEIR.

To distinguish between the policies in this long list, the policies were classified along four dimensions—objective, type of household, range of measures, type of mechanism—defined as follows. The objective of the policy identifies where its emphasis lies between fuel poverty and carbon emissions. The two dimensions of type of household and range of measures describe the coverage of the policy. A policy that covers more households and a larger portfolio of measures will be more effective. The last dimension is the type of mechanism used by the policy instrument, which will determine its compatibility with other instruments, the certainty with which its expected effects will be delivered, and its administrative costs and feasibility. See Table A8.2.

**Table A8.2 Policy descriptors**

| Objectives | Types of household | Range of measures | Type of mechanism |
|---|---|---|---|
| Fuel poverty | Owner-occupiers | CWI | Change in relative price of fuels |
| Carbon emissions | Private landlords | LI | General change in price of energy |
| | Social landlords | Choice of lighting | Provision of information (ie, increased awareness/understanding) |
| | Housing associations | Choice of appliances | Trust in installers |
| | | Use of appliances, lighting and heating | Change in cost of measures |
| | | | Change in capitalisation of savings |
| | | | Change in household budget constraint |

Source: Oxera.

Using this classification, the descriptors for each policy were determined in discussion within the EEIR team (see Table A8.3 below).

## Table A8.3 Factors influenced by the policies under consideration

| Policy | Measures affected | | | | | | Influences | | | | | | | | | | Who affected? | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CWI | LI | Boilers | Thermostats | Lighting | Appliances | Comfort-taking | Efficiency of current stock | Efficiency of new stock | Perceived benefit | Actual benefit | Capitalisation in house price | Awareness | Perceived cost | Actual cost | Building Regulations enforcement | Owner-occupied | Tenant | Landlord | Social tenant | Social landlord | Developers |
| 1 Payment upon moving house | ✓ | ✓ | ✓ | ✓ | – | – | | ✓ | – | ✓ | ✓ | – | ✓ | – | – | – | ✓ | – | – | – | – | – |
| 2 Carrot and stick payment upon moving house | ✓ | ✓ | ✓ | ✓ | – | – | | ✓ | – | – | – | – | ✓ | ✓ | ✓ | – | ✓ | – | – | – | – | – |
| 3 Lower mortgage rates | ✓ | ✓ | ✓ | ✓ | – | – | – | – | – | ✓ | ✓ | ✓ | ✓ | – | – | – | ✓ | – | ✓ | – | – | – |
| 4 Reduced energy efficiency product prices | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | ✓ | – | – | – | ✓ | ✓ | ✓ | – | ✓ | – | ✓ | – | ✓ | – |
| 5 Increased price of inefficient products | – | – | – | – | – | – | – | – | ✓ | – | – | – | ✓ | ✓ | ✓ | – | ✓ | – | ✓ | – | ✓ | – |
| 6 Capital grant to landlords | ✓ | ✓ | ✓ | ✓ | ✓ | – | – | ✓ | – | – | – | – | ✓ | ✓ | ✓ | – | – | – | ✓ | – | ✓ | – |
| 7 Capital grant to social housing landlords | ✓ | ✓ | ✓ | ✓ | ✓ | – | – | ✓ | – | – | – | – | ✓ | ✓ | ✓ | – | – | – | – | – | ✓ | – |
| 8 Fuel price increase | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | ✓ | ✓ | ✓ | ✓ | – | – | – | – | – | – | – | – | – | – | ✓ |
| 9 Capital grant to all owners | ✓ | ✓ | ✓ | ✓ | ✓ | – | – | ✓ | ✓ | – | – | – | ✓ | ✓ | ✓ | – | ✓ | – | ✓ | – | ✓ | ✓ |
| 10 Planning gain adjustment | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | – | – | – | – | – | ✓ | ✓ | ✓ | ✓ | – | – | – | – | – | ✓ |
| 11 Supplier carbon cap and trade | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | – | – | ✓ | ✓ | – | – | – | – | – | ✓ | ✓ | – | ✓ | – | |
| 12 Household carbon cap and trade | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | – | – | ✓ | ✓ | – | ✓ | – | – | – | ✓ | ✓ | – | ✓ | – | |
| 13 White certificates trading | – | – | ✓ | – | ✓ | ✓ | – | – | ✓ | – | – | – | – | ✓ | ✓ | – | ✓ | ✓ | – | ✓ | – | – |
| 14 Product standards | – | – | ✓ | – | ✓ | ✓ | – | – | ✓ | – | – | – | – | ✓ | ✓ | – | ✓ | – | ✓ | – | ✓ | – |
| 15 Manufacturer fleet average | – | – | ✓ | – | ✓ | ✓ | – | – | ✓ | – | – | – | – | ✓ | ✓ | – | ✓ | – | ✓ | – | ✓ | – |
| 16 Tradeable manufacturer/retailer obligation on super-efficient products | – | – | ✓ | – | ✓ | ✓ | – | – | ✓ | – | – | – | – | ✓ | ✓ | – | ✓ | – | ✓ | – | ✓ | – |
| 17 Retailer fleet average | – | – | ✓ | – | ✓ | ✓ | – | – | ✓ | – | – | – | – | ✓ | ✓ | – | ✓ | – | ✓ | – | ✓ | – |
| 18 Building Regulations | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | – | ✓ | – | – | – | – | – | – | – | – | – | – | – | – | ✓ |

| Policy | Measures affected | | | | | | Influences | | | | | | | | | | Who affected? | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CWI | LI | Boilers | Thermostats | Lighting | Appliances | Comfort-taking | Efficiency of current stock | Efficiency of new stock | Perceived benefit | Actual benefit | Capitalisation in house price | Awareness | Perceived cost | Actual cost | Building Regulations enforcement | Owner-occupied | Tenant | Landlord | Social tenant | Social landlord | Developers |
| 19 Home Condition Report | ✓ | ✓ | ✓ | ✓ | – | – | – | ✓ | ✓ | – | – | – | ✓ | – | – | – | ✓ | – | ✓ | – | ✓ | ✓ |
| 20 Building standard at time of occupant change | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | ✓ | ✓ | – | – | – | ✓ | – | – | – | ✓ | – | ✓ | – | ✓ | – |
| 21 Best-practice building code | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | – | ✓ | – | – | – | ✓ | – | – | – | – | – | – | – | – | ✓ |
| 22 Demolition | ✓ | ✓ | ✓ | – | – | – | – | ✓ | | – | – | – | – | – | – | – | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 23 Energy services companies | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | ✓ | – | – | – | ✓ | – | – | – | ✓ | ✓ | – | ✓ | – | – |
| 24 Schools and media campaign | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | – | – | ✓ | – | – | ✓ | ✓ | – | – | ✓ | ✓ | – | ✓ | – | – |
| 25 Enhanced metering and billing | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | – | ✓ | – | – | ✓ | – | – | – | ✓ | ✓ | – | ✓ | – | – |
| 26 Advice programmes | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | – | – | ✓ | – | – | ✓ | ✓ | – | – | ✓ | ✓ | – | ✓ | – | – |
| 27 Skills development | ✓ | ✓ | ✓ | – | – | – | | – | – | – | – | – | – | – | ✓ | – | ✓ | ✓ | – | ✓ | – | – |

Source: Oxera.

It was apparent that the policies generally address either insulation measures in existing dwellings, or insulation measures in new dwellings, or lighting, or appliances. This formed a natural grouping, and an inspection of these groupings uncovered a number of features.

The policy measures that address insulation measures in existing properties were grouped together. The picture, reproduced as Table A8.4, showed that these policies all act on either the capital cost of the installation or the perception gap. Therefore, the most successful combination is likely to tackle both, and to act over a wide customer base.

### Table A8.4 Classification of policies for insulation in existing policies

| Policy name | Capital cost | Perception gap | Owner-occupier | Private landlord | Social landlord | New properties |
|---|---|---|---|---|---|---|
| Insulation measures in existing properties | | | | | | |
| Payment on moving house (buy side) | ✓ | | ✓ | ✓ | | |
| Payment on moving house (sell side) | ✓ | | ✓ | ✓ | | |
| Council Tax rebate | ✓ | | ✓ | | | |
| Payments to owner-occupiers, private and social landlords | ✓ | | ✓ | ✓ | ✓ | |
| Supplier carbon cap and trade | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Supplier cap and trade applied to consumers | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Energy price increases | | | ✓ | ✓ | ✓ | |
| Engagement programmes | | ✓ | | | | |
| Home Condition Report | | | ✓ | | | |

Source: Oxera.

A similar exercise for lighting and appliances showed a much greater variety in the ways in which policies might act, including by changing the value of energy savings and changing product efficiency (see Table A8.5). However, the statistical evidence revealed that the value of energy savings has little influence.

### Table A8.5 Classification of policies for lighting and appliances

| Policy name | Capital cost | Perception gap | Energy savings | Product efficient |
|---|---|---|---|---|
| Reduced price of energy-efficient products | ✓ | | | |
| Increase price of energy-efficient products | ✓ | | | |
| White certificate trading | ✓ | | | |
| Supplier carbon cap and trade | ✓ | ✓ | ✓ | |
| Supplier cap and trade applied to consumers | ✓ | ✓ | ✓ | |
| Product standards | | | | ✓ |
| Manufacturing fleet average | | | | ✓ |
| Energy price increases | | | ✓ | |
| Engagement programmes | | ✓ | | |

Source: Oxera.

Lastly, the grouping for the construction of new properties shows how similar the policies in the long list are (see Table A8.6).

**Table A8.6 Classification of policies for new build**

| Policy name | Retirement of less efficient stock | Compliance with Building Regulations | Social landlord | New properties |
|---|---|---|---|---|
| Planning gain adjustment | | ✓ | | ✓ |
| Code for sustainable building | | ✓ | | ✓ |
| Demolition | ✓ | | ✓ | |

Source: Oxera.

Three pieces of evidence were key in drawing up a shortlist of policies:

– the first concerns types of owner-occupier. Of all owner-occupiers, the proportion with mortgages is 58%, and the proportion of housing transactions involving Stamp Duty is 40%, while there are only 1.5m housing market transactions per annum.[79] This suggests that instruments specific to the buying or selling of homes or the financing of homes should be discarded since they fail to reach a large number of properties;

– the measures available in socially rented properties will be largely exhausted by current policies, so any new instruments in the rented sector should be targeted at private landlords;

– private landlords are likely to be hard to influence. This is because most tenants pay for utility services, so the landlords do not benefit directly. Then, while insulation offers savings, the savings amount to around 1% of rental payments, so tenants are unlikely to discriminate on grounds of energy efficiency. Thus, overall, private landlords are likely to receive no benefit from investment in energy efficiency measures and, hence, to require a financial incentive that outweighs the cost of installation, or a regulation that stipulates the installation of measures.

Several of the candidate policies, including the supplier and household cap and trade, and energy services companies, rely on consumers signing long-term contracts with energy suppliers. Consumers do not appear keen to do so, which may diminish the level of competition between suppliers. For both reasons, these instruments were excluded from the long list, but the EEC was retained, because it uses a target and trade arrangement that places the obligation on suppliers and therefore does not rely on a long-term relationship between customer and supplier.

The awareness campaigns were removed from the long list as being too specific to be modelled. A summary of the reasons for excluding policies from the shortlist is given in Table A8.7.

[79] Typical figure from Particulars Delivered forms to HM Revenue & Customs' Stamp Office or the Land Registry.

### Table A8.7 Rationale for exclusion of candidate policies from the long list

| Policy | Reason for elimination from the long list |
|---|---|
| Payment upon moving house | House moving is infrequent |
| Carrot and stick payment upon moving house | House moving is infrequent |
| Lower mortgage rates | Only a sub-set of owner-occupiers have mortgages |
| Capital grant to social housing landlords | Social landlord measures will be exhausted |
| Fuel price increase | Value of energy savings does not influence the take-up of measures |
| Planning gain adjustment | Difficult to introduce a transparent administrative control |
| Supplier carbon cap and trade | Customers reluctant to enter into long-term contracts with suppliers |
| Household carbon cap and trade | Customers reluctant to enter into long-term contracts with suppliers |
| White certificates trading | Administratively complex; interacts with measures already covered by policies outside the household sector |
| Home Condition Report | Unlikely to make a material difference to house prices, and thus the pay-back on the cost of insulation |
| Building standard at time of occupant change | Impractical and infrequent |
| Best-practice building code | Uncertain delivery from a voluntary agreement |
| Energy service companies | Customers reluctant to enter into long-term contracts with suppliers |
| Schools and media campaign | Captured with awareness campaigns |
| Advice programmes | Captured with awareness campaigns |
| Skills development | Outside the scope of the Oxera study |

Source: Oxera.

**Oxera**
Park Central
40/41 Park End Street
Oxford OX1 1JD
United Kingdom

Tel: +44 (0) 1865 253 000
Fax: +44 (0) 1865 251 172

www.oxera.com