Reducing carbon emissions from the UK housing stock

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Summary

This report updates and extends analyses in BRE Report BR435 published in December 2001[1]. It is concerned with the carbon emission reductions that might be possible from the housing stock, addressing this issue from three different, but related, perspectives. Accordingly, the report is in three main parts, each of which is essentially a complete report in its own right, with its own summary, references and appendix containing relevant tables.

Part 1 of the report considers a wide range of energy efficiency measures and for each one assesses the potential carbon savings and their cost-effectiveness. The position that existed in 2001 in respect of each of these measures is examined, as well as looking forward to the likely situation in 2010, 2020 and 2050.

Part 2 focuses on the effectiveness of energy efficiency policies within the domestic sector, using historical data to assess the savings that have been achieved and to compare the effects of the different policies. Due to the differences between the various energy efficiency policies and the analyses that are possible, the discussions in this part of the report are divided into three main sections. These analyses provide evidence that is useful for considering the likely effects and costs of future policies, which is addressed in Part 3.

Part 3 looks at the potential future carbon emissions from the housing stock and considers five separate scenarios. The reference scenario describes what could happen if historical trends were to continue. The policy scenario takes account of the effects of planned energy efficiency policies. The efficiency scenario looks at what could happen if all of the standard energy efficiency measures were to be taken up as rapidly as seems feasible. Two further step change scenarios then examine how we might approach a 60% reduction in carbon emissions by 2050, as recommended by the Royal Commission on Environmental Pollution[2] and as adopted as a goal to work towards within the Government's Energy White paper[3].

The results presented in the report emphasise that, although large carbon emission savings are potentially available, they will not necessarily be easy to access and will involve quite large expenditures. In the medium-to-long term they will also require some fundamental changes to both the national energy supply infrastructure and, linked to this, to the individual energy choices that are made by the many millions of ordinary householders.

[1] *Carbon emission reductions from energy efficiency improvements to the UK housing stock*. L D Shorrock, J Henderson, J I Utley and G A Walters. BRE Report BR 435, December 2001.
[2] *Energy - The changing climate*. The Royal Commission on Environmental Pollution. Stationery Office, June 2000.
[3] Energy White Paper: *Our energy future – creating a low carbon economy*. DTI. The Stationery Office, February 2003.

Part 1. The scope for carbon emission reductions from the UK housing stock

SUMMARY

This part of the report describes a study to evaluate the carbon emissions saving potential of domestic energy efficiency measures. It considers the potential in 2001 (the latest year for which data is available), and looks ahead to 2010, 2020 and 2050.

Cost-effectiveness analysis is carried out on the energy saving measures considered allowing an estimate to be made of what proportion of the total carbon savings identified can be made at a negative overall cost. Low and high estimates of the capital costs of measures are used to indicate a likely range for the cost-effective carbon saving potential.

The study finds that around 22 MtC/yr* could potentially be saved if the energy efficiency measures identified are applied to all suitable dwellings. However, only between 9 and 17.5 MtC/yr of this could be saved cost-effectively (depending on whether low or high costs are assumed). The remainder could not be justified on the basis of fuel cost savings alone.

The savings potential is predicted to fall to approximately 17.5 and then 13.5 MtC/yr by 2010 and 2020 respectively. In 2010 between 6.5 and 13.5 MtC of the total potential will be cost-effective. In 2020, between 3.5 and 9.5 MtC is indicated as cost-effective.

By 2050 nearly all the potential from today's insulation measures will have been used up. For this reason, the increased use of renewables was considered. The potential carbon savings from the measures looked at for 2050 is thus estimated to be much higher at 29.5 MtC/yr. However, depending on the cost assumptions used, the analysis indicates a range of 0.2 to 17.5 MtC/yr of this might be cost-effective.

This indicates that it may become more expensive to reduce domestic carbon emissions in the future as the most cost-effective measures reach saturation. Of course, technical innovations and future reductions in the price of renewables could change this.

*Million tonnes of carbon emissions per year

1.1 INTRODUCTION

The study described in this part of the report looks at the potential carbon emissions savings that could be made in the housing stock, identifying which energy efficiency measures are likely to be cost-effective. The savings thus estimated are based on a static analysis which assumes that the measures could be implemented immediately. In reality, it takes time to implement energy efficiency measures and in that time other influencing factors are likely to change and so affect the savings that are made. Analyses that take account of these dynamic effects are described in Part 3 of this report which deals with possible scenarios for future carbon emissions from the housing stock.

Energy efficiency is expected to provide more than half of the greenhouse gas emission reductions in the UK government's current Climate Change Strategy and its importance is highlighted in the Energy White paper. For forward planning it is important to know what savings we can realistically expect from future strategies and how cost-effectively these savings might be achieved. It is likely we will have to make important choices between which methods to use to reduce our carbon emissions to meet increasingly tough targets. Evaluation of the potential savings and the cost-effectiveness of possible ways to achieve these are therefore required to make sure we obtain the biggest greenhouse gas emission reductions for the least cost.

This study evaluates the potential national carbon emissions savings from a number of energy efficiency measures that are applicable to the UK's housing stock for the years 2001, 2010, 2020, 2050, indicating what proportion of the overall saving is cost-effective for each year. It evaluates which measures offer the biggest potential savings and which offer the biggest savings per pound spent.

1.2 DESCRIPTION OF THE PROJECT

Overview of method

Information was collated on the costs and lifetimes of domestic energy efficiency measures and the amount of energy saved by each was calculated using BREDEM-12 (1). Using suitable carbon intensity factors for fuels, energy savings were converted to carbon emission savings. Similarly, using fuel cost factors, the cost saving for each measure was calculated. Using this information, cost-effectiveness analysis was carried out by calculating net annual cost. For each measure examined it was also estimated what number of dwellings in the UK housing stock it could reasonably be applied to, enabling an estimate to be made of the potential national carbon saving. By adding up the potentials for each energy efficiency measure, the total potential national saving was estimated. By adding up only the potentials of the measures which had a negative net annual cost, the cost-effective potential national saving was estimated.

Estimates of the potential savings in future years (2010, 2020 and 2050) were made by projecting uptake rates of energy efficiency measures forward (using the information that underlies the scenarios described in Part 3 of this report). Since by 2050 the potential savings from most fabric insulation measures is predicted to have fallen close to zero (as they near saturation), the possible savings for a different set of measures was considered for 2050, including more renewables.

The following sections describe the work in more detail.

Cost and lifetimes of insulation measures

Since the costs of insulation measures can vary widely depending on circumstances (e.g. availability of grants), a low and high set of costs were used to give a feel for the range of cost-effectiveness possibilities which exist. This highlights the fact that there is always an element of uncertainty when looking at what is cost-effective for a large group of dwellings, because of the variety of circumstances a single figure must encapsulate. The value and a description of each cost used are given in Table 1. Generally the low costs represent the gross cost less any grant available, or a marginal cost where it is assumed that work is needed anyway and it might make sense to make a more energy efficient upgrade. Where applicable, these are DIY costs. The high costs mainly represent the typical purchase price of the measure assuming no grants are available. They are usually not marginal costs (assuming the measure is installed not at a time when work was needed anyway). All costs quoted represent the value for a typical 3 bedroom semi-detached house. In a few cases the high and low costs were taken to be identical because there was no basis on which to make a distinction.

Table 1. Capital cost assumptions

Measure	Capital cost (£)		Description
	Low	High	
Loft insulation	138	273	DIY and installer cost
Cavity wall insulation	300	325	Grant aided and typical cost
Solid wall insulation	1309	3272	Marginal and full cost
Low-e double glazing	0	4000	Marginal and approximate full cost
Draught proofing	85	110	DIY and installer cost
Cylinder insulation	8	20	Low and high DIY cost
Condensing boiler	100	300	Low and high marginal cost
Better controls	125	250	Low and high installer cost
EE lighting	85	200	Low and high purchase cost (for 17 lamps)
EE appliances	0	114	Range of marginal costs covering all appliances considered
Solar water	1650	2475	Grant aided and typical costs
PV	6900	13300	Grant aided and typical costs
Floor insulation	50	1000	Marginal and full cost

Energy, carbon emission and cost savings

Energy savings for insulation and heating measures were calculated using BREDEM to model BRE's standard semi-detached dwelling, which is close to the average for the UK housing stock. This dwelling was assumed to have gas central heating with a typical heating regime. To avoid double counting it was assumed that insulation had already been improved when calculating savings for heating improvements. It is possible of course that heating upgrades could be made before insulation is installed, in which case the savings from the heating improvement would be higher and those from the insulation lower. However, it is generally recommended that insulation upgrades be made before heating upgrades so the heating output can be sized accordingly.

It was assumed that 30% of savings from heating-related measures would be taken in improved comfort instead of energy savings. This value is consistent with that used in other studies, but a definitive study on comfort factors would be useful to reduce the uncertainty in this during future work.

Appliance savings were determined from DECADE data [(2)], by comparing the 'reference case' scenario unit energy consumption for 2001 to the 2020 'scenario 1'. Appropriate 'heat replacement effect' factors from a recent Market Transformation Programme study [(3)] were applied to these savings to take account of the reduction in space heating gains from the more efficient appliances.

Carbon emission factors for electricity were based on DTI estimates for 2001, 2010 and 2020. For 2050, it was assumed that carbon free sources (e.g. renewables and nuclear) will make up about 45% of electricity production by extrapolating the current trends, but that the remaining electricity fuel mix stays the same as 2020. This gives a carbon intensity figure for 2050 about 30% lower than in 2020 and about 50% lower than in 2000. The carbon intensity for gas, oil and biomass were taken from SAP 2001 [(4)] and assumed not to change in future years. Table 2 contains the carbon factors used.

Fuel costs were taken from SAP 2001 [(4)]. They were assumed not to change in future years since this work aims to evaluate cost-effectiveness in present-day terms. DTI estimates of future fuel prices up to 2020 showed that prices are not expected to change greatly in real terms over this period. However, it is worth bearing in mind that should they change markedly, the cost-effectiveness of energy efficiency measures will be affected.

Table 2. Fuel carbon intensities

Year	Carbon intensity of fuel (kgC/GJ)			
	Electricity	Gas	Oil	Biomass
2001	36.8	14.7	20.5	1.9
2010	33.0	14.7	20.5	1.9
2020	27.2	14.7	20.5	1.9
2050	19.2	14.7	20.5	1.9

Cost-effectiveness calculation method

Several methods exist for estimating cost-effectiveness. For this study the indicator of cost-effectiveness used is net annual cost (NAC), which has the advantage of being easy to understand. A negative NAC indicates that a measure is cost-effective, whilst a positive one indicates it is not. The degree to which the answer is positive or negative indicates the degree to which something is cost-effective. A large negative number indicates a highly cost-effective measure while a small positive number indicates something that is marginally not cost-effective.

NAC is defined as follows:

$$\text{NAC} = \text{EAC} - \text{S}$$

Where S is the annual saving (£/year) due to the measure and EAC is the equivalent annual cost given by:

$$\text{EAC} = \frac{Cr}{1-(1+r)^{-n}}$$

Where C is the capital cost of the measure (£), r is the discount rate (%) and n is the lifetime of the measure over which the annual cost saving is supplied (years).

A discount rate of 3.5% was assumed for all calculations in this study, in line with treasury guidance [(5)]. The social cost of carbon has not been included. Clearly, its inclusion would tend to make the measures more cost effective, although calculations that have included it indicate that it actually makes relatively little difference in most cases. The only notable exception to this was for biomass boilers (which offer large carbon savings but hardly any direct saving from reduced fuel costs).

As it is of particular relevance to this work, the NAC was divided by the annual carbon saving to give the net annual cost per tonne of carbon saved.

Cost-effectiveness was assessed for each measure for each of the four years considered using both low and high estimates of capital cost, resulting in eight sets of primary results.

Potentials for each measure

In order to estimate the total carbon savings deliverable through domestic energy efficiency measures for the whole housing stock, it was necessary to estimate the number of homes each measure could be applied to. The potential number that most heating and insulation measures could be applied to in 2001 was based on figures from the Domestic Energy Fact File [(6)]. Other sources of data (such as EHCS and DECADE) were consulted for certain measures. From two of the principal sources, 2001 was the most recent year for which reliable figures were available, hence it was chosen as the base year.

In most cases the potential was taken to be the number of homes that could have a measure but currently lack it. For a few cases other factors which affect how many dwellings can realistically have a measure applied are taken into account. For example, it is assumed that only 95% of cavity walls can be insulated because of the risk of rain penetration in exposed regions. The remaining 5% are assumed to be amenable to the techniques applied to insulate solid walls and have been included as part of the solid wall insulation potential. A description of what each potential represents is given in Table 3.

Table 3. Potential numbers of homes suitable for energy efficiency measures

Measure	Potential number of homes in 2001 (000's)	Description
Loft insulation	Various	Potentials at a number of starting thicknesses were evaluated individually (see Tables A1 to A4)
Cavity wall insulation	8540	Total number of cavity walled dwellings less 5%, and less those already insulated
Solid wall insulation	9080	Total number of solid walled dwellings plus 5% of cavity walled dwellings, and less those already insulated
Low-e double glazing	10746	Equivalent number of dwellings* that have single glazing
Draught proofing	9793	Number of dwellings lacking either draught proofing or double glazing
Cylinder insulation	Various	Potentials for several thicknesses were evaluated individually
Condensing boiler	17128	Number of dwellings with gas boilers less those which already have condensing boilers
Better controls	2102	Number of dwellings presently with no heating controls
EE lighting	20908	Equivalent number of homes* which lack low energy lighting
EE appliances	Various	Total number of each appliance
Solar water	19330	80% of all homes less the number which already have solar water heating
PV	9892	Half of all dwellings (excluding flats)
Floor insulation	10987	All homes with raised timber floors less the number already insulated

* 'Equivalent number of homes' is used where homes can be partially upgraded (e.g. by having 50% of their windows double-glazed). For example, if it is known that 50% of a group of dwellings have 50% of their windows double-glazed, it is equivalent to saying that 25% of that group have 100% of their windows double-glazed.

For future years projections were made of likely uptake rates by fitting S-curves through past data and assuming a continuation of that trend (see Part 3). This has been shown to offer a good fit to past data for many insulation and heating measures. But of course, whilst it offers a sensible basis for prediction, past trends will not necessarily continue in future so this introduces an element of uncertainty, increasing the further into the future one looks. Where new policies have already been announced that are likely to change uptake rates significantly, this is taken into consideration. For example, the draft of Part L of the next Building Regulations will require most new boilers to be A or B rated, which is expected to significantly increase their uptake rate (for discussion of this see Part 2).

Using these projections it was found that by 2050 very little potential for saving more carbon will remain for most of the traditional insulation measures, such as cavity wall insulation, since nearly all homes that can have it will do so. For the 2050 analysis therefore, the potential savings from a different set of measures was examined, including more renewable technologies. Since uptake rates of these are presently very low, the potential number of homes these could be applied to is expected still to be large.

For 2001, 2010 and 2020, the capital costs of measures and the fuel costs were those for 2001. But by 2050, it is likely that, in real terms, capital costs of PV generation in particular will have reduced significantly. Hence, an estimate of its 2050 cost was obtained from a recent study 'Options for a Low Carbon Future' (7).

1.3 FINDINGS

Detailed results are presented in Tables A1 to A4 in Appendix A, with one table for each year. For each measure looked at, the delivered energy saving was calculated (shown in column 2 in the tables). For some measures a comfort factor was applied before carbon and cost savings were calculated. The cost savings were then combined with the capital cost and lifetime data to estimate the cost-effectiveness by calculating equivalent and net annual costs. Figures for an individual dwelling were then converted to national figures by multiplying up by the number of dwellings each measure could be applied to, giving the total capital costs, carbon saving and energy saving potentials needed to produce the graphs that follow.

The main findings of the work are illustrated in Figures 1 to 14. Figures 1 and 2 show the results of analysis for 2001 using the low cost assumptions (Figure 1 covers insulation measures, Figure 2 covers appliances). Figures 3 and 4 are also for 2001, but are based on the high cost assumptions. In the charts used to represent the findings, the measures are ranked according to their cost-effectiveness (the vertical axis), with the horizontal axis representing their potential carbon saving. Those measures which have bars that extend well below zero are highly cost-effective and those which have bars indicating a positive NAC are not cost-effective. Those close to zero are marginal in terms of their cost-effectiveness. Those measures with the widest bars have the potential to save the greatest amount of carbon emissions if they are taken up by all the dwellings that could potentially have them. The total width of all the bars represents the national potential carbon saving from all the measures considered.

Figure 1. Potential National Carbon Savings – 2001 (Insulation measures, low costs)

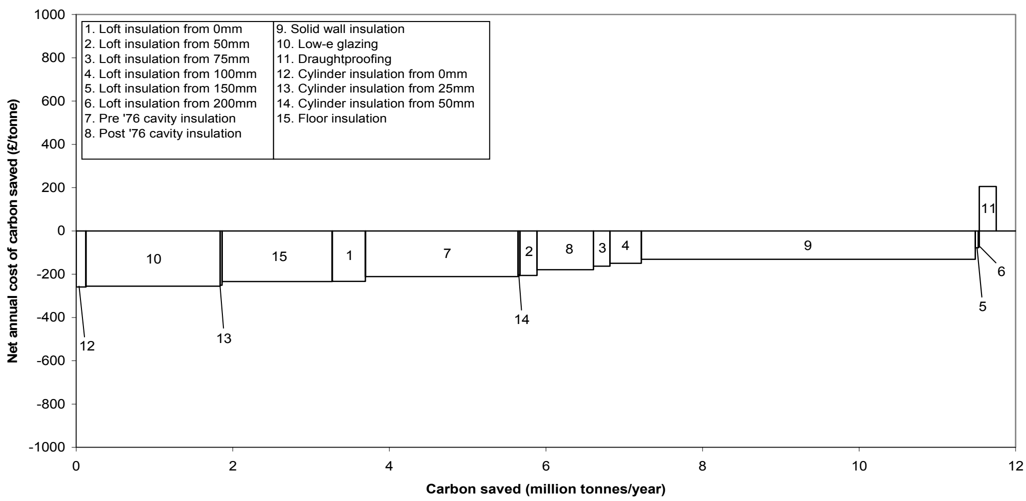


Figure 2. Potential National Carbon Savings – 2001 (Appliances, low costs)

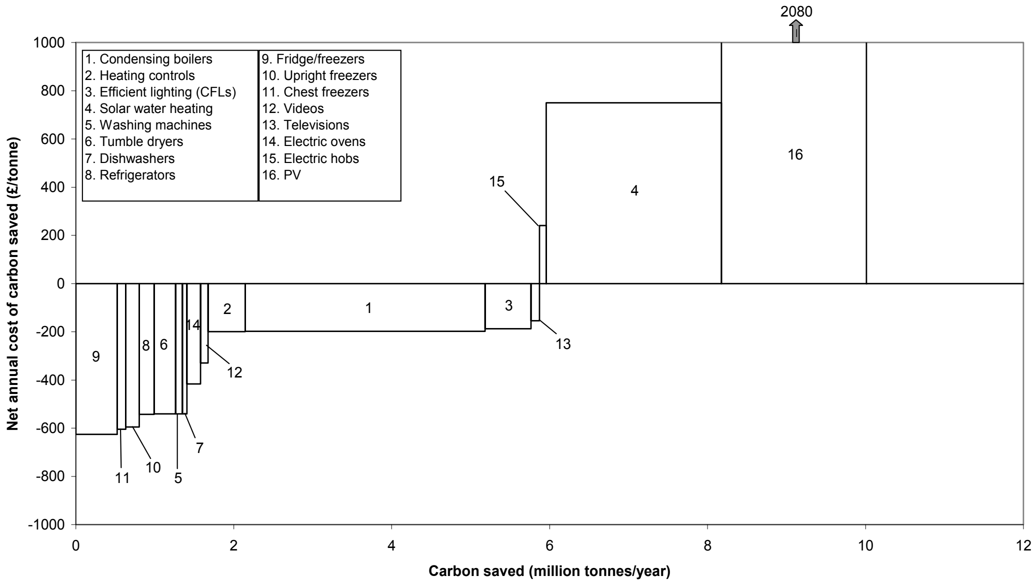


Figure 3. Potential National Carbon Savings – 2001 (Insulation measures, high costs)

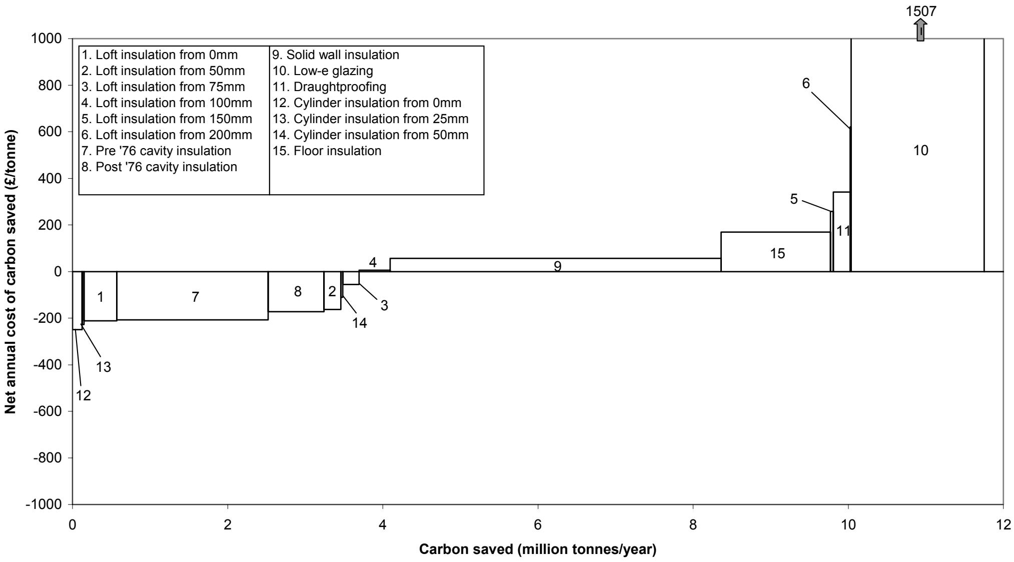
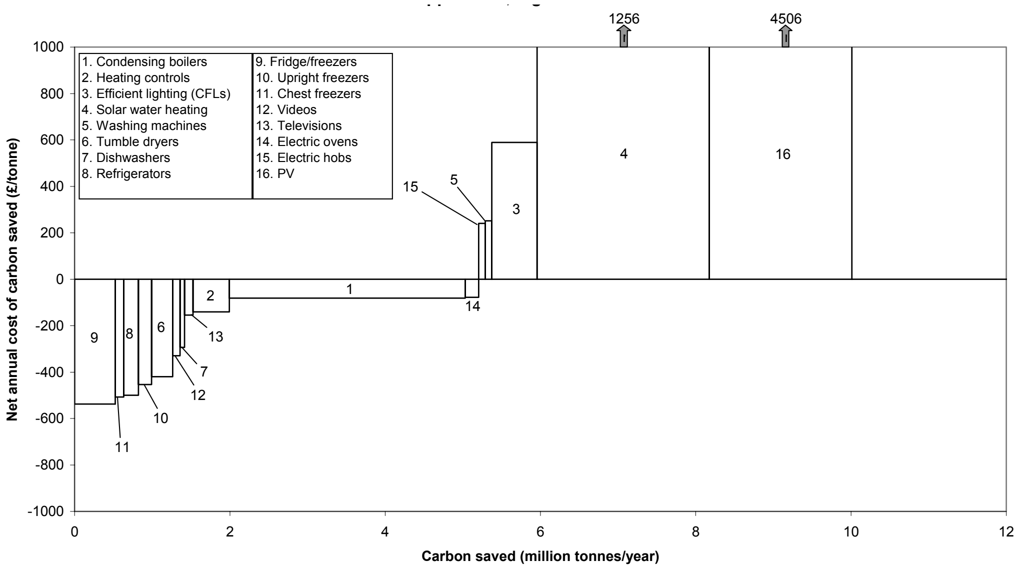


Figure 4. Potential National Carbon Savings – 2001 (Appliances, high costs)



The analysis indicates that the total potential saving from the energy efficiency measures looked at is about 22 MtC/yr (million tonnes of carbon emissions per year). Of this, Figures 1 and 2 suggest that about 17.5 MtC/yr can be saved cost-effectively. However, using the higher cost assumptions, Figures 3 and 4 suggest that only 9 MtC/yr of the total saving is cost-effective. Given the range of circumstances found in the housing stock, the true cost-effective potential carbon saving is likely to fall somewhere between these two figures.

It can be seen from Table A1 in Appendix A that the 2001 analysis indicates that the total expenditure required to implement all the measures is currently about £123bn using low costs, or £282bn using high cost assumptions. However, if just the cost-effective measures were implemented the cost would be a more modest £21bn using the low costs or £15.4bn using the high costs. The latter figure is lower because many fewer measures are included since they are not cost effective.

The total energy savings associated with all the measures are estimated to be 980 PJ/yr (roughly half of current national domestic energy consumption), although in practice these savings would be largely offset by increasing levels of service and by the additional energy use of new homes. Assessing the likely savings in practice requires the development of detailed scenarios including an explicit time dimension, and such calculations are described in

Part 3 of this report. Of the total energy saving potential about 810 PJ could be achieved cost-effectively assuming low costs, or about half of that if the high costs are assumed.

Even using the low costs, some measures do not appear to be cost-effective (for example solar water heating), so even if they offer a large potential for saving energy, it may prove rather expensive to unlock that. Conversely, those measures which appear cost-effective even using the higher cost assumptions can be viewed as ‘no regrets’ measures which are almost universally justifiable purely in terms of their cost-effectiveness, regardless of the environmental benefits.

Figures 5 to 8 show the key figures for 2010. As expected, this indicates that the potential for savings from energy efficiency measures will have fallen slightly to about 17.5 MtC/yr. Of this, using the low cost assumptions, about 13.5 MtC/yr appears cost-effective, or 6.5 MtC/yr if the high costs are assumed. The reduction in the total potential is caused by the uptake of some of that potential between 2001 and 2010. Not surprisingly the most cost-effective measures are taken up fastest, so the proportion of the total potential that is cost-effective under each set of assumptions falls as a percentage of total. There is another reason for the potential savings falling. The carbon intensity of electricity is predicted to be lower in 2010 (and lower still in later years), so the potential for saving carbon through efficient electrical devices falls accordingly.

Figure 5. Potential National Carbon Savings – 2010 (Insulation measures, low costs)

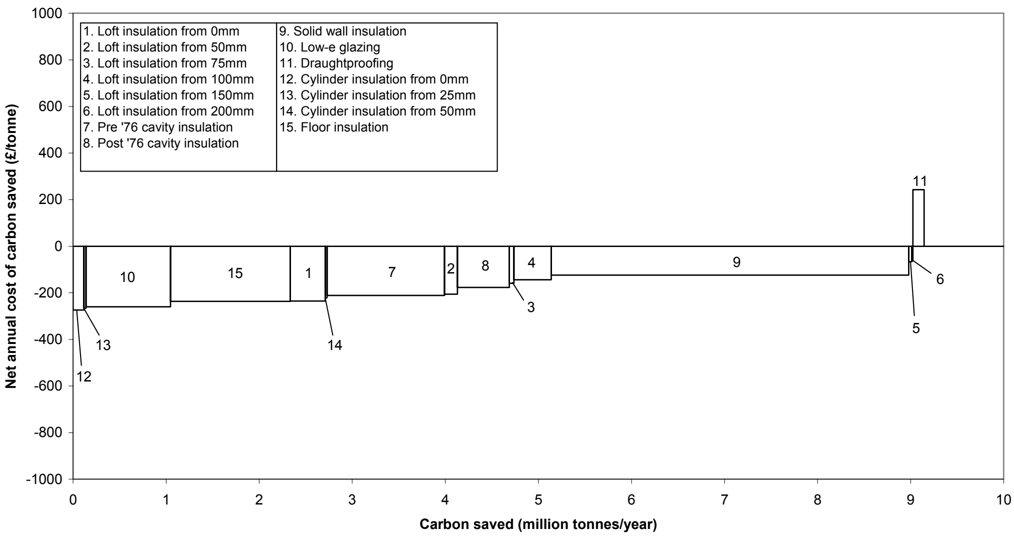


Figure 6. Potential National Carbon Savings – 2010 (Appliances, low costs)

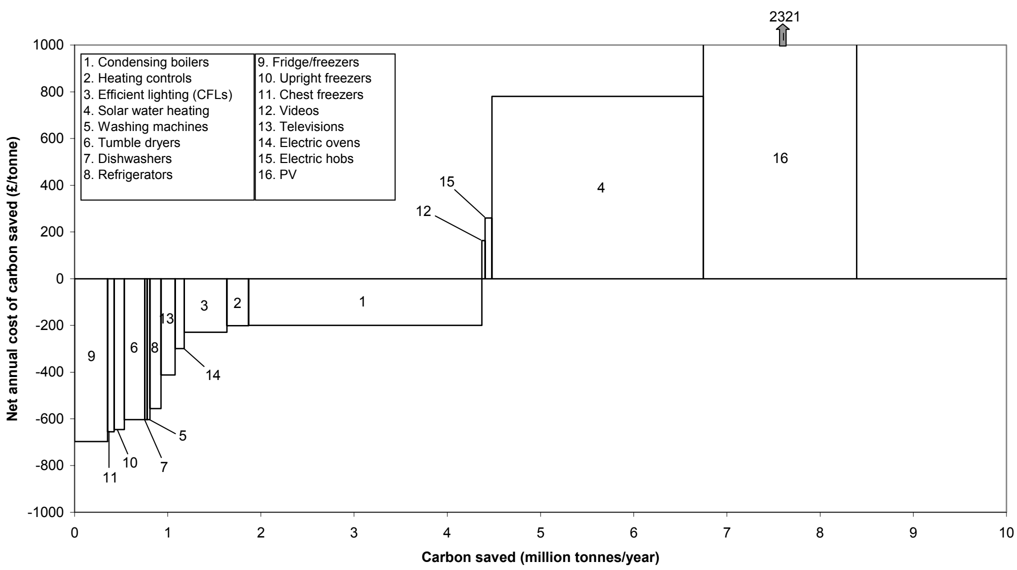


Figure 7. Potential National Carbon Savings – 2010 (Insulation measures, high costs)

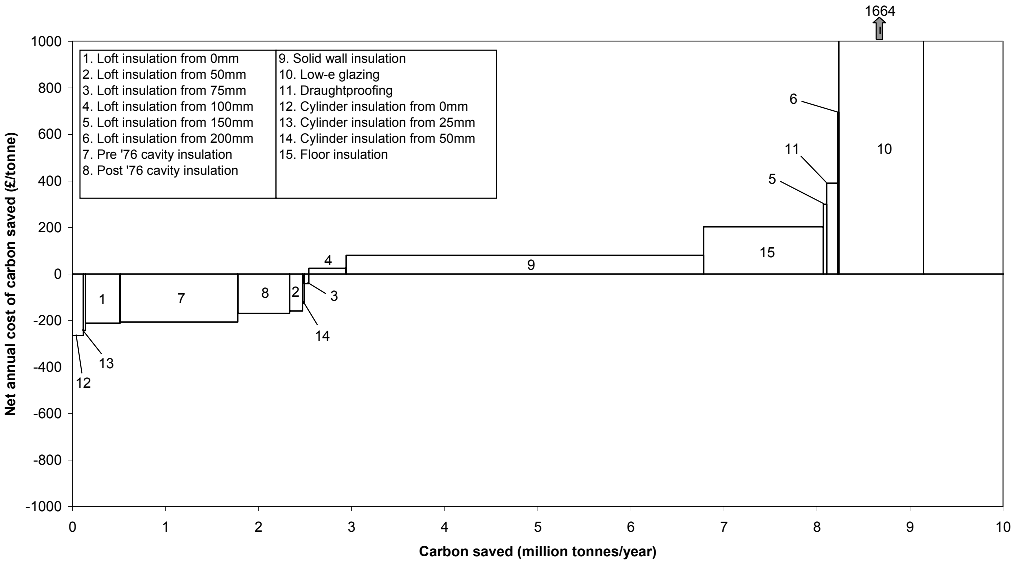
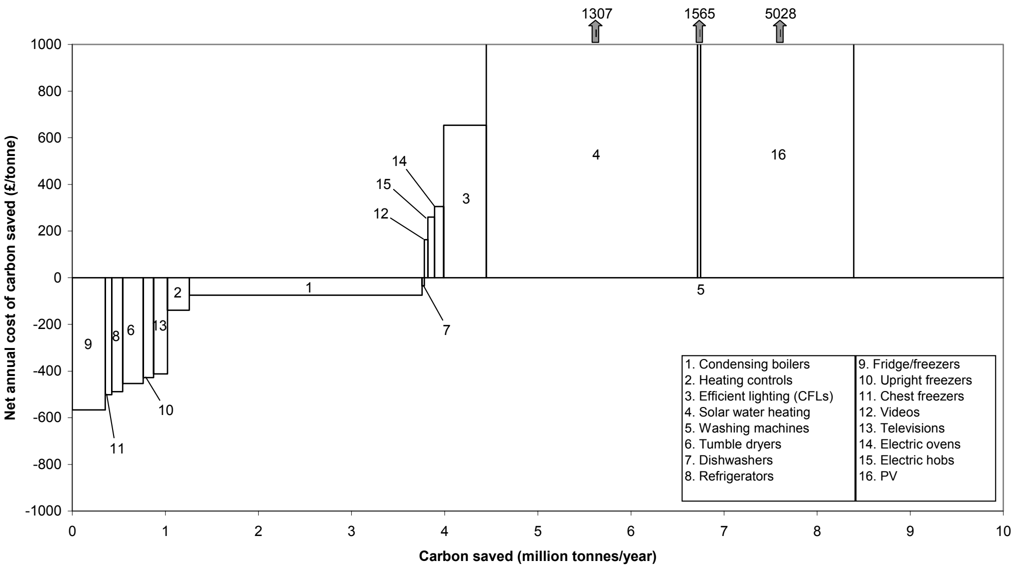


Figure 8. Potential National Carbon Savings – 2010 (Appliances, high costs)



Figures 9 to 12 represent the situation in 2020. The total potential carbon saving indicated for 2020 is about 13.5 MtC/yr, of which 9.5 MtC/yr or 3.5 MtC/yr is indicated as being cost-effective assuming low and high capital costs respectively. Of course, this neglects the possibility that new measures will be available by 2020 through technological progress and assumes the prices of the energy efficiency measures looked at will remain the same in real terms, which may not be the case.

The potential for domestic energy savings in 2050 is estimated in Figures 13 and 14. The total potential for 2050 is significantly larger than for any other year because instead of including traditional energy efficiency measures, such as loft insulation, it includes a number of renewable generation measures, some of which offer large potential savings. It is assumed for 2050 that a larger area of PV will be feasible, hence the potential saving for this measure appears much greater than for earlier years. The total potential carbon saving from the measures considered is shown to be about 29.5 MtC/yr. However, only 17.5 MtC/yr of this is indicated to be cost-effective using low cost estimates and only 0.2 MtC/yr if high cost estimates are used. The latter figure indicates that, whilst it is possible to save a great deal of energy, once all the ‘easy’ domestic efficiency measures are done, it may become increasingly expensive to save additional tonnes of carbon.

Figure 9. Potential National Carbon Savings – 2020 (Insulation measures, low costs)

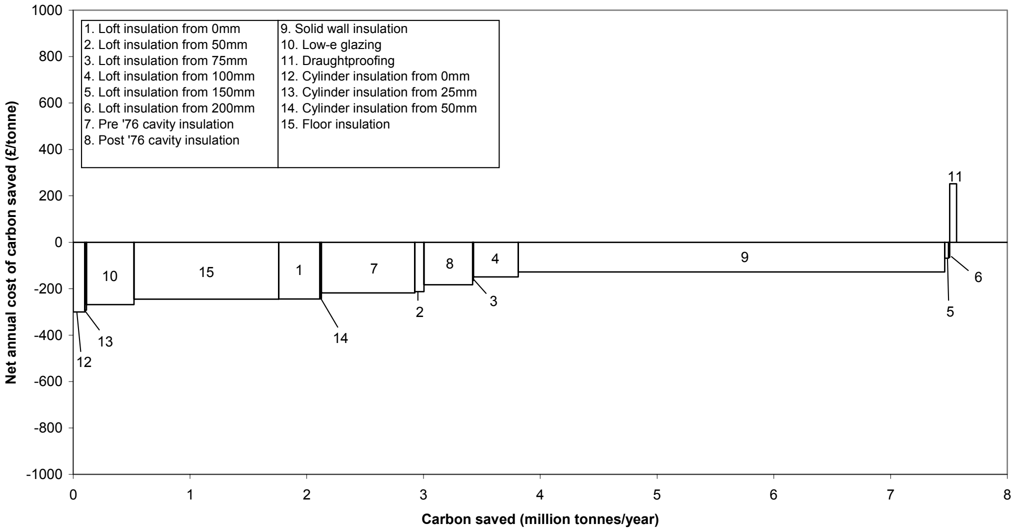


Figure 10. Potential National Carbon Savings – 2020 (Appliances, low costs)

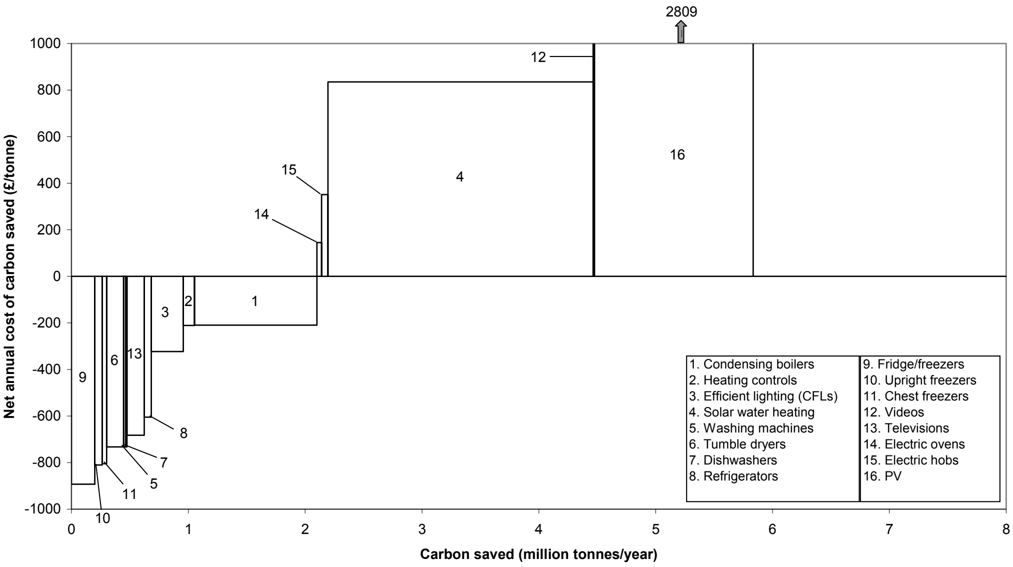


Figure 11. Potential National Carbon Savings – 2020 (Insulation measures, high costs)

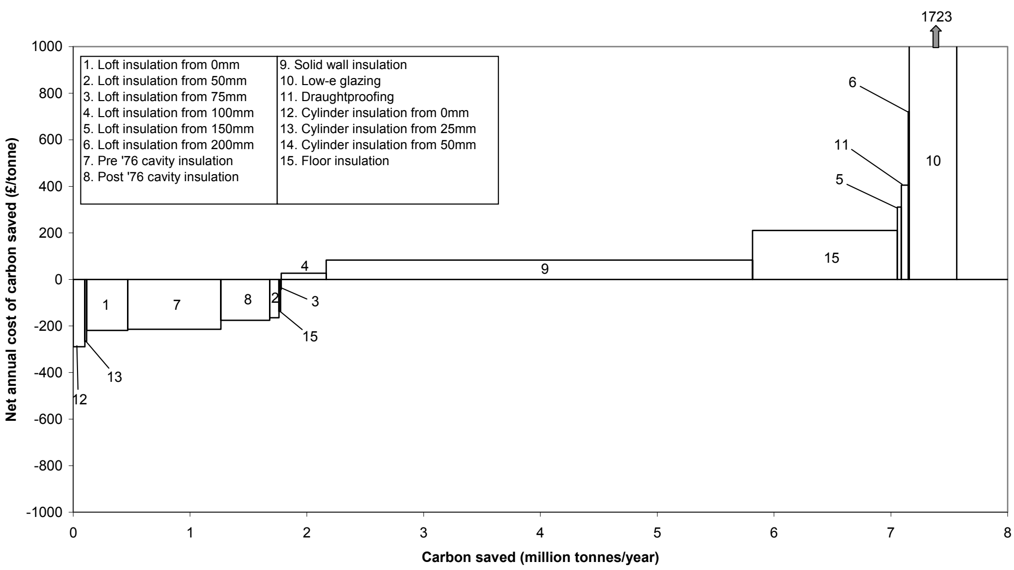


Figure 12. Potential National Carbon Savings – 2020 (Appliances, high costs)

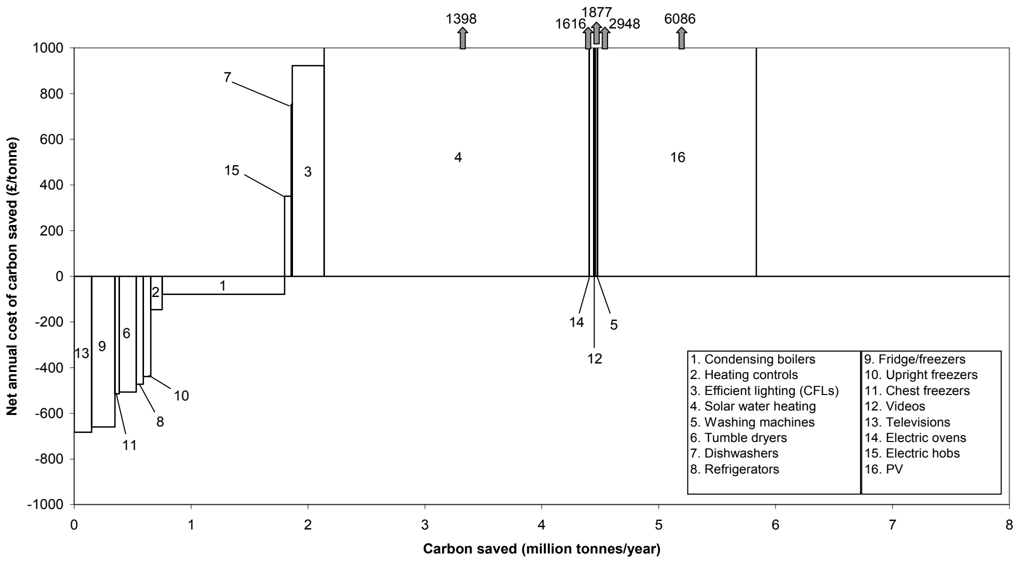


Figure 13. Potential National Carbon Savings – 2050 (All measures, low costs)

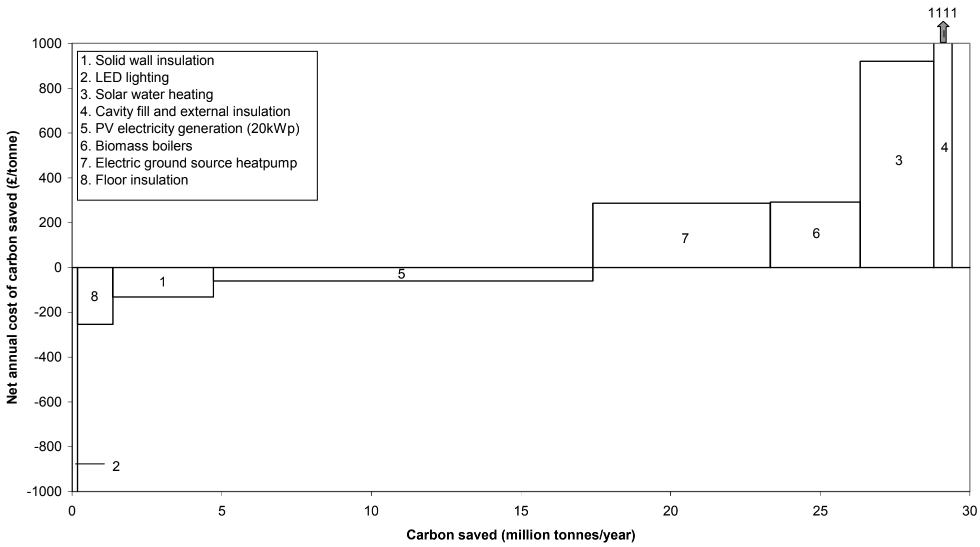
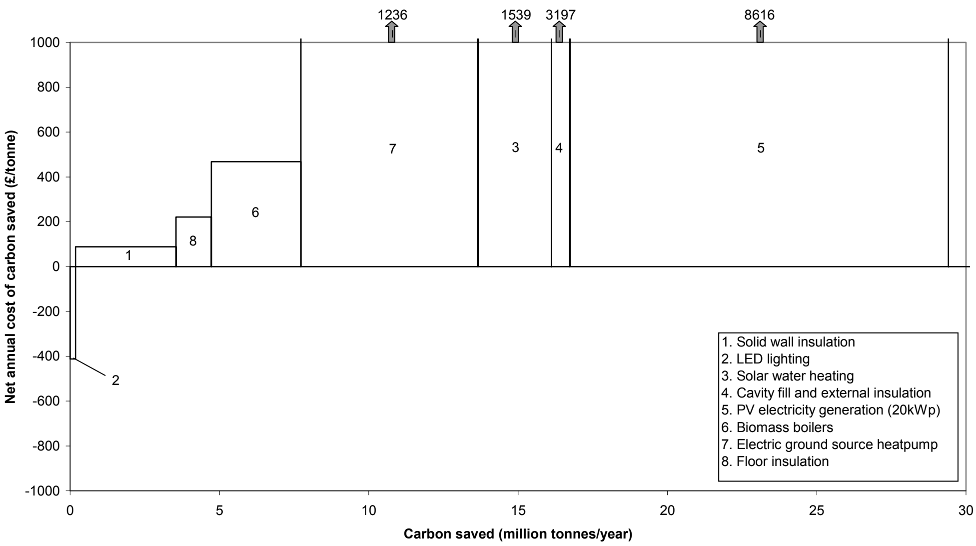


Figure 14. Potential National Carbon Savings – 2050 (All measures, high costs)



However, it must be noted that estimates for 2050 are highly speculative and a lot could change by then. A single new technology might perhaps be invented that could allow carbon to be saved much more cheaply, or costs could be radically different for those measures considered, as could the price of fuels.

1.4 FINDINGS FOR SPECIFIC MEASURES

Loft insulation is a cost-effective way to save energy and reduce domestic carbon emissions, although its potential is diminishing fast as it nears saturation. It is cost-effective to add loft insulation where there is none or less than 150 mm. When 150 mm or more is already installed in a loft, to add more is not justifiable in terms of the cost savings alone under present circumstances. (Note that the inclusion of the social cost of carbon at £70/tonne makes an upgrade from 150 mm to 300 mm marginally cost-effective.)

Cavity wall insulation is shown to be highly cost-effective in all cases considered, but the current big savings potential from it looks likely to tail off in coming years as its penetration begins to saturate.

Solid wall insulation does not seem likely to reach saturation in the next few decades due to its much slower uptake rate, hence it still offers significant potential savings in future years. However, it is not shown to be a cost-effective upgrade except as a marginal cost measure (assuming work is taking place on a solid wall anyway). This may explain why its uptake rate is slow. However, if through technological innovation its cost could be reduced, this large potential saving could be realised more quickly. If the cost could be reduced to around £2500 this measure would become marginally cost-effective.

Low-emissivity double glazing is now installed whenever windows are replaced and so its potential saving will be realised gradually over the coming decades as windows are replaced. Due to the high capital costs, there appears little chance of it ever being cost-effective to prematurely replace windows to improve energy efficiency, so the current situation is likely to continue.

The potential saving from **draught proofing** is shown to be fairly small, but very cost-effective.

Cylinder insulation is a very cost-effective measure, though its potential is fairly small. Since all new cylinders are now well insulated, the potential for this measure will continue to fall as older ones are replaced at the end of their lives.

Condensing boilers are shown to be very cost-effective and to offer the potential for large savings. This saving is likely to be realised quite rapidly in coming years because of the forthcoming change in the Building Regulations requiring most new boilers to be condensing models.

Installing **heating controls** in dwellings that lack them offers fairly small (but cost-effective) potential energy savings because there are a relatively small number of homes which still have no controls. There may also be a savings potential from upgrading controls where limited controls already exist (this was not considered in this analysis due to limited data on existing controls).

Energy efficient lighting is cost-effective and offers the potential for a significant carbon saving, even taking into account the heat replacement effect.

Energy efficient appliances are a cost-effective energy efficiency measure, with the potential for significant savings.

Solar water heating offers the potential to save a considerable amount of carbon emissions, but currently does not appear cost-effective. It does not seem likely to become cost-effective in the near future.

PV offers potentially significant savings, but it is currently not a cost-effective carbon saving measure, because it is very expensive. However, it is predicted that the cost of PV will fall dramatically over the coming decades, in which case it could become a much more attractive option. By 2050 it is estimated it could cost just 1/10 of its current price, in which case it would be cost-effective (at current fuel prices).

Floor insulation offers the potential for a significant carbon saving, but is only ever likely to be cost-effective as a marginal measure when a floor is in need of repairs anyway. Hence, this saving is likely to be realised only very slowly

1.5 CONCLUSIONS

In 2001 the potential carbon saving from domestic energy efficiency measures is about 22 MtC/yr, of which between 9 and 17.5 MtC/yr can be saved cost-effectively.

This equates to a total potential energy saving of about 980 PJ/yr (but this level of saving could not actually be achieved in practice) and would cost between £123bn and £282bn to realise. The potential saving from just the cost-effective measures is between 400 and 810 PJ/yr, costing between £15.4bn and £21bn.

In 2010 the potential carbon saving from the same energy efficiency measures will have fallen to about 17.5 MtC/yr, of which between 6.5 and 13.5 MtC/yr could be saved cost-effectively.

In 2020 the potential reduces to 13.5 MtC/yr of which between 3.5 and 9.5 MtC/yr could be saved cost-effectively.

In 2050, by considering a greater range of possible measures, perhaps around 29.5 MtC/yr could potentially be saved. Of this, 0.2 to 17.5 MtC/yr might be saved cost-effectively if the cost assumptions used here are roughly correct.

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Appendix A: Tables

Table A1. Cost-effectiveness analysis for 2001

Measure considered	Delivered energy saving (GJ/yr)	Comfort factor	Carbon saved (kgC/yr)	Cost saved (£/yr)	Capital cost of measure (£)		Lifetime (years)	Equivalent annual cost (£/yr)		Net annual cost (£/yr)		Potential homes (000's)	Total capital costs (£M)		Total carbon saving (MTC/yr)	Total energy saving (PJ/yr)	Cost per tonne of carbon saved (£/tonne)	
					LOW	HIGH		LOW	HIGH	LOW	HIGH		LOW	HIGH			LOW	HIGH
Loft insulation to 300mm																		
Currently with none	25.128	0.7	337.1	86.22	138	273	30	7.5	14.8	-78.7	-71.4	1253	172.9	342.0	0.42	22.0	-234	-212
Currently with 50mm or less	11.138	0.7	149.4	38.21	137	254	30	7.4	13.8	-30.8	-24.4	1455	199.4	370.0	0.22	11.3	-206	-163
Currently with 75mm	4.518	0.7	60.6	15.50	103	223	30	5.6	12.1	-9.9	-3.4	3478	358.3	774.1	0.21	11.0	-163	-56
Currently with 100mm	3.282	0.7	44.0	11.26	86	211	30	4.7	11.5	-6.6	0.2	9098	782.4	1924.2	0.40	20.9	-150	5
Currently with 150mm	1.572	0.7	21.1	5.39	69	199	30	3.8	10.8	-1.6	5.4	1855	128.0	369.1	0.04	2.0	-78	258
Currently with 200mm	0.787	0.7	10.6	2.70	35	170	30	1.9	9.2	-0.8	6.5	927	32.5	157.7	0.01	0.5	-75	621
Pre- 76 Cavity insulation	23.369	0.7	313.4	80.13	300	325	40	14.0	15.2	-66.1	-64.9	6219	1865.6	2023.7	1.95	101.7	-211	-207
Post- 76 Cavity insulation	13.731	0.7	184.2	47.10	300	325	40	14.0	15.2	-33.0	-31.9	3923	1176.8	1276.5	0.72	37.7	-179	-173
Solid wall insulation	42.531	0.7	570.4	145.85	1309	3272	30	71.2	177.9	-74.7	32.1	7479	9789.7	24470.5	4.27	222.7	-131	56
From single to low-e double glazing	11.903	0.7	159.6	40.81	0	4000	20	0.0	281.4	-40.8	240.6	10746	0.0	42982.7	1.72	89.5	-256	1507
Draughtproofing	1.653	0.7	22.2	5.67	85	110	10	10.2	13.2	4.6	7.6	9793	832.4	1077.3	0.22	11.3	205	341
Hot water cylinder insulation to >75mm													0.0					
Currently with no insulation	7.061	0.7	108.3	28.75	8	20	15	0.7	1.7	-28.1	-27.0	1137	8.7	22.7	0.12	5.6	-259	-249
Currently with 25mm insulation	2.927	0.7	45.1	12.00	8	20	15	0.7	1.7	-11.3	-10.3	578	4.4	11.6	0.03	1.2	-251	-227
Currently with 50mm insulation	0.723	0.7	11.2	2.97	8	20	15	0.7	1.7	-2.3	-1.2	2107	16.1	42.1	0.02	1.1	-207	-111
Condensing boilers	12.917	0.7	177.3	45.48	100	300	12	10.3	31.0	-35.1	-14.4	17128	1712.8	5138.3	3.04	154.9	-198	-81
Improved heating controls	11.353	1	223.4	57.38	125	250	12	12.9	25.9	-44.4	-31.5	2102	262.8	525.5	0.47	23.9	-199	-141
Energy efficient lighting	0.195	1	27.8	21.16	85	200	6	16.0	37.5	-5.2	16.4	20908	1777.2	4181.5	0.58	4.1	-188	589
Solar water heating	7.966	0.7	114.8	29.93	1650	2475	20	116.1	174.1	86.2	144.2	19330	31893.8	47840.8	2.22	107.8	750	1256
Energy efficient appliances													0.0					
Washing machines	0.103	1	3.9	2.09	0	30	12.2	0.0	3.1	-2.1	1.0	22317	0.0	669.5	0.09	2.3	-540	252
Tumble dryers	0.589	1	22.0	11.89	0	30	14.6	0.0	2.7	-11.9	-9.2	12390	0.0	371.7	0.27	7.3	-540	-420
Dishwashers	0.260	1	9.7	5.25	0	31	17.5	0.0	2.4	-5.3	-2.9	5814	0.0	180.2	0.06	1.5	-540	-294
Refrigerators	0.250	1	18.1	12.44	27	35	13.1	2.6	3.4	-9.8	-9.1	10404	280.9	364.1	0.19	2.6	-542	-500
Fridge/freezers	0.470	1	34.1	23.40	27	67	18.1	2.0	5.1	-21.4	-18.3	15348	414.4	1028.3	0.52	7.2	-626	-538
Upright freezers	0.369	1	26.8	18.36	27	69	14.3	2.4	6.2	-15.9	-12.1	6337	171.1	437.3	0.17	2.3	-595	-454
Chest freezers	0.362	1	26.3	18.01	27	59	16.9	2.1	4.7	-15.9	-13.3	4207	113.6	248.2	0.11	1.5	-604	-508
Videos	0.050	1	4.0	2.78	10	10	7.9	1.5	1.5	-1.3	-1.3	23855	238.6	238.6	0.09	1.2	-329	-329
Televisions	0.032	1	2.5	1.77	10	10	8.5	1.4	1.4	-0.4	-0.4	42769	427.7	427.7	0.11	1.4	-154	-154
Electric ovens	0.158	1	12.5	8.71	50	110	20	3.5	7.7	-5.2	-1.0	13916	695.8	1530.8	0.17	2.2	-417	-78
Electric hobs	0.095	1	7.5	5.24	100	100	20	7.0	7.0	1.8	1.8	11164	1116.4	1116.4	0.08	1.1	240	240
PV	5.049	1	185.6	99.41	6900	13300	20	485.5	935.8	386.1	836.4	9892	68251.4	131557.0	1.84	49.9	2080	4506
Floor insulation (raised timber floors)	6.690	1	128.2	32.75	50	1000	30	2.7	54.4	-30.0	21.6	10987	549.4	10987.0	1.41	73.5	-234	169
												TOTALS	**123273**	**282687**	**21.8**	**983**		

Table A2. Cost-effectiveness analysis for 2010

Measure considered	Delivered energy saving (GJ/yr)	Comfort factor	Carbon saved (kgC/yr)	Cost saved (£/yr)	Capital cost of measure (£)		Lifetime (years)	Equivalent annual cost (£/yr)		Net annual cost (£/yr)		Potential homes (000's)	Total capital costs (£M)		Total carbon saving (MTC/yr)	Total energy saving (PJ/yr)	Cost per tonne of carbon saved (£/tonne)	
					LOW	HIGH		LOW	HIGH	LOW	HIGH		LOW	HIGH			LOW	HIGH
Loft insulation to 300mm																		
Currently with none	25.128	0.7	308.9	80.33	138	273	30	7.5	14.8	-72.8	-65.5	1216	167.9	332.0	0.38	21.4	-236	-212
Currently with 50mm or less	11.138	0.7	136.9	35.60	137	254	30	7.4	13.8	-28.1	-21.8	1006	137.8	255.8	0.14	7.8	-206	-159
Currently with 75mm	4.518	0.7	55.5	14.44	103	223	30	5.6	12.1	-8.8	-2.3	896	92.3	199.5	0.05	2.8	-159	-42
Currently with 100mm	3.282	0.7	40.4	10.49	86	211	30	4.7	11.5	-5.8	1.0	9910	852.2	2095.9	0.40	22.8	-144	25
Currently with 150mm	1.572	0.7	19.3	5.02	69	199	30	3.8	10.8	-1.3	5.8	1855	128.0	369.1	0.04	2.0	-66	300
Currently with 200mm	0.787	0.7	9.7	2.51	35	170	30	1.9	9.2	-0.6	6.7	927	32.5	157.7	0.01	0.5	-63	696
Pre- 76 Cavity insulation	23.369	0.7	287.3	74.66	300	325	40	14.0	15.2	-60.6	-59.4	4399	1319.8	1431.7	1.26	72.0	-211	-207
Post- 76 Cavity insulation	13.731	0.7	168.8	43.88	300	325	40	14.0	15.2	-29.8	-28.6	3299	989.8	1073.7	0.56	31.7	-177	-170
Solid wall insulation	42.531	0.7	522.8	135.88	1309	3272	30	71.2	177.9	-64.7	42.0	7350	9621.4	24049.9	3.84	218.8	-124	80
From single to low-e double glazing	11.903	0.7	146.3	38.02	0	4000	20	0.0	281.4	-38.0	243.4	6228	0.0	24910.4	0.91	51.9	-260	1664
Draughtproofing	1.653	0.7	20.3	5.28	85	110	10	10.2	13.2	4.9	7.9	5935	504.4	652.8	0.12	6.9	243	391
Hot water cylinder insulation to >75mm													0.0					
Currently with no insulation	7.061	0.7	107.8	30.20	8	20	15	0.7	1.7	-29.5	-28.5	1078	8.2	21.6	0.12	5.3	-274	-264
Currently with 25mm insulation	2.927	0.7	45.1	12.66	8	20	15	0.7	1.7	-12.0	-10.9	471	3.6	9.4	0.02	1.0	-266	-242
Currently with 50mm insulation	0.723	0.7	11.2	3.14	8	20	15	0.7	1.7	-2.5	-1.4	1717	13.1	34.3	0.02	0.9	-222	-126
Condensing boilers	12.917	0.7	165.3	43.46	100	300	12	10.3	31.0	-33.1	-12.4	15135	1513.5	4540.4	2.50	136.8	-200	-75
Improved heating controls	11.353	1	208.8	55.01	125	250	12	12.9	25.9	-42.1	-29.1	1111	138.9	277.8	0.23	12.6	-202	-140
Energy efficient lighting	0.195	1	24.4	21.56	85	200	6	16.0	37.5	-5.6	16.0	18737	1592.6	3747.3	0.46	3.7	-229	654
Solar water heating	7.966	0.7	110.4	29.92	1650	2475	20	116.1	174.1	86.2	144.2	20543	33895.7	50843.6	2.27	114.6	781	1307
Energy efficient appliances													0.0					
Washing machines	0.042	1	1.4	0.85	0	30	12.2	0.0	3.1	-0.9	2.2	22317	0.0	669.5	0.03	0.9	-604	1565
Tumble dryers	0.528	1	17.7	10.67	0	30	14.6	0.0	2.7	-10.7	-8.0	12390	0.0	371.7	0.22	6.5	-604	-453
Dishwashers	0.126	1	4.2	2.55	0	31	17.5	0.0	2.4	-2.5	-0.1	5814	0.0	180.2	0.02	0.7	-604	-35
Refrigerators	0.177	1	11.4	8.93	27	35	13.1	2.6	3.4	-6.3	-5.6	10404	280.9	364.1	0.12	1.8	-556	-489
Fridge/freezers	0.360	1	23.1	18.17	27	67	18.1	2.0	5.1	-16.1	-13.1	15348	414.4	1028.3	0.36	5.5	-697	-567
Upright freezers	0.271	1	17.4	13.67	27	69	14.3	2.4	6.2	-11.2	-7.5	6337	171.1	437.3	0.11	1.7	-646	-428
Chest freezers	0.257	1	16.5	12.97	27	59	16.9	2.1	4.7	-10.8	-8.3	4207	113.6	248.2	0.07	1.1	-656	-502
Videos	0.022	1	1.5	1.22	10	10	7.9	1.5	1.5	0.2	0.2	23855	238.6	238.6	0.04	0.5	163	163
Televisions	0.051	1	3.5	2.84	10	10	8.5	1.4	1.4	-1.5	-1.5	42769	427.7	427.7	0.15	2.2	-413	-413
Electric ovens	0.100	1	7.0	5.61	50	110	20	3.5	7.7	-2.1	2.1	13916	695.8	1530.8	0.10	1.4	-299	305
Electric hobs	0.095	1	6.6	5.31	100	100	20	7.0	7.0	1.7	1.7	11164	1116.4	1116.4	0.07	1.1	260	260
PV	5.049	1	166.3	99.41	6900	13300	20	485.5	935.8	386.1	836.4	9892	68251.4	131557.0	1.65	49.9	2321	5028
Floor insulation (raised timber floors)	6.690	1	117.5	30.51	50	1000	30	2.7	54.4	-27.8	23.9	10941	547.1	10941.0	1.29	73.2	-237	203
												TOTALS	**123269**	**264114**	**17.5**	**860**		

Table A3. Cost-effectiveness analysis for 2020

Measure considered	Delivered energy saving (GJ/yr)	Comfort factor	Carbon saved (kgC/yr)	Cost saved (£/yr)	Capital cost of measure (£)		Lifetime (years)	Equivalent annual cost (£/yr)		Net annual cost (£/yr)		Potential homes (000's)	Total capital costs (£M)		Total carbon saving (MTC/yr)	Total energy saving (PJ/yr)	Cost per tonne of carbon saved (£/tonne)	
					LOW	HIGH		LOW	HIGH	LOW	HIGH		LOW	HIGH			LOW	HIGH
Loft insulation to 300mm																		
Currently with none	25.128	0.7	298.4	80.33	138	273	30	7.5	14.8	-72.8	-65.5	1181	163.0	322.3	0.35	20.8	-244	-219
Currently with 50mm or less	11.138	0.7	132.2	35.60	137	254	30	7.4	13.8	-28.1	-21.8	604	82.7	153.5	0.08	4.7	-213	-165
Currently with 75mm	4.518	0.7	53.6	14.44	103	223	30	5.6	12.1	-8.8	-2.3	114	11.8	25.5	0.01	0.4	-165	-44
Currently with 100mm	3.282	0.7	39.0	10.49	86	211	30	4.7	11.5	-5.8	1.0	9861	848.0	2085.6	0.38	22.7	-149	26
Currently with 150mm	1.572	0.7	18.7	5.02	69	199	30	3.8	10.8	-1.3	5.8	1855	128.0	369.1	0.03	2.0	-68	311
Currently with 200mm	0.787	0.7	9.3	2.51	35	170	30	1.9	9.2	-0.6	6.7	927	32.5	157.7	0.01	0.5	-65	721
Pre- 76 Cavity insulation	23.369	0.7	277.5	74.66	300	325	40	14.0	15.2	-60.6	-59.4	2879	863.8	937.0	0.80	47.1	-218	-214
Post- 76 Cavity insulation	13.731	0.7	163.0	43.88	300	325	40	14.0	15.2	-29.8	-28.6	2554	766.1	831.0	0.42	24.5	-183	-176
Solid wall insulation	42.531	0.7	505.0	135.88	1309	3272	30	71.2	177.9	-64.7	42.0	7231	9465.3	23659.7	3.65	215.3	-128	83
From single to low-e double glazing	11.903	0.7	141.3	38.02	0	4000	20	0.0	281.4	-38.0	243.4	2882	0.0	11527.2	0.41	24.0	-269	1723
Draughtproofing	1.653	0.7	19.6	5.28	85	110	10	10.2	13.2	4.9	7.9	2979	253.3	327.7	0.06	3.4	252	405
Hot water cylinder insulation to >75mm													0.0					
Currently with no insulation	7.061	0.7	98.4	30.20	8	20	15	0.7	1.7	-29.5	-28.5	1018	7.8	20.4	0.10	5.0	-300	-289
Currently with 25mm insulation	2.927	0.7	41.0	12.66	8	20	15	0.7	1.7	-12.0	-10.9	353	2.7	7.1	0.01	0.7	-292	-266
Currently with 50mm insulation	0.723	0.7	10.2	3.14	8	20	15	0.7	1.7	-2.5	-1.4	1288	9.8	25.8	0.01	0.7	-244	-138
Condensing boilers	12.917	0.7	157.9	43.46	100	300	12	10.3	31.0	-33.1	-12.4	6639	663.9	1991.8	1.05	60.0	-210	-79
Improved heating controls	11.353	1	199.1	55.01	125	250	12	12.9	25.9	-42.1	-29.1	485	60.6	121.3	0.10	5.5	-211	-146
Energy efficient lighting	0.195	1	17.3	21.56	85	200	6	16.0	37.5	-5.6	16.0	15752	1338.9	3150.4	0.27	3.1	-324	922
Solar water heating	7.966	0.7	103.2	29.92	1650	2475	20	116.1	174.1	86.2	144.2	21979	36265.4	54398.1	2.27	122.6	835	1398
Energy efficient appliances													0.0					
Washing machines	0.030	1	0.8	0.61	0	30	12.2	0.0	3.1	-0.6	2.5	22317	0.0	669.5	0.02	0.7	-733	2948
Tumble dryers	0.427	1	11.8	8.62	0	30	14.6	0.0	2.7	-8.6	-6.0	12390	0.0	371.7	0.15	5.3	-733	-507
Dishwashers	0.059	1	1.6	1.18	0	31	17.5	0.0	2.4	-1.2	1.2	5814	0.0	180.2	0.01	0.3	-733	753
Refrigerators	0.122	1	5.9	6.15	27	35	13.1	2.6	3.4	-3.5	-2.8	10404	280.9	364.1	0.06	1.3	-605	-473
Fridge/freezers	0.270	1	13.0	13.62	27	67	18.1	2.0	5.1	-11.6	-8.6	15348	414.4	1028.3	0.20	4.1	-892	-660
Upright freezers	0.212	1	10.2	10.68	27	69	14.3	2.4	6.2	-8.2	-4.5	6337	171.1	437.3	0.06	1.3	-811	-439
Chest freezers	0.182	1	8.8	9.20	27	59	16.9	2.1	4.7	-7.1	-4.5	4207	113.6	248.2	0.04	0.8	-805	-515
Videos	0.010	1	0.5	0.54	10	10	7.9	1.5	1.5	0.9	0.9	23855	238.6	238.6	0.01	0.2	1877	1877
Televisions	0.067	1	3.5	3.75	10	10	8.5	1.4	1.4	-2.4	-2.4	42769	427.7	427.7	0.15	2.9	-683	-683
Electric ovens	0.055	1	2.9	3.10	50	110	20	3.5	7.7	0.4	4.6	13916	695.8	1530.8	0.04	0.8	145	1616
Electric hobs	0.095	1	4.9	5.31	100	100	20	7.0	7.0	1.7	1.7	11164	1116.4	1116.4	0.05	1.1	351	351
PV	5.049	1	137.4	99.41	6900	13300	20	485.5	935.8	386.1	836.4	9892	68251.4	131557.0	1.36	49.9	2809	6086
Floor insulation (raised timber floors)	6.690	1	113.5	30.51	50	1000	30	2.7	54.4	-27.8	23.9	10921	546.1	10921.0	1.24	73.1	-245	210
												TOTALS	**123219**	**249202**	**13.4**	**705**		

Table A4. Cost-effectiveness analysis for 2050

Measure considered	Delivered energy saving (GJ/yr)	Comfort factor	Carbon saved (kgC/yr)	Cost saved (£/yr)	Capital cost of measure (£)		Lifetime (years)	Equivalent annual cost (£/yr)		Net annual cost (£/yr)		Potential homes (000's)	Total capital costs (£M)		Total carbon saving (MTC/yr)	Total energy saving (PJ/yr)	Cost per tonne of carbon saved (£/tonne)	
					LOW	HIGH		LOW	HIGH	LOW	HIGH		LOW	HIGH			LOW	HIGH
Solid wall insulation	42.531	0.7	484.2	135.12	1309	3272	30	71.2	177.9	-63.9	42.8	6945	9091	22724	3.36	206.8	-132	88
Energy efficient lighting (LED)	0.433	1	9.1	12.56	17	85	12	1.8	8.8	-10.8	-3.8	20000	340	1700	0.18	8.7	-1184	-412
Solar water heating	7.966	0.7	93.9	29.67	1650	2475	20	116.1	174.1	86.4	144.5	26201	43231	64846	2.46	146.1	920	1538
Externally insulate filled cavity walls	4.494	0.7	51.2	14.31	1309	3272	30	71.2	177.9	56.9	163.6	12000	15708	39264	0.61	37.7	1111	3197
PV	54.000	1	1038.3	1063.26	14225	142246	20	1000.9	10009	-62.4	8945.3	12211	173697	1736966	12.68	659.4	-60	8616
Biomass boilers	0.000	1	600.0	0.97	2500	4000	20	175.9	281.4	174.9	280.5	5000	12500	20000	3.00	0.0	292	467
Ground source heat pumps	19.905	1	237.1	93.85	2300	5500	20	161.8	387.0	68.0	293.1	25000	57500	137500	5.93	497.6	287	1236
Floor insulation (raised timber floors)	6.690	1	108.8	30.34	50	1000	30	2.7	54.4	-27.6	24.0	10861	543	10861	1.18	72.7	-254	221
												TOTALS	**312610**	**2033861**	**29.4**	**1629**		

Part 2. Assessing the effects of domestic sector energy efficiency policies

SUMMARY

This part of the report addresses the effectiveness of domestic sector energy efficiency policies.

Section 2.2 follows on from work previously undertaken on assessing the effects of grants, updating these analyses and also extending the basic methodology to consider the effects of specific schemes.

The results indicate marked differences between the effectiveness of different schemes and allow a ranking to be established between four key schemes (the Homes Insulation Scheme, the Energy Conservation Programme, the Standards of Performance and the Home Energy Efficiency Scheme / Warm Front).

As regards the updating, there are some limitations to what is possible due to data availability difficulties. In particular, grant expenditure figures are not available after 1999/2000, so the quantitative analyses cannot be extended beyond this.

Section 2.3 considers the effects of other types of domestic sector energy efficiency policies. It presents several examples that look specifically at the effects of energy labelling, minimum standards and Building Regulations and how these interact. Cold appliances (refrigerators, freezers, etc.), wet appliances (washing machines, dishwashers, etc.) and boilers are considered.

The results show that energy labelling, when coupled with minimum standards (whether introduced voluntarily, through EU regulations or via national Building Regulations), is generally able to transform the market for individual appliances in five to seven years.

Energy labelling in isolation, however, does not appear to have much effect in transforming the market. Indeed, the results for cold appliances in particular suggest very strongly that the market would definitely not have been transformed without the minimum standards, and also that manufacturers will wait until the last possible moment before complying with such minimum standards.

One further analysis shows that Building Regulation standards that apply only to new dwellings tend to be taken up as good practice for the refurbishment of existing dwellings. This emphasises the importance of continually upgrading Building Regulations.

Section 2.4 presents the results of calculations of the energy and carbon savings due to the energy efficiency policies discussed in Sections 2.2 and 2.3. The analyses for grants are essentially an update of previous work, and they lead to fairly similar conclusions to those reached previously. The other analyses are completely new and allow the effects of the various energy efficiency policies to be compared.

These comparisons show that Building Regulations and grants have been broadly equal in their effects and together they dominate the calculated savings. The savings from labelling and minimum standards are much lower, but this is only to be expected because they have not been running for as long.

2.1 INTRODUCTION

The effects of individual energy efficiency policies can be difficult to establish. Firstly, the policies are generally not separable from one-another, so that all that one can normally measure is an overall effect due to several policies. Secondly, the available data are subject to limitations that restrict the analyses that are possible. Nonetheless, previous work has been successful in identifying the effects of grants for three separate energy efficiency measures [(1)]. Such findings are useful for making realistic assessments of the likely effects of policies in the future, and hence the impact on future carbon emissions.

Section 2.2 updates the earlier work by incorporating the latest data available. It also extends the previous analyses by looking at the effects of individual grant schemes, as far as this is possible. Some conclusions on the effectiveness of different schemes can be drawn from the analyses.

Section 2.3 considers the effects of policies other than grants. In particular, the effects of energy labelling, minimum standards and Building Regulations are considered. Several examples illustrate the effectiveness of such policies and allow this to be quantified in terms of the time that it takes to transform the relevant market.

Section 2.4 presents the results of calculations of energy and carbon savings for the policies discussed in Sections 2.2 and 2.3. These calculations allow the current relative importance of the different energy efficiency policies to be determined. Broadly, they show that grants and Building Regulations are equally important and together they dominate the calculated overall savings.

2.2 THE EFFECTS OF GRANTS

Update of earlier analyses

Previous work has demonstrated the actual effects of grants for loft insulation, cavity wall insulation and condensing boilers up to 1999/2000. Despite some data limitations, in each case a reasonably comprehensive picture was possible, illustrating the link between grant expenditures and acquisitions of the measures, and allowing this to be quantified [(1)].

To update the analyses, data on the acquisitions of these measures to 2001/2002 were first assembled. In addition, data on grants were obtained from the Energy Saving Trust (the Standards of Performance and Cashback schemes), and through the Energy Efficiency Partnership for Homes (HEES/Warm Front grants for cavity wall insulation). However, data provided in the published National Audit Office report on HEES/Warm Front [(2)] has been used in preference to the latter as it is more complete and is considered more reliable.

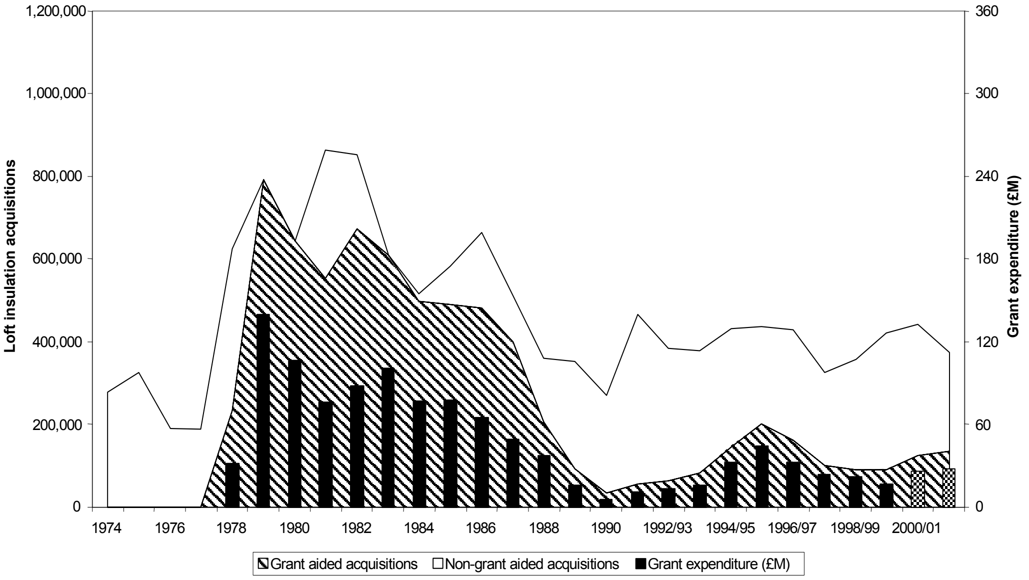
A limitation with all the new data is that since 1999/2000 there appears to be no requirement for information on expenditures to be provided by suppliers. Thus, the quantitative analyses relating acquisitions to grant expenditures cannot be updated beyond 1999/2000. In one sense therefore there is no point in pursuing the data collection as comprehensively as might otherwise be the case. On the other hand, assuming that the previous regression analyses remain valid, it is possible to make a reasonable estimate of the relevant expenditures from the number of grants. Thus, the illustrative charts showing the link between grants and acquisitions can be updated, albeit in a slightly approximate manner. This is useful for illustrating the current trends.

Of course, this assumes that data on the number of grants for each of the additional years is available and is complete, which at the time that this work was undertaken was actually not entirely the case. Some estimates had to be made to complete the picture. These are noted under the tables in Appendix B. Indeed, it also has to be noted that many of the grants figures that were provided appear to be estimates anyway. For example, Standards of Performance (SoP3) figures for 2000/2001 and 2001/2002 are shown as being identical – which either means that 2001/2002 figures were not known and were just set equal to the previous year as the best estimate, or else that a total for the two years of SoP3 was known but the individual year figures could only be estimated. Either way, this implies that there is not much point in focusing on the precise numbers at this stage – all numbers for grants beyond 1999/2000 should be simply regarded as best estimates, subject to revision when, and if, more robust figures become available in the future.

Loft insulation

Figure 15 presents an update to the chart showing the relationship between grant expenditures and acquisitions of loft insulation. The expenditures for the final two years are shown in grey rather than black to indicate that these are just estimates based on the regression result for the data to 1999/2000 (note that for this reason all expenditures are given in 1999/2000 money values – and this applies to all expenditure figures presented in this part of the report). Note also that most of the historical grants figures for the Standards of Performance for this measure have been revised by the Energy Saving Trust since the original work was done. However, these changes are too small to show a visible difference as compared with the earlier version of the chart, and indeed even the more detailed quantitative analyses do not significantly change as a result of these revisions.

Figure 15. Loft insulation acquisitions in existing homes related to grant expenditure



Note that there has been a sharp fall in the number of loft insulation acquisitions between 2000/2001 and 2001/2002. Both the Standards of Performance and HEES data actually indicate a substantially higher number of grants in each of 2000/2001 and 2001/2002 as compared with 1999/2000, so this means that there must have been a large fall in the number of households acquiring loft insulation without a grant. The available figures suggest that the proportion of acquisitions without a grant has fallen from about 78% in 1999/2000 to 64% in 2001/2002. This latter figure is similar to the proportion which applied in the mid-1990s.

Table B1 in Appendix B presents the updated data for loft insulation acquisitions and grants in more detail.

Cavity wall insulation

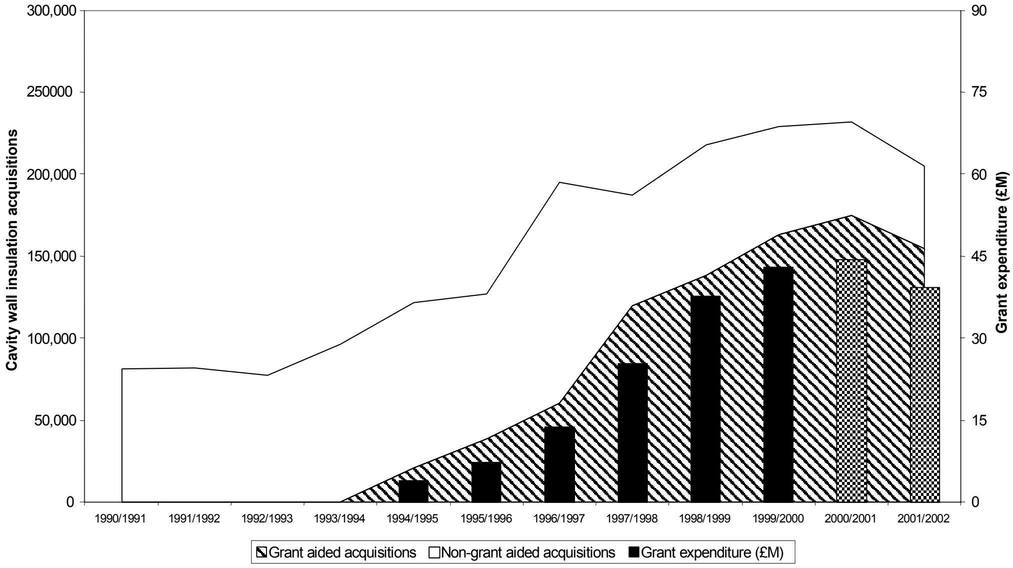
Figure 16 shows the update to the chart illustrating the relationship between grants and acquisitions for cavity wall insulation. Again, the last two expenditure figures are shown in grey to indicate that they are estimates based on the regression result for the earlier data.

This shows the same fall-off in acquisitions between 2000/2001 and 2001/2002 as seen in the loft insulation figures. The difference is that the number of grants for this measure has also fallen off markedly. The Standards of Performance data actually indicate substantially more grants after 1999/2000 than before, but there is a significant drop shown in HEES/Warm Front and other grants which counteracts this.

This is perhaps related to problems with the timing of the introduction of the latest HEES scheme, and probably more importantly to the fact that the grants are now available for a wider range of measures, including heating systems. This implies that the available resources are being spread more thinly, thereby resulting in less insulation work taking place than was the case previously. Indeed, figures in the National Audit Office report [(2)] can be used to show that in 2001/2002 over 40% of the grant expenditure must have gone on heating systems, and this was more than that on loft insulation and cavity wall insulation combined. Loft insulation and cavity wall insulation each accounted for only around 13% of the measures installed under the scheme in that year.

Table B2 in Appendix B presents the updated data for cavity wall insulation acquisitions and grants in more detail.

Figure 16. Cavity wall insulation acquisitions in existing homes related to grant expenditure



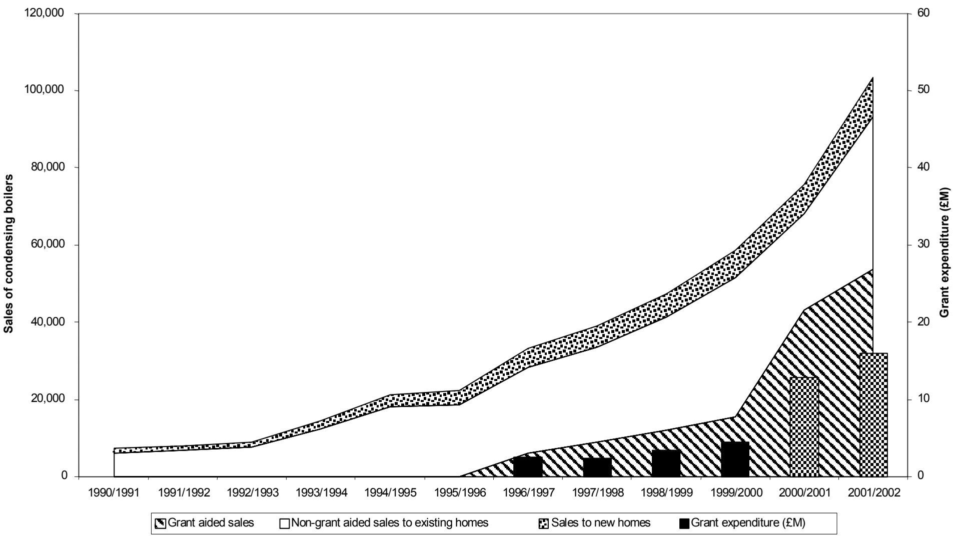
Condensing boilers

Figure 17 shows the update to the chart illustrating the relationship between grants and sales for condensing boilers. Unlike the other two measures, the sales of condensing boilers have not decreased since 2000/2001. Again, the last two expenditure figures are shown in grey to indicate that they are estimates based on the regression result for the earlier data.

Clearly, the sales of condensing boilers have continued to grow rapidly – more rapidly than the number of grants alone can explain, although grants have clearly been important as Figure 17 indicates. As will be discussed later, it appears likely that plans for changes to the Building Regulations are providing a strong driver for the increasing sales of condensing boilers.

Table B3 in Appendix B presents the updated data for condensing boiler sales and grants in more detail.

Figure 17. Condensing boiler sales related to grant expenditure



The effects of individual schemes

The effects of individual schemes are difficult to determine. This is because it is generally impossible to identify which acquisitions occurred under which schemes. However, there are instances where such identifications can be made, at least approximately. In the original analyses for loft insulation, for example, two distinct time periods were considered and shown to have different characteristics. These different characteristics could be identified with a change in the nature of the grants – going from generally available grants to grants targeted on low-income households. However, the change also coincided with the transition between the rapid growth phase and the saturation phase of the ownership curve. Consequently, it was not possible to read too much into the differences that were observed.

In the following, analyses focusing on the acquisitions in the target households for individual schemes are considered further in order to try to better identify any differences between schemes. Firstly, the data on loft insulation up to the end of the Homes Insulation Scheme and the Energy Conservation Programme is examined. Secondly, the early years of the Standards of Performance, when the scheme was focused entirely on electrically heated homes, are considered.

The Homes Insulation Scheme and Energy Conservation Programme

The Homes Insulation Scheme (HIS) was aimed primarily at homeowners. Consequently, the acquisitions in owner occupied homes can be associated with this scheme. Conversely, the Energy Conservation Programme (ECP) was designed to improve local authority homes. Thus, the effects of the two schemes, which ran side-by-side from 1978 to 1990, can be examined using the available data.

Figure 18 shows the data for the HIS in the same format as the figures presented earlier. It is clear from this that there is a strong link between the acquisitions of loft insulation in owner occupied homes and the HIS grants. This is examined in more detail in Figure 19, which shows that the effect of the grants was to increase the number of acquisitions by 5.4 thousand for each million pounds of grant expenditure. The fact that the gradient of the acquisitions line is less than that of the grants line indicates the presence of a free-rider effect [(1)].

Figure 20 shows the data for ECP grants and the loft insulation acquisitions in local authority homes. The link, although still evident, is not as clear as for the HIS data. Indeed it has to be noted that the ECP figures for the numbers of grants often exceed the numbers of acquisitions (for the purposes of the presentation in Figure 20 they have been restricted to the number of acquisitions), which is clearly not possible.

Figure 18. Loft insulation acquisitions in existing owner occupied homes related to Homes Insulation Scheme grant expenditure

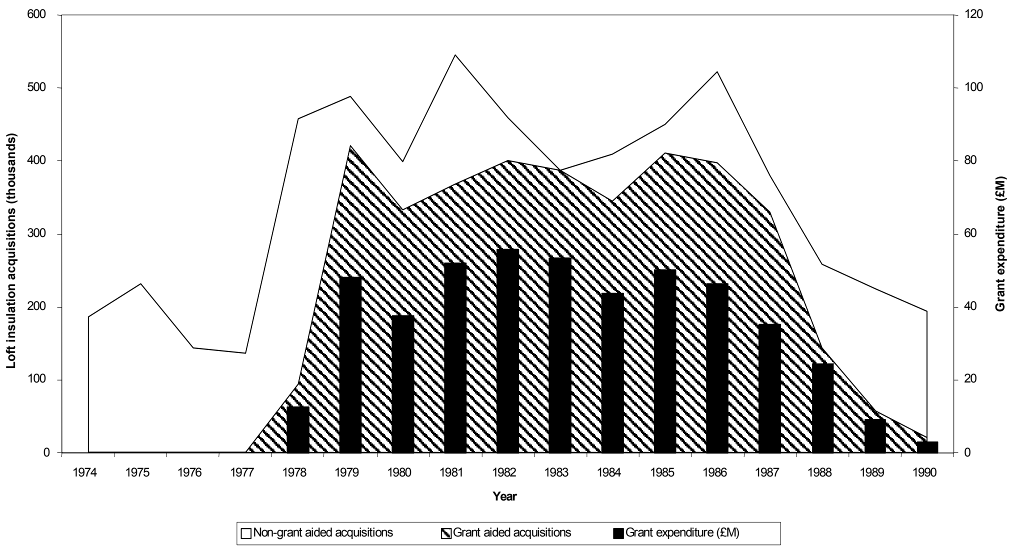


Figure 19. Loft insulation acquisitions in existing owner occupied homes related to Homes Insulation Scheme grant expenditure

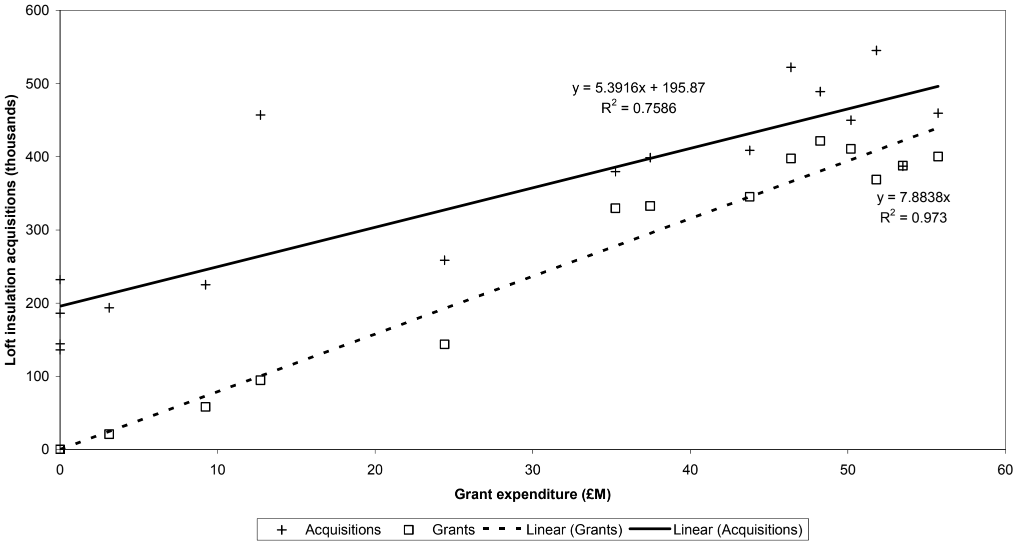
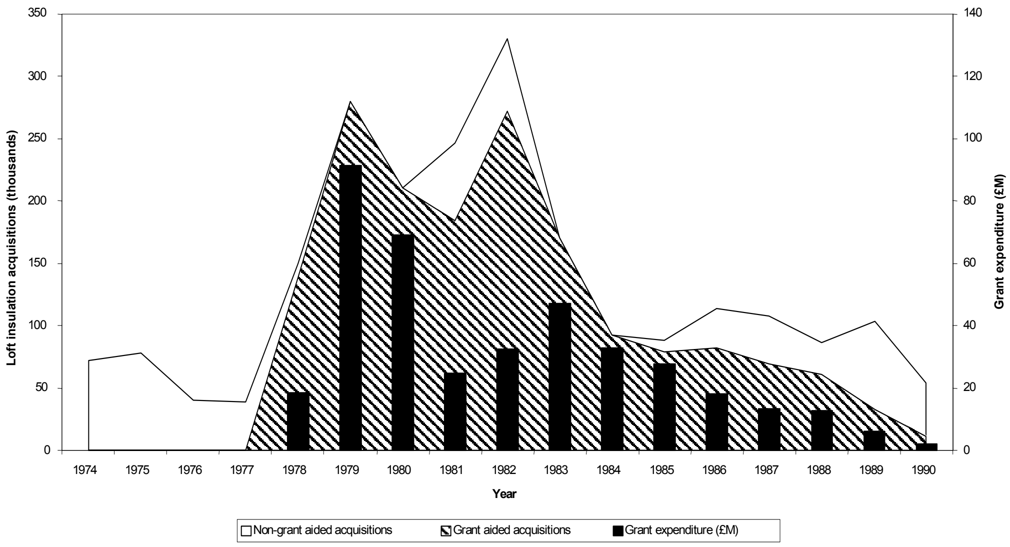


Figure 20. Loft insulation acquisitions in existing local authority homes related to Energy Conservation Programme grant expenditure



One possible explanation for this lies in the fact that the grants did not cover just loft insulation, although most of the expenditure would undoubtedly have been for this measure. However, if there were a lot of homes that benefited from just hot water tank insulation (and this may have been the case given that many local authority homes are flats, only a proportion of which would be on the top floor and have a loft) these would appear in the numbers of grants even though they had nothing to do with loft insulation. Unfortunately, there are no figures available on the ECP grants that would allow this hypothesis to be checked.

Bearing in mind the above point, Figure 21 shows the link between the ECP grant expenditures and the acquisitions. The grant expenditures are dominated by loft insulation, so the relationship between expenditure and acquisitions is probably fairly robust. The relationship between the number of grants and the grant expenditures needs to be viewed with more caution, for the reasons noted above. Nonetheless, the different gradients again point to the presence of a free rider effect.

Figure 21. Loft insulation acquisitions in existing local authority homes related to Energy Conservation Programme grant expenditure

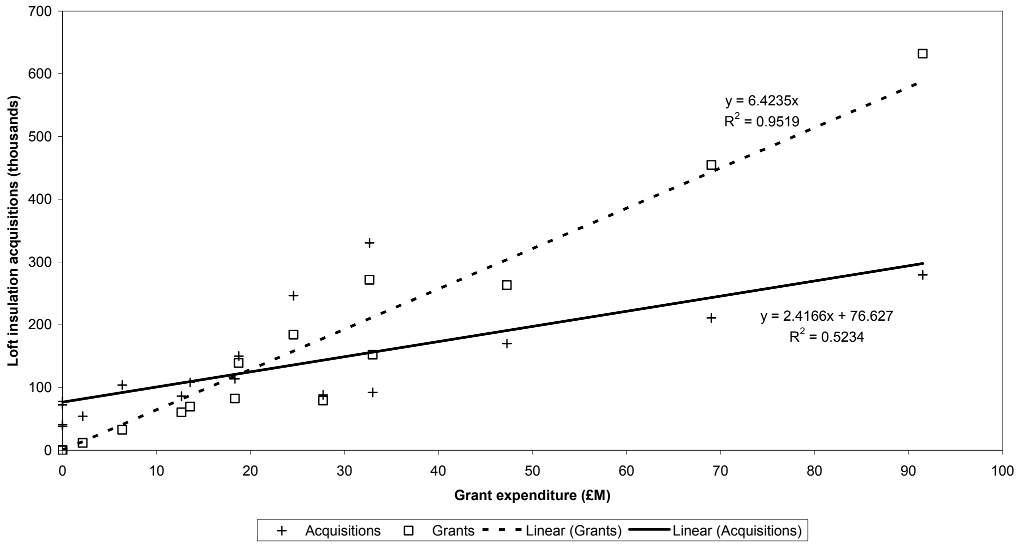


Figure 21 indicates that loft insulation acquisitions in local authority homes increased by 2.4 thousand for each million pounds of grant expenditure. It will be noted that this is less than half of the increase that the HIS grants achieved.

However, it is not surprising that the HIS gradient should be greater because this was, until 1988, only providing 66% of the cost of the improvement whereas the ECP was fully funding the improvement. On this basis, a gradient of about 1.5 times that for the ECP would be expected. The fact that the ratio is actually about 1.5 times this indicates that the HIS was indeed more effective than the ECP, even when correcting for the different expenditure levels.

This is a slightly surprising result. Received wisdom suggests that it is hard to achieve energy efficiency improvements where the responsibility for those improvements is distributed amongst many householders, but much easier where there are fewer decision makers who are making the choice on behalf of many households. This result suggests that, in this case at least, this view is incorrect. The obvious interpretation is that householders perceived the HIS grants to be an opportunity that was too good to be missed, and they took full advantage of it thereby making the scheme highly successful. This is clearly the sort of success story that needs to be replicated with cavity wall insulation and other measures. In fact, as will be seen later, it does appear that the Standards of Performance have managed to come fairly close to achieving a similar level of success for cavity wall insulation.

The Energy Efficiency Standards of Performance and Home Energy Efficiency Scheme

The Energy Efficiency Standards of Performance (SoP) scheme between 1994/1995 and 1999/2000 applied exclusively to electrically heated homes. Moreover, for the first two of these years this was the only scheme that was providing grants for cavity wall insulation. Even in later years where other schemes such as HEES provided grants, these would have tended to be complementary (i.e. principally addressing non-electrically heated homes). Thus, for cavity wall insulation, it is possible to use the available data on acquisitions in electrically heated homes to identify the effect of SoP.

Note that this is not possible for loft insulation because the number of installations under SoP was very small compared to those under HEES, and the latter was already providing grants to the SoP target homes before the SoP scheme began. Thus, it is impossible to reliably identify the loft insulation acquisitions that were due to SoP.

Even for cavity wall insulation, the identification is not perfect. In the later years, some electrically heated homes could have received grants through HEES rather than SoP. Also it has to be noted that the sample sizes are quite small for acquisitions in electrically heated homes so the data is inevitably a little noisy. Finally, it is worth noting that the definition of electrically heated for SoP may not entirely correspond with the definition for the surveys that collect the acquisitions data. Indeed, there is strong anecdotal evidence that many homes that benefited from SoP grants used other fuels for heating as well as electricity [(3)], so it is quite possible that such homes might actually have been recorded in some cases as being non-electrically heated in the acquisitions surveys.

Bearing in mind the above caveats, Figure 22 shows the acquisitions of cavity wall insulation in electrically heated homes compared with the SoP grants and expenditures. Note again that for the purposes of this plot any grants figure that is greater than the corresponding acquisitions figure has been restricted to the latter. Despite the rather noisy plot, due to sample size difficulties, it is evident that there is a relationship between the acquisitions and the grants. In fact, by plotting the data cumulatively much of the noise is removed and the relationship becomes rather clearer, as illustrated in Figure 23.

Figure 22. The effect of the Standards of Performance on cavity wall insulation uptake (acquisitions in electrically heated existing homes only)

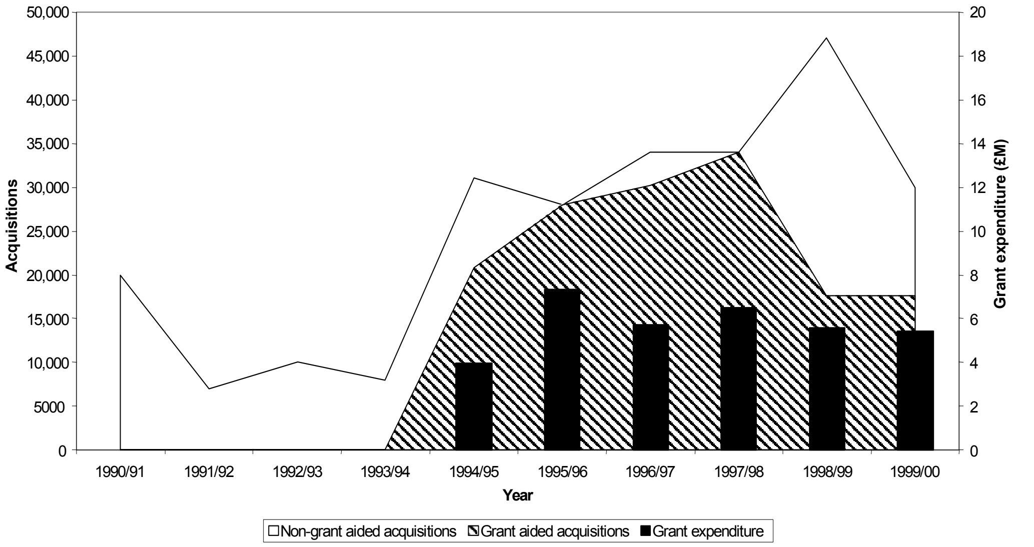
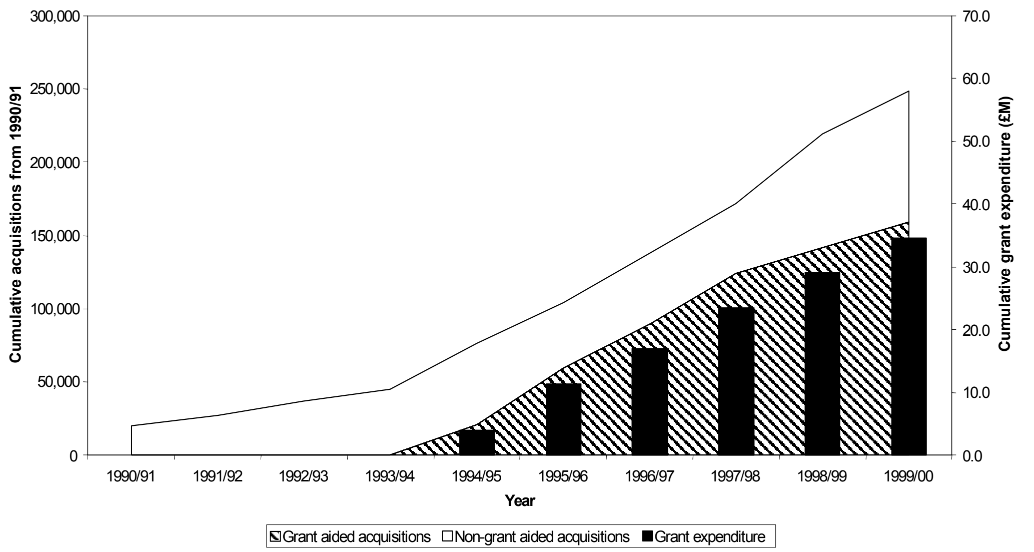


Figure 23. The effect of the Standards of Performance on cavity wall insulation uptake (acquisitions in electrically heated existing homes only)



These results clearly show that the introduction of SoP grants for this measure had an immediate effect. The rate of acquisitions in electrically heated homes after 1993/1994 was four times as great as the rate before, as indicated by the sudden change of gradient in 1993/1994 on Figure 23. Looked at in another way Figure 24 shows the relationship between acquisitions, grants and grant expenditures and quantifies the effect per million pounds of expenditure. It is worth noting that the gradient of the acquisitions line is greater than that for cavity wall insulation grants overall [1], indicating that the SoP grants were more effective by this metric than other grants at this time.

Indeed, Figures 25 to 27 repeat the same plots as Figures 22 to 24 but focus on the effect of non-SoP grants (i.e. mainly HEES grants) on the acquisitions in non-electrically heated homes. Again, the effect of the relevant schemes being introduced is evident. The rate of acquisitions after 1995/1996 is about twice as great as that before, as indicated by the sudden change of gradient in 1995/1996 on Figure 26. The acquisitions line on Figure 27 is not as steep as that on Figure 24 indicating the lower effectiveness of these grants.

Figure 24. Cavity wall insulation acquisitions in existing electrically heated homes related to Standards of Performance grant expenditure

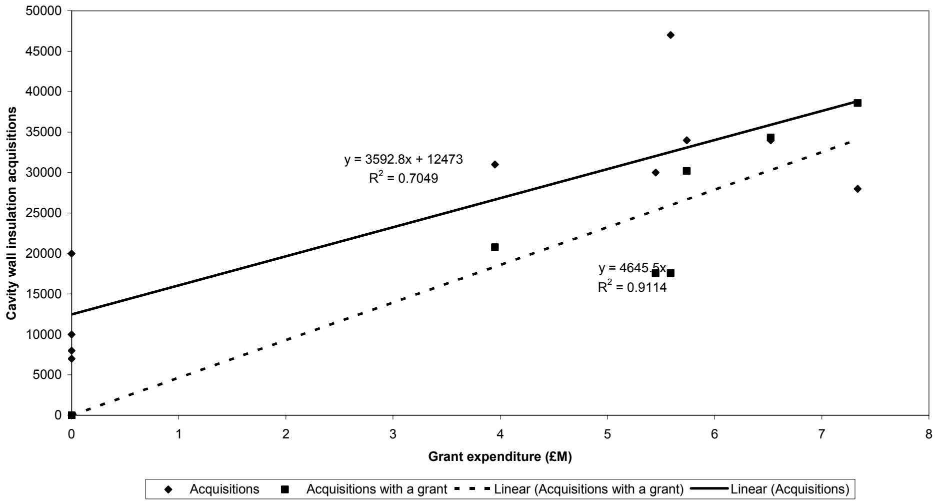


Figure 25. The effect of grants other than the Standards of Performance on cavity wall insulation uptake (acquisitions in non-electrically heated existing homes only)

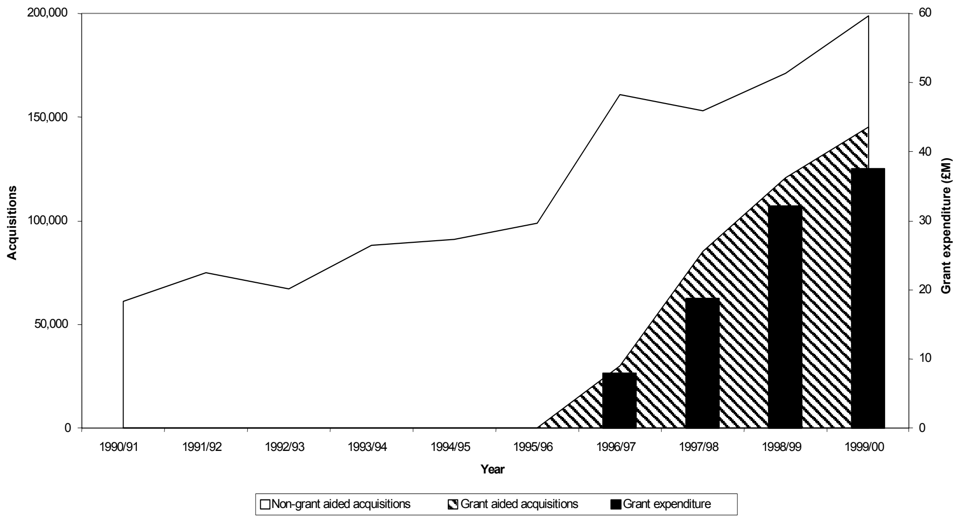


Figure 26. The effect of grants other than the Standards of Performance on cavity wall insulation uptake (acquisitions in non-electrically heated existing homes only)

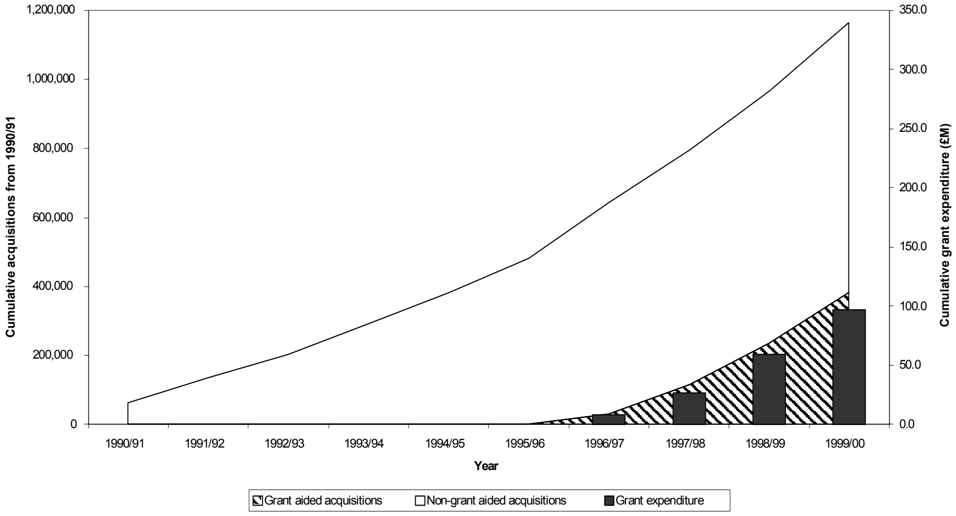
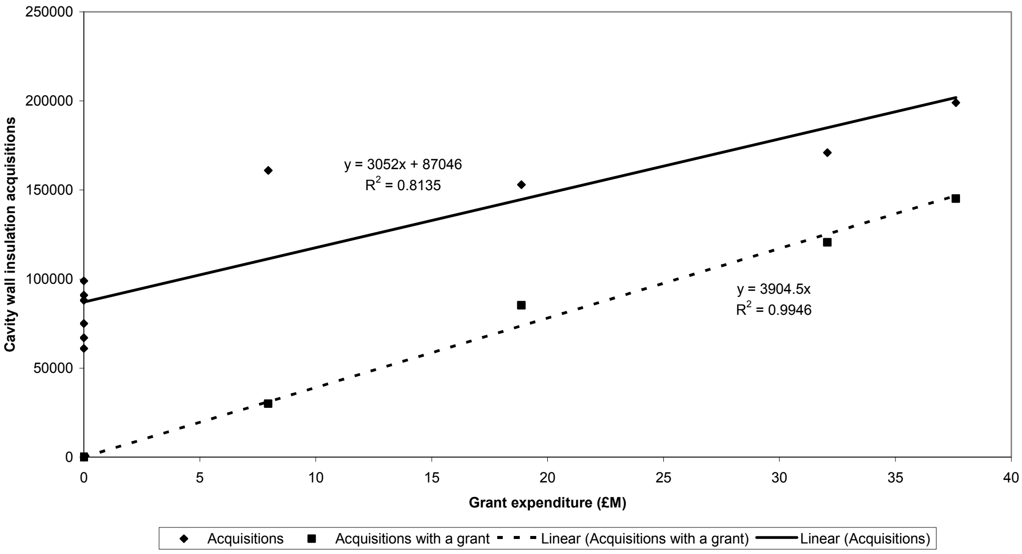


Figure 27. Cavity wall insulation acquisitions in existing non-electrically heated homes related to non-Standards of Performance grant expenditure



Conclusions on the effectiveness of different types of grant

The preceding discussions have allowed the following increases in acquisitions for each million pounds of expenditure to be identified:

Homes Insulation Scheme (loft insulation)	5.4 thousand
Energy Conservation Programme (loft insulation)	2.4 thousand
Standards of Performance (cavity wall insulation)	3.6 thousand
Home Energy Efficiency Scheme (cavity wall insulation)	3.1 thousand *

* This is actually all non-SoP scheme related acquisitions but these are dominated by HEES (during the period considered, approximately 70% of non-SoP grants for cavity wall insulation were provided by HEES: see Table B2 in Appendix B).

Clearly, it is a little difficult to directly compare the schemes because of the two different measures being considered and their different costs. However, by considering the present day relative costs of each measure (determined from the relevant regression of numbers of grants against grant expenditures contained in reference 1) it is possible to adjust the loft insulation figures to produce an estimate of what they would have been if cavity wall insulation had been the measure that was addressed by the scheme. This then allows the schemes to be ranked as follows, again using the metric of the extra number of acquisitions achieved per million pounds of expenditure:

Homes Insulation Scheme	4.3 thousand
Standards of Performance	3.6 thousand
Home Energy Efficiency Scheme	3.1 thousand
Energy Conservation Programme	1.9 thousand

Thus, assessed using this metric, the Standards of Performance have come fairly close to repeating the success of the Homes Insulation Scheme. The Home Energy Efficiency Scheme / Warm Front has been slightly less successful, but has achieved results that are considerably better than the Energy Conservation Programme. There is a factor of more than two between the results achieved by the schemes.

It turns out that the overall relative performance of grants prior to 1990 (on the adjusted basis discussed above) is almost the same as that afterwards – around 3.4 thousand extra acquisitions per million pounds of expenditure (i.e. on average about £295 in 1999/2000 money needs to be spent on grants to produce each additional acquisition).

2.3 EFFECTS OF LABELLING, MINIMUM STANDARDS AND BUILDING REGULATIONS

Introduction to the following analyses

Section 2.2 showed how the effects of grants can be quantified in terms of a response that results from a given level of expenditure. There are other energy efficiency policies that it is not possible to quantify in the same sort of numeric way but which nonetheless have an observable, and important, effect. These include energy labelling, minimum standards and Building Regulations. In fact, it is generally the combination of these that produces an improvement in energy efficiency, as this section will show.

The discussion that follows will focus in turn on cold appliances (refrigerators, fridge-freezers, etc), wet appliances (washing machines, dishwashers, etc) and boilers. Building Regulations will mainly be discussed in relation to boilers but a further analysis showing how Building Regulations energy efficiency requirements for new dwellings can filter through to the existing stock will also be presented.

Although this section is about labelling, minimum standards and Building Regulations, the discussion on cold appliances will also touch upon the effect of grants through the Standards of Performance and how these affected the uptake of A-rated appliances, those with the highest efficiency.[ϕ]

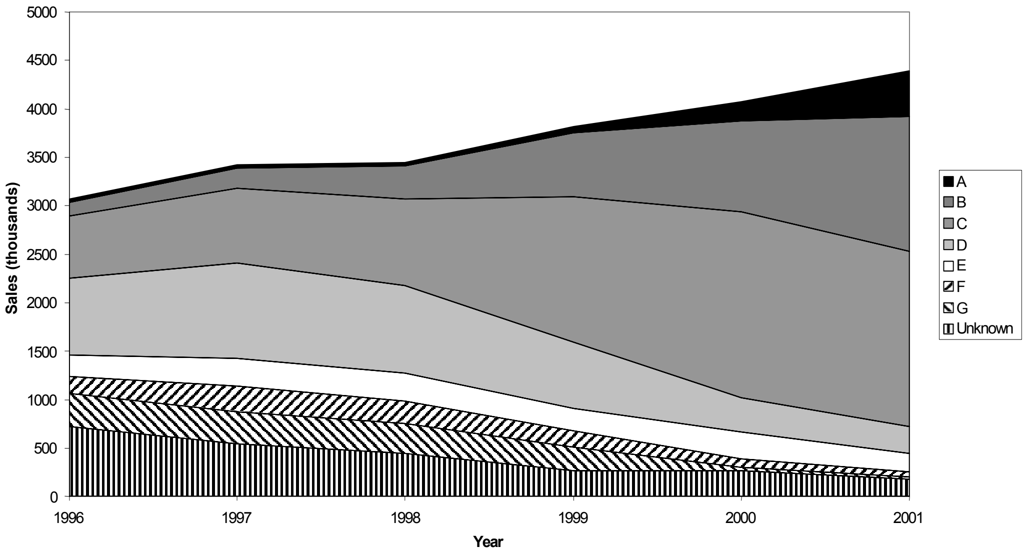
Cold appliances

Figure 28 shows the data (supplied by the Energy Saving Trust) on sales of all cold appliances (refrigerators, fridge-freezers, upright freezers and chest freezers) by energy band from 1996 (the year after the introduction of the energy label in January 1995) to 2001. It should be noted that the data do not cover all sales, but they do encompass sales by the majority of retailers so they are still reasonably comprehensive and the trends they show should be representative of the true situation. In September 1999 a maximum consumption directive was introduced requiring all appliances to be rated C or above (except for chest freezers where D and E rated appliances were permitted).

It is clear from the figure that the combination of labelling and minimum standards has successfully transformed the market, but that it seems to have taken a couple of years beyond the introduction of the minimum standard for this to have been fully achieved. It is possible that this may be because of retailers still having stocks of less efficient appliances, or it could equally be a problem with the collection of the statistics (the presence of an “unknown” category suggests that it was not that easy, at least initially, to identify the rating of all appliances). In any case, the figure indicates that it actually took about seven years to completely transform the market whereas the intention of the minimum standard had been to do this within about five years of the introduction of labelling.

[ϕ] EU energy labels rank appliances on an A to G scale according to their efficiencies (e.g. measured in terms of consumption per unit volume in the case of cold appliances) under standard test conditions. A-rated appliances are the most efficient and G-rated the least efficient.

Figure 28. Sales of cold appliances by energy class (A to G)



Figures 29 to 32 look in more detail at the effect of the minimum standards for each appliance type, showing the percentage of appliance sales that met the minimum standard during each quarter leading up to, and beyond, its introduction. To produce these plots it has been assumed that the unknown category may be distributed pro-rata between the various energy classes. The figures confirm the general conclusions discussed above but they also indicate that certain appliances met the minimum standard in quarter 4 of 1999 rather better than others. It is also very clear from the figures, particularly Figure 31 which shows the data for upright freezers, that the market would not have been transformed in the absence of the minimum standard. It is also quite evident that manufacturers waited until the last possible moment before complying with the minimum standard. This is particularly clear in the case of upright freezers.

Clearly, now that the market has been transformed and almost all sales are of A, B and C rated appliances consideration needs to be given to revising the label to better distinguish between the range of appliance efficiencies and to provide the opportunity for further market transformation through the introduction of another minimum standard. At the time of writing, such issues were under discussion and it was anticipated that the label would be revised. As part of the discussions on the revision of the label, CECED (the European association of domestic appliance manufacturers) tabled a voluntary agreement to remove appliances with a C rating from the market by the end of quarter 1 2004. Other initiatives have also been under-way aimed at further improving the efficiency of the stock of cold appliances. In particular, the Energy Saving Trust has been running a scheme through the Standards of Performance to offer rebates for the purchase of more efficient A-rated appliances. The effect of this is shown in Figure 33.

It is evident from Figure 33 that sales of A-rated cold appliances during the first three years of the SoP scheme appear to have been essentially all associated with that scheme (bearing in mind the fact that the sales figures are not totally comprehensive so they may have actually been a little higher than shown). This clearly was important in giving the market a push towards higher efficiency appliances. Since then, sales of A-rated appliances have increased rapidly beyond those that can be attributed to the SoP scheme. This increase is perhaps related to the changes in the market that are required if the voluntary standard referred to above is to be met by quarter 1 2004, as well as to the anticipated introduction of a revised label in 2004.

Figure 29. Percentage of refrigerator sales at energy class C or better (minimum standard effective from Q4 1999)

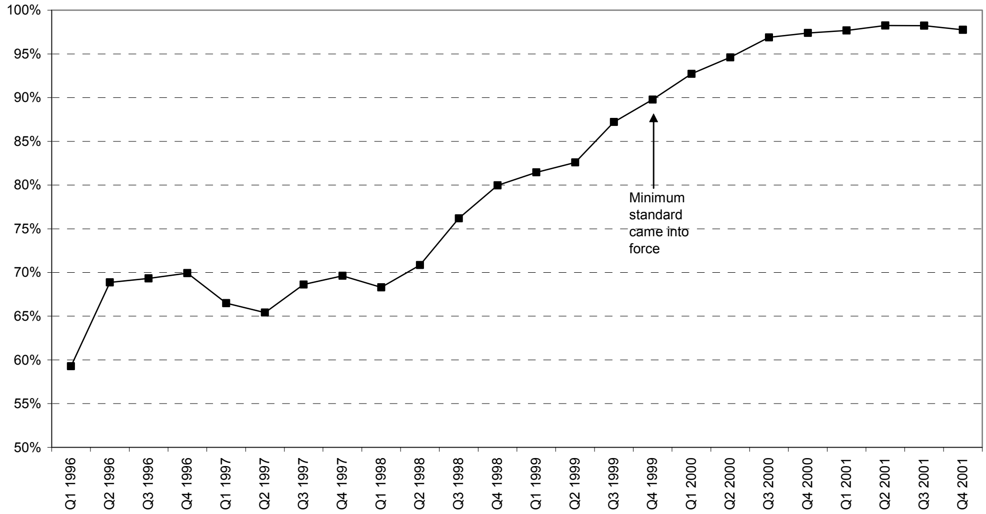


Figure 30. Percentage of fridge-freezer sales at energy class C or better (minimum standard effective from Q4 1999)

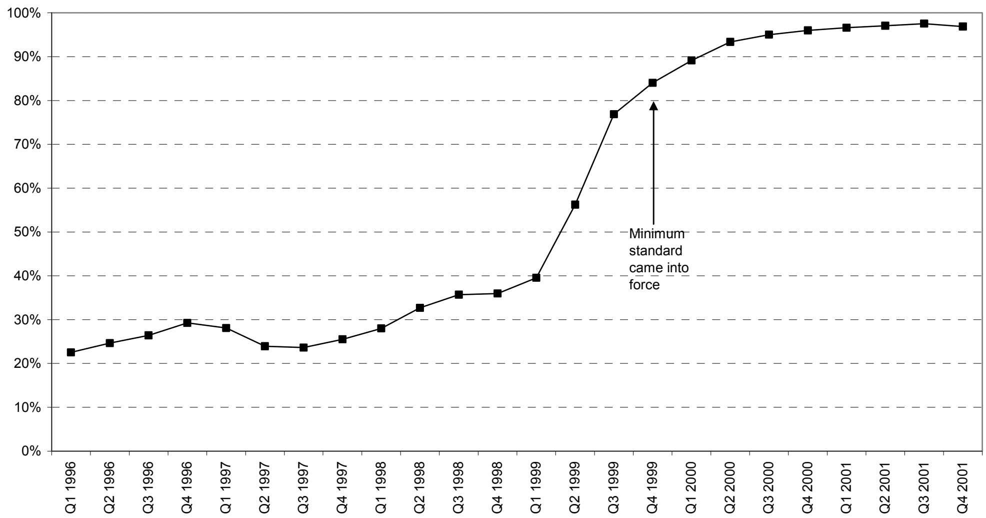


Figure 31. Percentage of upright freezer sales at energy class C or better (minimum standard effective from Q4 1999)

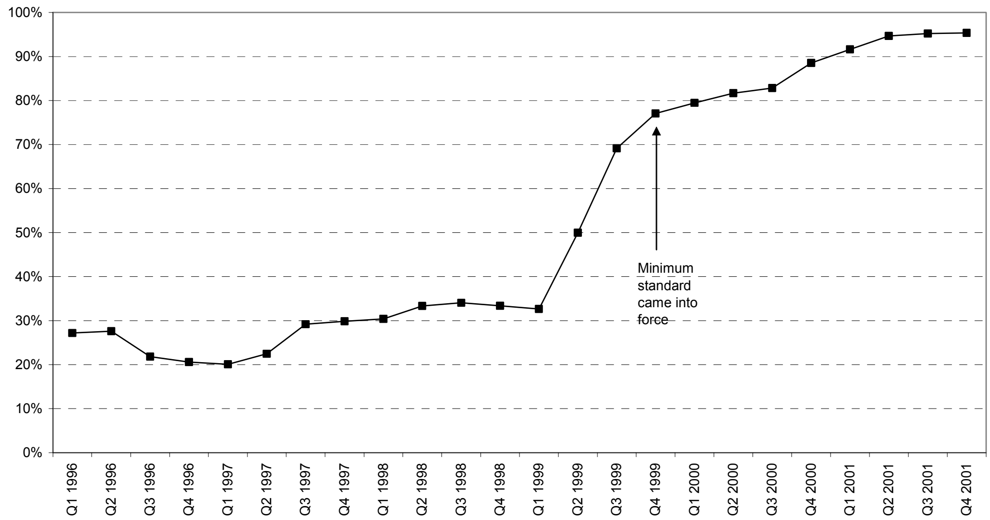


Figure 32. Percentage of chest freezer sales at energy class E or better (minimum standard effective from Q4 1999)

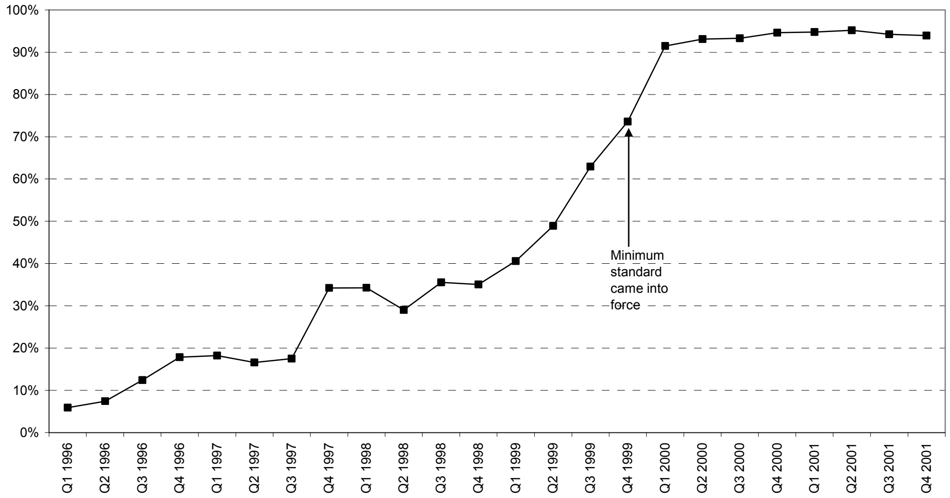
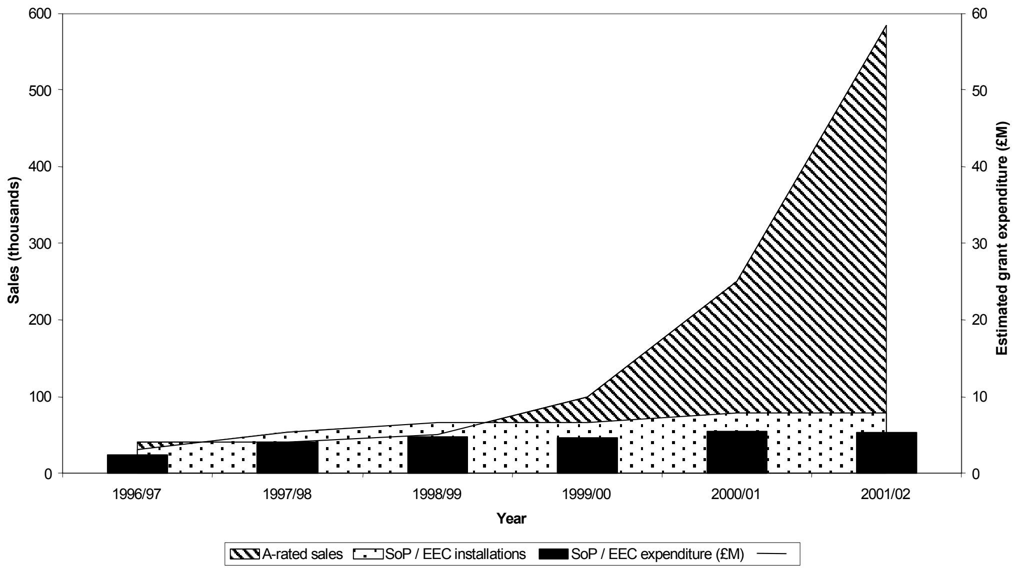


Figure 33. Sales of A-rated cold appliances and the effect of SoP / EEC schemes



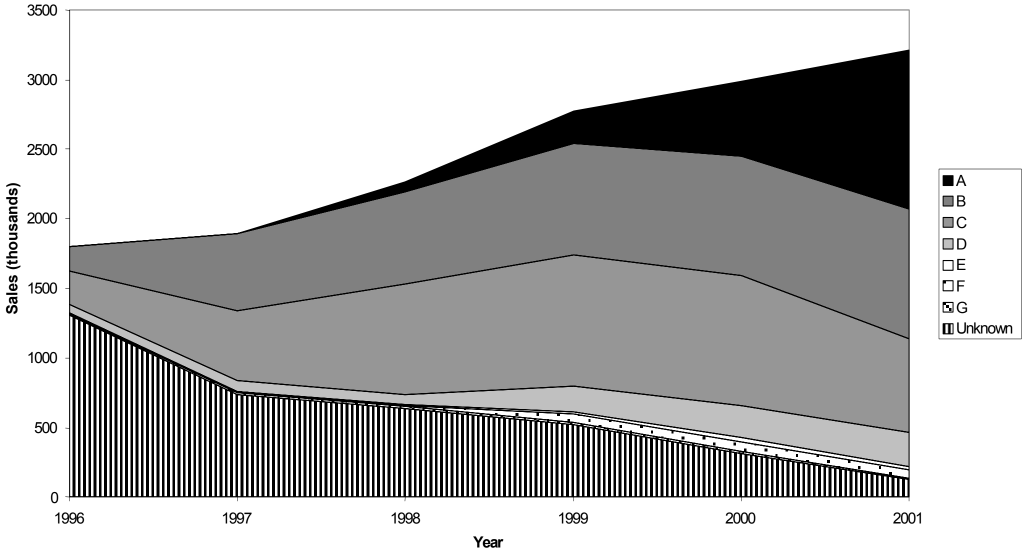
Wet appliances

Figure 34 shows the data (supplied by the Energy Saving Trust) on sales of wet appliances (washing machines, dishwashers and washer-dryers) by energy band from 1996 (the energy label was introduced in October 1996) to 2001. Note that wet appliances are normally also defined as including tumble dryers but data for these were unfortunately not supplied. Note also that the data by efficiency band are incomplete for washer dryers and dishwashers, such figures only becoming available in quarter 1 1999 and quarter 3 1998 respectively (in contrast, the washing machine figures by band commence in quarter 3 1996).

It is for this reason that the "unknown" category in Figure 34 is so large in the early years. As for the cold appliances data, the sales figures are also not entirely comprehensive, but they should nonetheless be representative of the true situation.

For washing machines (which account for about 70% of the wet appliance sales), CECED voluntary agreements to remove efficiency classes E, F and G by the end of quarter 4 1997, and efficiency class D by the end of quarter 4 1999, have been in operation. No equivalent voluntary agreements appear to have been in operation for washer dryers and dishwashers. In addition, the Energy Saving Trust has been running a scheme ("Energy Efficiency Recommended") to promote appliances with the highest efficiencies (i.e. A-rated appliances). It is clear from Figure 34 that these initiatives have successfully transformed the market.

Figure 34. Sales of wet appliances by energy class (A to G)



Figures 35 to 37 look in more detail at the results. Figure 35 shows the percentage of washing machine sales that met the voluntary minimum standards during each quarter leading up to, and beyond, their introduction. This shows that both minimum standards were very close to being met on time. However, the first minimum standard was clearly not particularly challenging as most sales were meeting this standard well before it was introduced. Even so, the first minimum standard actually took a couple of years extra to get up to 100% compliance. In contrast, the second minimum standard was more-or-less up to 100% compliance on time.

Figures 36 and 37 present the same information for washer dryers and dishwashers respect-tively. It is evident that there appears to have been no significant improvement in the energy efficiency of washer dryers in the absence of minimum standards. Dishwashers, however, do appear to have shown a slow but steady improvement since the end of 1999.

Figure 35. Percentage of washing machine sales at energy class D, and C, or better (voluntary minimum standards effective from Q4 1997 and Q4 1999)

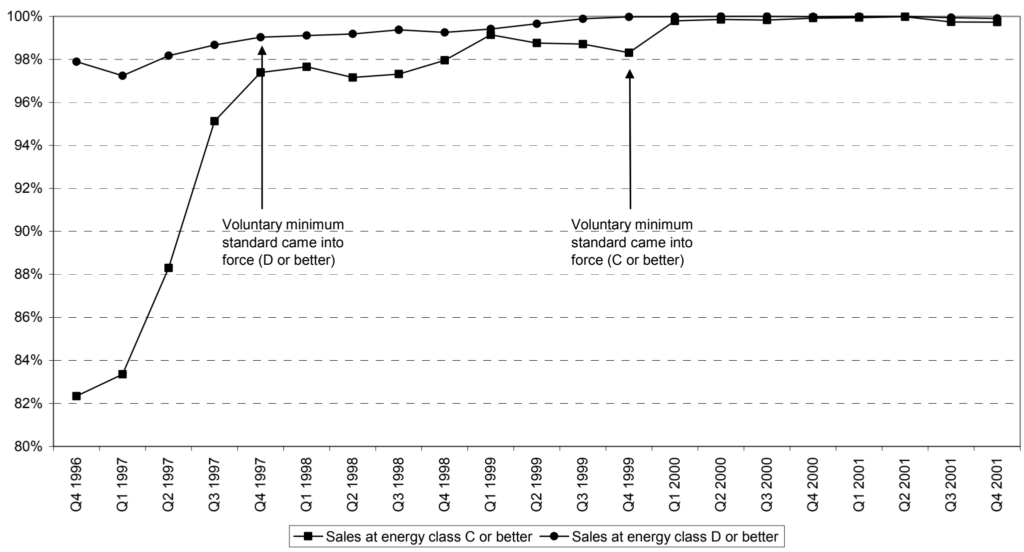


Figure 36. Percentage of washer dryer sales at energy class D, and C, or better (voluntary minimum standards for washing machines effective from Q4 1997 and Q4 1999)

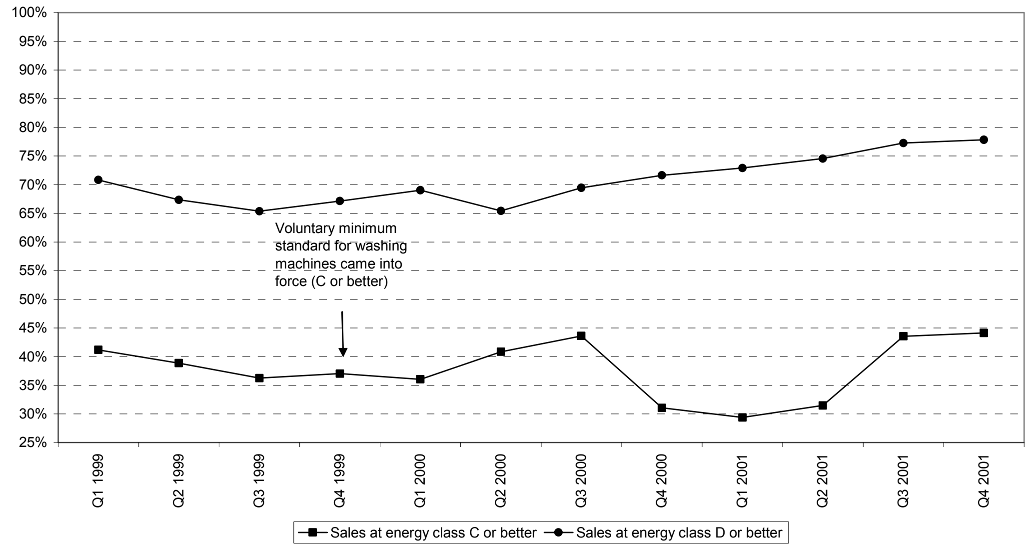
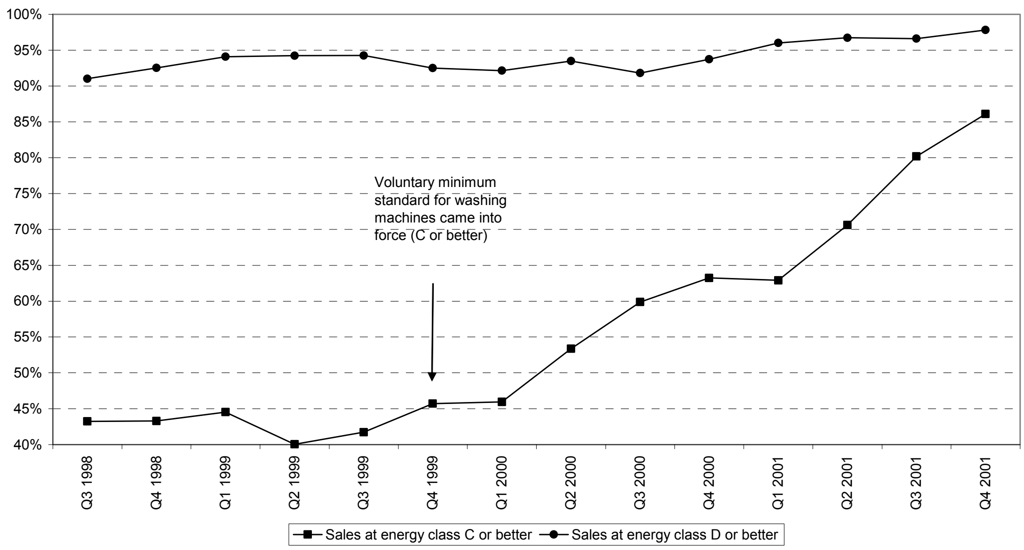


Figure 37. Percentage of dishwasher sales at energy class D, and C, or better (voluntary minimum standards for washing machines effective from Q4 1997 and Q4 1999)

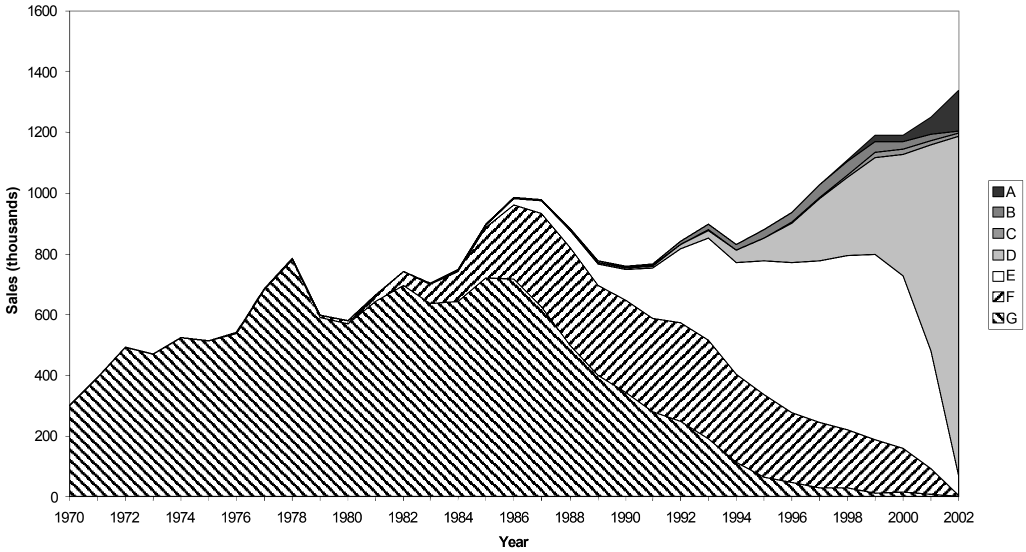


Boilers

Figure 38 shows the available data on the sales of gas boilers by the SEDBUK efficiency bands.[ϕ] It is important to recognise that the figure shows data for years long before the SEDBUK methodology was developed. Thus, the distribution of sales between bands is, until recently, based on expert assessments made during the development of the boiler model under the Market Transformation Programme, the underlying sales data for this coming from BSRIA statistics updated with more recent market intelligence. The data in recent years, on the other hand, is based on actual sales figures provided by the SBGI, and the earlier figures have been adjusted to ensure consistency with these. This means that the data since about 1990 should be quite robust. Anything before this is necessarily a little speculative, although undoubtedly still realistic.

Figure 38. Gas boiler sales by efficiency band (A to G)

[ϕ] There is currently no EU-wide labelling scheme for boilers. However, the UK has already defined its own label based on the seasonal efficiency assessment methodology known as SEDBUK. The standard EU approach of defining A to G bands has been adopted.



The Boiler Efficiency Directive of 1992 introduced boiler efficiency regulations that came into force in 1998. These required the removal of boilers having efficiencies below 70% (i.e. G-rated) from the market, with the exception of back boilers. As Figure 38 illustrates, this minimum standard target had a major effect on the market and such boilers were virtually eliminated by 1998. Therefore, it took about six years between the Directive being introduced and the minimum standard being met.

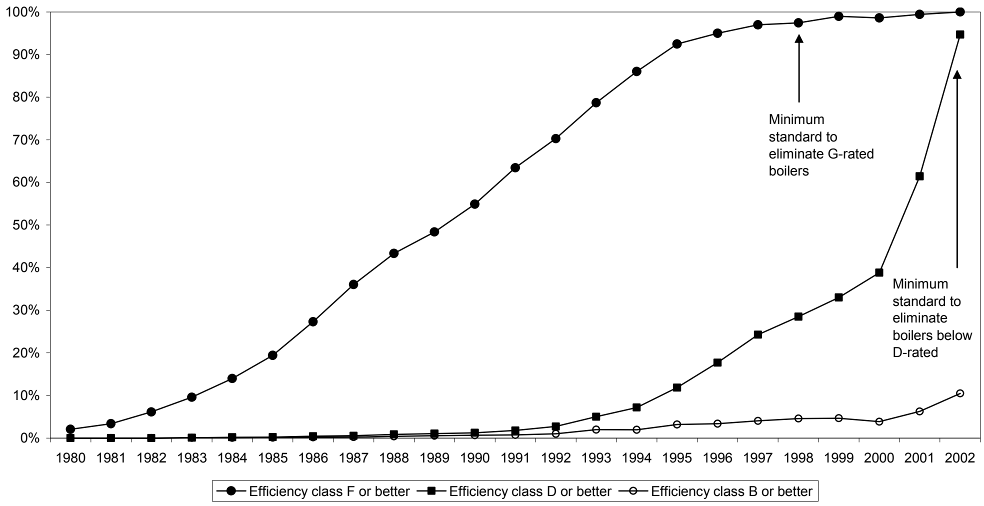
The Building Regulations revision in 2000 introduced a further minimum standard, requiring the elimination of boilers below D-rated (78% efficient) by August 2002, again with an exception for back boilers. Once again, the market was able to adapt, this time rather more rapidly. The proposed minimum standard would have been common knowledge before the revision to the Building Regulations was published so in effect it probably took about three or four years for the market to adapt, rather than the two years implied by the respective dates of the Building Regulations revision and the minimum standard.

The next Building Regulations revision will require all boilers to be B-rated or better (i.e. better than 86% efficiency, which implies the use of condensing boilers). Again, there are likely to be exceptions (not all dwellings will be suitable for condensing boilers) but the majority will have to comply. If these Building Regulations were to come into force in 2007 this would imply that the market has about four years to adapt (from the time that the anticipated intentions of these Regulations became known). The experience of the last minimum standard suggests that this should be achievable, although undoubtedly challenging. As illustrated on Figure 39, which shows the percentage of boiler sales meeting the various minimum standards, about 10% of boiler sales already met this forthcoming minimum standard in 2002.

However, the boiler requirements have in fact been brought forward of the rest of the Building Regulations requirements, to April 2005, by statements made in the Energy White Paper. This then gives the market only two years to adapt. Clearly, meeting this target will be extremely difficult and it would therefore be unrealistic to anticipate full compliance being achieved in April 2005. Indeed, recent data for boiler sales indicates that the proportion represented by condensing boilers, although rising fast, at the end of 2004 had only reached about 30%. There is clearly no way that this can increase sufficiently to meet the Building Regulations target within just four months.

It is important to note that the Building Regulations requirements for boiler efficiencies apply to boiler replacements as well as to new installations. Thus, these requirements have a direct impact on the energy efficiency of the existing stock as well as the new stock. In general, however, the Building Regulations requirements only apply to new dwellings (the corresponding savings from which are considered in Section 2.4). Even so, the standards set by Building Regulations can come to be seen as the standards that existing homes should be refurbished to, as the following discusses.

Figure 39. Percentage of gas boiler sales that are F-rated or better, D-rated or better and B-rated or better (respectively, the minimum standards effective in 1998, 2002 and as anticipated in the next Building Regulations revision)



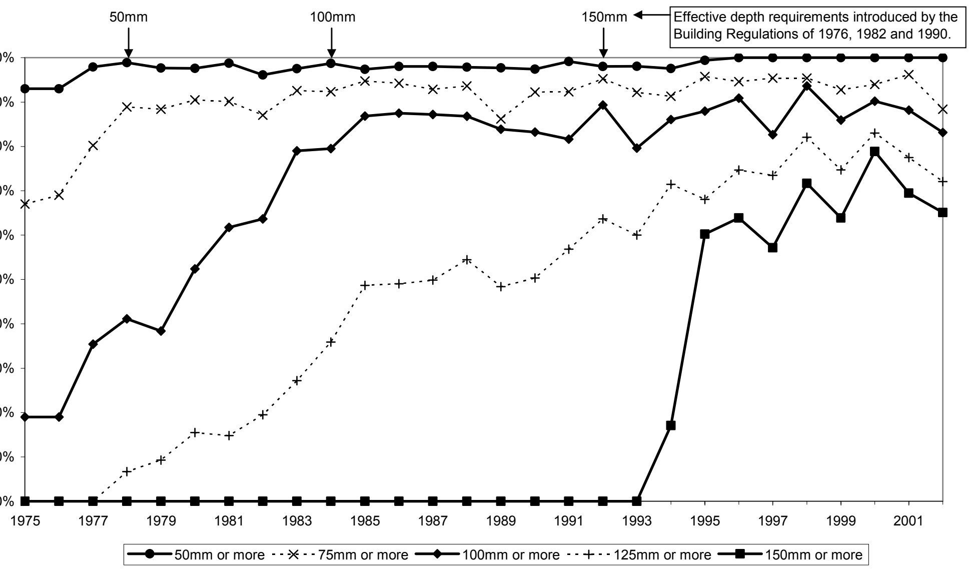
The effect of Building Regulations on existing homes

The thermal insulation requirements of the Building Regulations have been progressively increased. For example, the roof U-values required by the 1976, 1982 and 1990 Building Regulations were 0.6, 0.35 and 0.25 W/m^2°C, respectively. In terms of an insulation thickness these requirements would have typically corresponded with about 50, 100 and 150 mm of mineral wool.

Figure 40 shows how the acquisitions of loft insulation in existing homes varied by the thickness achieved between 1975 and 2002. The dates from which the Building Regulations of 1976, 1982 and 1990 would have been effective (about two years after their introduction) are also shown.

It is clear from this that the requirement of the 1976 Regulations was not very onerous at all because this was what was already happening in the improvement of existing dwellings. As the Building Regulations were progressively revised, loft insulation acquisitions in existing homes generally increased in thickness to match – such that currently 100% of acquisitions meet or exceed the 1976 Regulations, about 90% meet or exceed the 1982 Regulations and about 70% meet or exceed the 1990 Regulations. This clearly shows that, for this measure at least, the standards in existing homes tend to follow the practice that is established in new homes via the Building Regulations.

Figure 40. Percentage of loft insulation acquisitions achieving at least 50, 75, 100, 125 and 150 mm depth



Conclusions on the effectiveness of energy labelling, minimum standards and Building Regulations

The preceding analyses have indicated the following approximate periods of time elapsing between a minimum standard being proposed, being formally introduced and being fully complied with.

Table 4. Time elapsing between minimum standard being proposed, introduced and complied with

Appliance type	Time to minimum standard being formally introduced and % compliance at this time		Time to minimum standard being fully complied with
Refrigerators	5 years	90%	6-7 years
Fridge-freezers	5 years	84%	6-7 years
Upright freezers	5 years	78%	7 years
Chest freezers	5 years	74%	7 years
Washing machines (first voluntary minimum standard)	1 year	99%	3 years
Washing machines (second voluntary minimum standard)	3 years	98%	3.5 years
Gas boilers (EU boiler efficiency regulations)	6 years	98%	6 -7 years
Gas boilers (revision of Building Regulations)	3 - 4 years	95%	4 – 5 years

Broadly speaking, these results indicate that it generally takes about 5 years between a minimum standard being proposed and being formally introduced. At the time of introduction, compliance will be high but will not generally be full. It can be expected to take one or two years more before full compliance is achieved. Nonetheless, these results demonstrate that minimum standards are a powerful means of transforming the market in a relatively short period of time.

The high levels of compliance observed for washing machines are likely to be the result of the minimum standard being voluntary on the part of the manufacturers – i.e. standards were probably set that they knew that they would be able to meet without any difficulty. Mandatory standards are probably more difficult to achieve, as indicated above by the lower levels of compliance at the time of introduction of the minimum standard.

Energy labelling alone, in the absence of minimum standards, does not appear to have much effect at all on the market. Indeed, it was very clear from some of the results (particularly for fridge-freezers and upright freezers) that the energy performance of appliances would not have improved significantly without the minimum standards.

Building Regulations provide a convenient mechanism for introducing minimum standards relating to the building and its integral systems. Such standards traditionally only apply to new dwellings but recent revisions of the Building Regulations have begun applying certain requirements to refurbishments, including those relating to boiler efficiencies where the minimum standard has dramatically transformed the market in quite a short time, and looks set to do so again. Even standards that are set by Building Regulations and only apply to new dwellings tend to be seen as good practice in the improvement of existing dwellings – and are often applied in such dwellings, as seen from the results on loft insulation.

2.4 ENERGY AND CARBON SAVINGS FROM ENERGY EFFICIENCY POLICIES

Loft insulation grants

Table B4 in Appendix B summarises the results of calculations of energy and carbon savings due to loft insulation grants. For years up to 1999/2000 the results are more-or-less as reported previously [(1)], although there are some small differences due to the use of new data on the numbers of grants under the Energy Efficiency Standards of Performance schemes, and the use of updated fuel mix data (and hence slightly revised carbon emission factors) derived during the preparation of the Domestic Energy Fact File 2003 [(4)].

As Table B4 shows, the energy savings in 2001/02 due to loft insulation grants amount to about 94.5 PJ/year, equivalent to about 1.65 MtC/year. These values are reduced by about 44% (to 52.5 PJ/year and 0.9 MtC/year respectively) when free riders are allowed for. Cumulatively, over the period 1978 to 2001/02 the grants have saved about 1675 PJ and 30 MtC, these figures being reduced by about 41% when free riders are removed.

Over this period, the energy saving is worth about £9.5bn in 1999/2000 money values (£5.6bn allowing for free riders) which may be compared with an overall expenditure of about £1.1bn. Overall the net cost per tonne of carbon saved is shown to be -£279/tC (i.e. a net benefit of £279/tC). This reduces to -£253/tC when free riders are allowed for.

Cavity wall insulation grants

Table B5 in Appendix B presents the same information as Table B4, but for cavity wall insulation grants. Again, the results up to 1999/2000 are almost the same as reported previously [(1)] aside from small differences that have occurred for the same sort of reasons.

The energy savings in 2001/02 due to cavity wall insulation grants amount to about 13.5 PJ/year, equivalent to 0.27 MtC/year (11.5 PJ/year and 2.3 MtC/year allowing for free riders). Cumulatively, the grants have saved about 45 PJ and 1.2 MtC (39 PJ and 1 MtC allowing for free riders). The cumulative costs are still about 10% higher than the cumulative savings so the net cost per tonne of carbon saved is currently just positive at £16/tC (£43/tC allowing for free riders). Clearly, this will become negative very soon and should, in fact, have done so in 2002/03 (see Figures 41 and 42).

Condensing boiler grants

Table B6 in Appendix B summarises the savings for condensing boiler grants. Again, the figures to 1999/2000 are almost identical to those reported previously [(1)].

The energy savings in 2001/02 due to condensing boiler grants amount to about 2.3 PJ/year, equivalent to 0.034 MtC/year (1.2 PJ/year and 0.018 MtC/year, allowing for free riders). Cumulatively, the grants have saved 5.2 PJ and 0.076 MtC (2.7 PJ and 0.04 MtC allowing for free riders). Cumulative costs still heavily outweigh cumulative savings so the net cost per tonne of carbon saved is positive at £260/tC (about £760/tC allowing for free riders. It will be noted that the net cost per tonne of carbon saved rose between 1999/2000 and 2000/01, before falling again in 2001/02.

The reason for this is that there was a large increase in the number of grants between 1999/2000 and 2000/01 so there was a large jump in the grant expenditure (the actual amount in 2000/01 is not well known for the reasons explained earlier, but the regression-based estimate must be about right). In contrast, the savings take time to accumulate and they could not match the increased expenditure within a single year, although two years were sufficient to do so. In effect, the large expenditure rise in 2000/01 shifted the net costs characteristic for this measure onto a different curve (see Figures 41 and 42) slightly delaying the time that it will take to reach the situation where the net costs become negative.

Loft insulation, cavity wall insulation and condensing boiler grants combined and compared

Table B7 in Appendix B combines the information in Tables B4, B5 and B6, indicating that currently the housing stock consumes about 110 PJ/year less than it would otherwise do due to the grants for loft insulation, cavity wall insulation and condensing boilers. This corresponds to a carbon emission saving of about 1.95 MtC/year. Allowing for free riders the savings are around 40% lower at about 65 PJ/year and 1.15 MtC/year. Cumulatively, the grants have saved 1725 PJ, or almost 31.5 MtC (1024 PJ and 18.7 MtC allowing for free riders). The overall net cost per tonne of carbon saved is -£267/tC (-£235/tC allowing for free riders) indicating that not only have the grants saved a lot but that they have done so very cost-effectively.

Figure 41 compares the net cost per tonne of carbon saved for the grants for each of the three measures, plotted against the number of years since the inception of the grants for the individual measures). Solid points on this chart correspond to historical information. Open points correspond to projections based on considering the grants up to 2001/02 only and assuming that the annual savings from these would repeat each year so the savings would accumulate, but the corresponding expenditure would remain at its 2001/02 level. This indicates that the cost per tonne of carbon saved for cavity wall insulation grants should become negative in year 9 of the grants (i.e. in 2002/03). For condensing boilers it will be in year 9 also when this happens (this being 2004/05). This is later than determined previously for the reasons discussed in the previous section.

Figure 42 is the same as Figure 41 except that it allows for free riders. This suggests that the net cost per tonne saved will still become negative in year 9 for cavity wall insulation (because there are relatively few free riders for this measure) but for condensing boilers it could be year 13 (i.e. 2008/09) before this happens.

Finally, Figure 43 presents the updated plot of the annual energy savings that can be attributed to the grants, for all three measures combined, against the cumulative expenditure on the grants. As before, two lines are plotted corresponding to the cases where free riders are either included or excluded. The relevant data for this graph is in Table B7 in Appendix B.

Figure 41. Net cost of carbon savings due to grants (not allowing for free-riders)

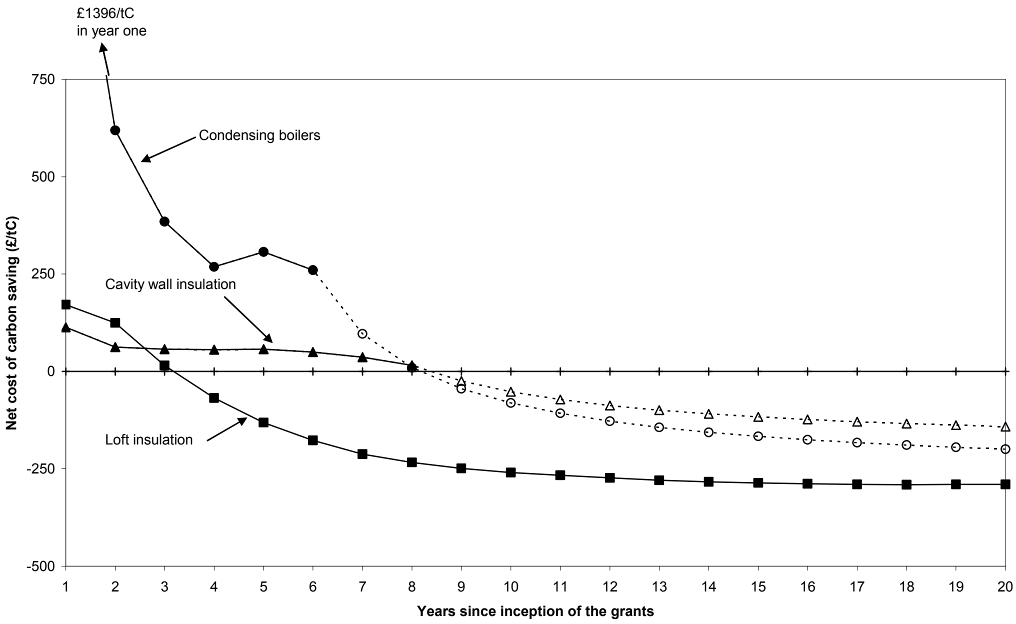


Figure 42. Net cost of carbon savings due to grants (allowing for free-riders)

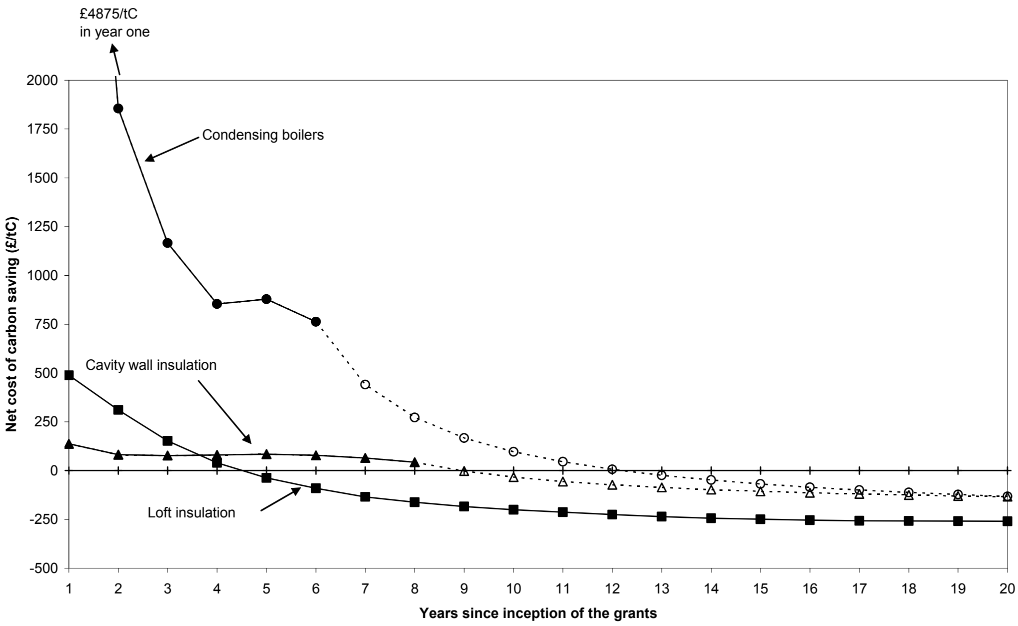
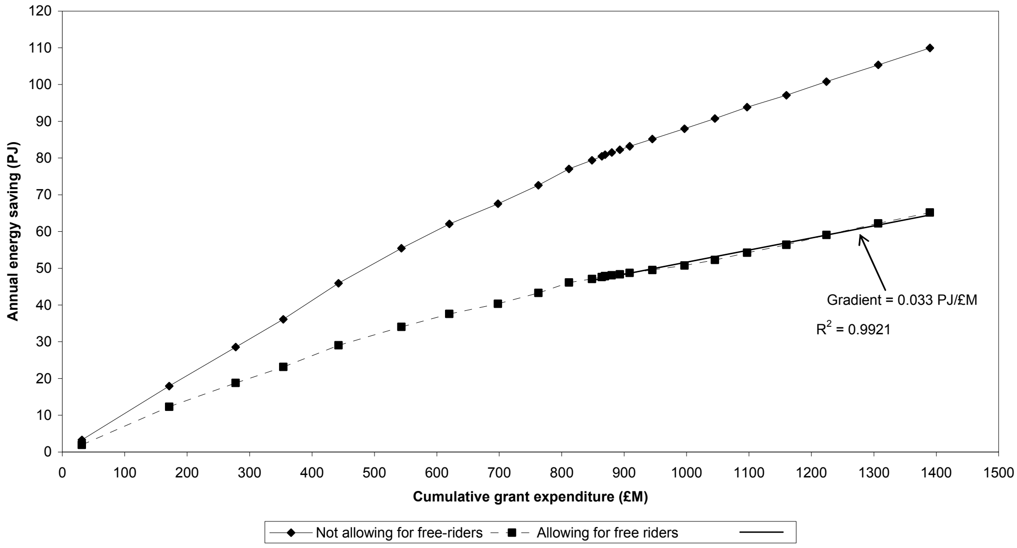


Figure 43. Annual energy saving related to cumulative grant expenditure (based on actual data relating to grant schemes for the period 1978 to FY 2001/2002)



Bearing in mind that the two extreme right-hand points on each line refer to 2000/01 and 2001/02 for which grant expenditure data can only be estimated based on the regressions contained in the previous work, it is no real surprise to see that the recent gradient on which policy scenarios have previously been based is still more-or-less the same as determined before (0.033 PJ/£M now as opposed to 0.03 PJ/£M previously).

Savings from energy labelling and minimum standards for appliances and boilers

Methodology for appliances

In the following, savings are assessed only for appliances for which minimum standards have been combined with energy labelling. It is assumed, as concluded in Section 2.3, that energy labelling in the absence of minimum standards does not yield significant improvements. The basic methodology is the same for each of the appliances considered and is discussed below.

The savings determined are the difference between the estimated energy use of appliances sold since the time when the minimum standards were proposed and what those appliances would have consumed if there had been no improvement since that time. The point in time at which the minimum standards were proposed is rather difficult to define precisely but it would undoubtedly have been around the mid-1990s. In practice, 1996 has to be used as the reference point because sales data by energy band only began being collected from this year.

It is important to note that this calculation makes no allowance for savings being lost due to the phenomenon whereby the reduced level of internal gains has to be made up by additional energy use of the heating system. So the calculated savings presented here probably represent an upper limit for what labelling and minimum standards have achieved for these appliances. Balancing this to some extent, however, is the fact that the sales data on which the analyses are based are not totally comprehensive, so a (relatively small) part of the savings will have been missed by the calculations.

Calculating the average energy use of appliances sold rests on knowing the sales within each of the energy bands and the relative energy use of products in those bands, as defined by the efficiency index for that particular category of appliance, on which the label is based. In fact, the analyses and the results presented here build on previously undertaken work in this area, aimed at assessing the feasibility of developing the BREDEM model to allow energy savings from efficient appliances to be directly calculated by the model (these procedures are likely to be incorporated in the next updates to the BREDEM specifications, probably to be published in 2005). In turn, that work was based on energy use information for the individual appliances extracted from Market Transformation programme data, as well as on the appliance sales data obtained from the EST.

Results for appliances

The detailed sales data and the associated calculation results for the five appliances considered (refrigerators, fridge-freezers, upright freezers, chest freezers and washing machines) are presented in Tables B8 to B12 in Appendix B. Table 5 below summarises the energy and carbon savings across all five appliances. It will immediately be noted that the savings are very small in comparison with those discussed for grants. This is, of course, to be expected since the labels have only been operating for a few years, whereas the grants discussed earlier have been running for many years.

Table 5. Savings in the stated years from labelling and minimum standards for five major appliances (refrigerators, fridge-freezers, upright freezers, chest freezers and washing machines)

	1997	1998	1999	2000	2001	Total
PJ/year	0.10	0.37	1.12	2.47	4.42	**8.5**
MtC/year	0.003	0.013	0.039	0.087	0.173	**0.32**

Methodology for boilers

The basic methodology for boilers is similar to that for appliances. The data in this case come from the boiler model that has been developed under the Market Transformation programme, together with more recent data on boiler sales from the SBGI (which will in due course be incorporated into the boiler model).

The sales data by efficiency band since the minimum standards were proposed are used to calculate an average new boiler efficiency in each year. In the absence of the minimum standards it is assumed that the average boiler efficiency would have remained at the level that applied when the minimum standards were proposed. These boiler efficiencies are then applied to the estimated useful energy requirement for space and water heating in a typical home. This then leads to two sets of energy use figures from which savings can be deduced. The time at which the first minimum standard was proposed is taken as being 1992, the year in which the Boiler Efficiency Directive was introduced.

It is important to note that the savings thus calculated implicitly include the savings that have already been calculated and ascribed to condensing boiler grants. To avoid double counting these grants savings will need to be subtracted off the calculated labelling and minimum standards savings.

Results for boilers

Table B13 in Appendix B provides the detailed sales data and the associated savings calculation results. Table 6 below summarises the energy and carbon savings. It will be noted that these savings are considerably greater than those for labelling and minimum standards for appliances even though they span a fairly similar period of time. This simply reflects the fact that space and water heating represents the majority of the energy use of typical homes so any measure that improves the efficiency with which that service is supplied will inevitably achieve quite large savings. It will also be noted that allowing for the double counting effect referred to above actually does not make a very large difference. This simply indicates that the sales of condensing boilers, and hence the corresponding numbers of grants, are still relatively small compared to the overall number of boiler sales.

Table 6. Savings in the stated year from labelling and minimum standards for boilers

	1993	1994	1995	1996	1997	1998	1999	2000	2001	Total
PJ/year*	0.61	1.56	3.15	5.60	8.53	11.90	15.86	19.65	24.73	**91.6**
PJ/year	0.61	1.56	3.15	5.70	8.78	12.35	16.56	21.06	27.03	**96.8**
MtC/year*	0.009	0.023	0.046	0.082	0.125	0.174	0.231	0.286	0.363	**1.34**
MtC/year	0.009	0.023	0.046	0.084	0.129	0.181	0.241	0.307	0.397	**1.42**

* deducting savings already ascribed to grants for condensing boilers

Savings from improvements to Building Regulations

Methodology

Building Regulations have been discussed earlier largely in relation to the minimum standards that they have introduced for boiler efficiencies. But it is possible to consider and quantify the effect of Building Regulations more widely than this. Knowing the numbers of new homes built in each year, and the respective elemental insulation standards that each successive regulation introduced, it is possible to estimate energy savings relative to what those homes would have consumed if built to the standards that might have applied otherwise. For this purpose it is assumed that the first regulations that really had any impact on energy efficiency were those introduced in 1976, which would have become fully effective in about 1978. So the "standards that might have applied otherwise" correspond to the requirements of the 1965 Building Regulations.

Savings calculated in the manner outlined above have been determined by considering a typical dwelling built to the standards of successive Building Regulations. The resulting savings have then been scaled up to national figures according to the numbers of homes completed in each year. Note that these calculations take account of the fact that the mix of heating systems in new homes differs from that in the stock as a whole, which in turn affects the average carbon emission factor and hence the carbon savings. In fact, however, the overall emission factors generally turn out to be not that different in practice. This is because the reduction in emission factor due to the higher proportion of homes using gas is balanced by an increase from the higher proportion using electricity.

The calculations take account of the changing mix of heating systems as already indicated, and this means that improvements in heating efficiency are automatically included. However, in order to avoid double counting of those savings from improved boiler efficiencies in new homes that have already been included within the savings from labelling, the gas boiler efficiencies that have been applied from 1993 onwards have been capped at the 1992 efficiency.

Results

Table B14 in Appendix B presents the data on the numbers of completions and the corresponding energy and carbon savings in each year that may be ascribed to Building Regulations. Overall, the savings in 2001 due to Building Regulations amount to about 137 PJ/year or 2.5 MtC. Cumulatively, the Building Regulations have saved about 1660 PJ or 32.5 MtC up to 2001. It will be noted that these figures are quite similar to those discussed earlier for grants which have, of course, been in operation over much the same period of time. The savings relative to other policies are discussed further in the following.

Conclusions on savings from grants, energy labelling and Building Regulations

Table B15 in Appendix B brings together the results of the energy and carbon savings calculations for grants, energy labelling and Building Regulations that have been discussed in the preceding paragraphs. Note that the grants figures discussed here are the full savings, excluding any adjustments to allow for free riders. Note also that the slight time shift between the various analyses (i.e. some analyses having been done on a financial year basis and some on a calendar year basis, depending upon the available data) has been ignored. Thus, 2001 actually means 2001/02 in some cases. Clearly this slight inconsistency is of little consequence when assessing the effects of the different policies over the long term, which is what the table does.

The results for the energy savings are presented more clearly in Figure 44. Those for carbon savings are shown in Figure 45.

It is clear from Figure 44 that the savings in PJ/year for grants and for Building Regulations have grown steadily over the years and have broadly been of quite similar magnitude. From the early 1990s the savings from labelling of boilers have been growing quite rapidly and are now becoming significant. Savings from labelling of appliances have only been accumulating since the mid-1990s and so it is not surprising to see that they are still relatively insignificant in comparison to the other energy efficiency policies. Overall, for the policies considered, the savings being achieved in 2001 amount to about 275 PJ/year, which represents around 14% of the current housing stock energy use.

Figure 45 shows the same information in terms of carbon savings in MtC/year and exactly the same general comments apply. The only additional point worth noting is that the savings for labelling of appliances become slightly more significant, and those from labelling of boilers slightly less significant, when looked at in terms of carbon. This is because of the difference between the carbon emission factors for electricity and gas. Overall, for the policies considered, the savings being achieved in 2001 amount to about 5 MtC/year, representing about 13% of the current carbon emissions associated with the energy use of the housing stock.

Figure 44. Energy savings due to quantifiable domestic sector energy efficiency policies

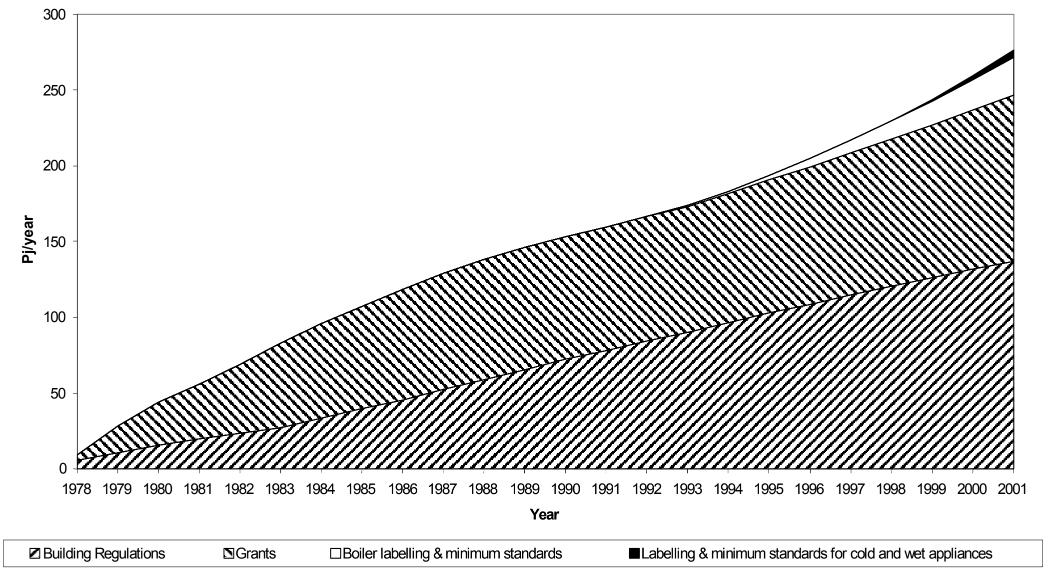
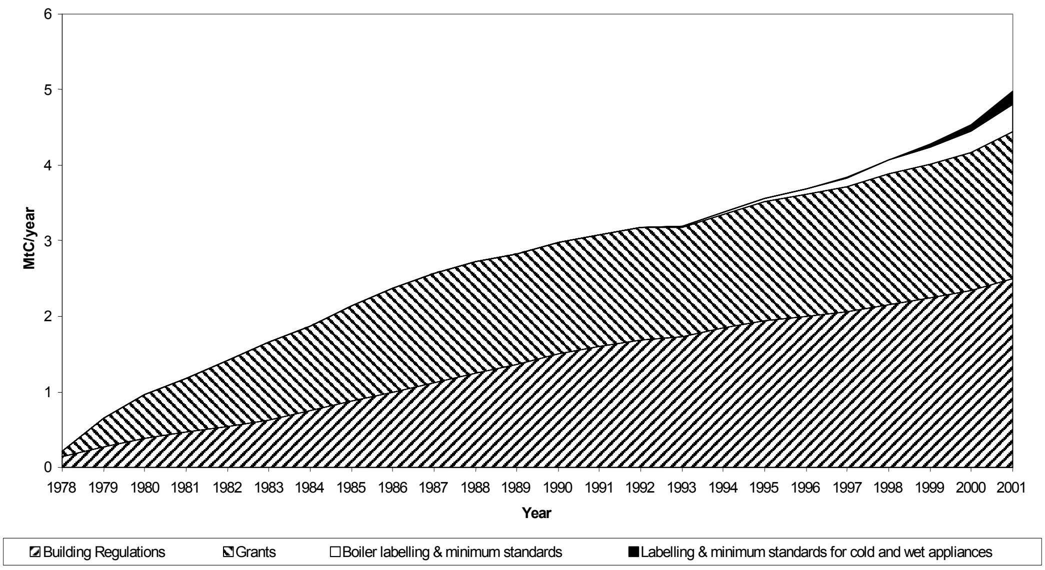


Figure 45. Carbon savings due to quantifiable domestic sector energy efficiency policies



What these figures emphasise is the fact that it takes time for savings to accumulate so it is important to take a long-term view when developing energy efficiency policies. The figures represent the culmination of all the preceding analyses, which in turn have depended upon the availability of a lot of detailed data and associated modelling tools. There were some gaps in the data for grants, explained in the notes under Tables B1, B2 and B3, but it has been possible to overcome these by introducing appropriate interpolation and assumptions thereby producing a reasonably complete picture.

The study has demonstrated that the regular collection of data, together with associated modelling and analysis work, is of key importance for the monitoring of the effects of energy efficiency policies. The findings help with the development of future scenarios taking account of energy efficiency policies that are either already in place or yet to be implemented, as discussed in Part 3 of this report.

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2. *Warm Front: Helping to combat fuel poverty*. National Audit Office. June 2003.
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4. L D Shorrock and J I Utley. *Domestic Energy Fact File 2003.* BRE Report BR 457. May 2003.

Appendix B: Tables

Table B1. Loft insulation in existing homes – acquisitions and grants

	Homes Insulation Scheme		Energy Conservation Programme		Home Energy Efficiency Scheme		Standards of Performance		All schemes				
Year	Grants	Grant expenditure (£M)	Grants	Grant expenditure (£M)	Grants	Grant expenditure (£M)	Grants	Grant expenditure (£M)	Grants	Grant expenditure (£M)	GDP deflator (1990=100)	GDP adjusted grant expenditure (£M) (1999/2000 values)	Acquisitions
1974									0	0.0	21.5	0.0	278000
1975									0	0.0	27.4	0.0	325000
1976									0	0.0	31.5	0.0	189000
1977									0	0.0	35.9	0.0	187000
1978	94493	3.8	139099	5.6					233592	9.4	40.0	31.5	624000
1979	421555	16.5	632163	31.3					1053718	47.8	45.8	139.8	791000
1980	332628	15.3	454669	28.2					787297	43.5	54.7	106.5	644000
1981	368838	23.6	184429	11.2					553267	34.8	61.0	76.4	863000
1982	400346	27.3	271625	16.0					671971	43.3	65.6	88.4	853000
1983	387861	27.6	263215	24.4					651076	52.0	69.1	100.8	609000
1984	345203	23.6	152243	17.8					497446	41.4	72.2	76.8	517000
1985	410903	28.6	79137	15.8					490040	44.4	76.3	77.9	581000
1986	397599	27.3	82567	10.8					480166	38.1	78.8	64.7	664000
1987	329482	21.8	69522	8.4					399004	30.2	82.8	48.8	509000
1988	143749	16.0	60582	8.3					204331	24.3	87.8	37.1	358000
1989	58263	6.5	32609	4.5					90872	11.0	94.0	15.6	351000
1990	20919	2.3	11708	1.6					32627	3.9	100.0	5.3	269000
1991/92	438	0.0	245	0.0	53268	8.4			53951	8.5	107.3	10.6	465000
1992/93					61982	10.9			61982	10.9	111.6	13.1	384000
1993/94					82028	13.4			82028	13.4	114.6	15.6	378000
1994/95					133906	26.0	12226	2.2	146132	28.2	116.2	32.5	432000
1995/96					177335	34.4	23800	5.0	201135	39.4	119.5	44.2	436000
1996/97					132096	25.6	28034	4.1	160130	29.7	123.4	32.2	428000
1997/98					82856	20.1	16556	2.6	99412	22.6	126.9	23.9	324000
1998/99					71410	16.0	17589	5.2	88999	21.2	130.6	21.7	357000
1999/00					72666	15.6	17589	1.0	90255	16.6	133.9	16.6	421000
2000/01					83583		39988		123571		136.7	25.6	442000
2001/02					94500		39988		134488		140.1	27.8	373000

Notes: To ensure that no data are omitted by the transition from calendar years to financial years "1991/92" actually refers to the period Jan 1991 to Mar 1992 inclusive.
Numbers shown shaded in grey are estimates determined as follows:
The Home Energy Efficiency Scheme figure for 2000/2001 is interpolated
Grant expenditures in 2000/2001 and 2001/2002 are estimated using the previous regression of grants against expenditures (which, by definition, refers to 1999/2000 money values).

Table B2. Cavity wall insulation in existing homes – acquisitions and grants

	Home Energy Efficiency Scheme		EST Cashback Scheme / others		Standards of Performance / EEC		All schemes				
Year	Grants	Grant expenditure (£M)	Grants	Grant expenditure (£M)	Grants	Grant expenditure (£M)	Grants	Grant expenditure (£M)	GDP deflator (1990=100)	GDP adjusted grant expenditure (£M) (1999/2000 values)	Acquisitions
1990/1991							0	0.0	101.8	0.0	81000
1991/1992							0	0.0	108.1	0.0	82000
1992/1993							0	0.0	111.6	0.0	77000
1993/1994							0	0.0	114.6	0.0	96000
1994/1995					20784	3.4	20784	3.4	116.2	4.0	122000
1995/1996					38590	6.5	38590	6.5	119.5	7.3	127000
1996/1997			30000	7.3	30205	5.3	60205	12.6	123.4	13.7	195000
1997/1998	40282	11.1	45000	6.8	34324	6.2	119606	24.1	126.9	25.4	187000
1998/1999	97845	25.8	22747	5.5	17559	5.5	138151	36.7	130.6	37.7	218000
1999/2000	126130	32.7	19058	4.9	17559	5.5	162747	43.1	133.9	43.1	229000
2000/2001	112740		11970		50345		175055		136.7	44.5	232000
2001/2002	99350		4882		50345		154577		140.1	39.3	205000

Notes: Numbers shown shaded in grey are estimates determined as follows:
HEES grants in 2000/2001 are not known - value shown is an interpolated figure
EST Cashback Scheme / other grants in 2000/2001 are not known - value shown is interpolated
Grant expenditures in 2000/2001 and 2001/2002 are estimated using the previous regression of grants against expenditures (which, by definition, refers to 1999/2000 money values).

Table B3. Condensing boilers – sales and grants

Year	Home Energy Efficiency Scheme: Grants	Home Energy Efficiency Scheme: Grant expenditure (£M)	EST Cashback Scheme: Grants	EST Cashback Scheme: Grant expenditure (£M)	Standards of Performance: Grants	Standards of Performance: Grant expenditure (£M)	All schemes: Grants	All schemes: Grant expenditure (£M)	GDP deflator (1990=100)	GDP adjusted grant expenditure (£M) (1999/2000 values)	Total sales	Estimated sales into existing homes
1990/1991			0	0.0	0		0	0.0	101.8	0.0	7250	6163
1991/1992			0	0.0	0		0	0.0	108.1	0.0	8000	6800
1992/1993			0	0.0	0		0	0.0	111.6	0.0	9000	7650
1993/1994			0	0.0	0		0	0.0	114.6	0.0	14500	12325
1994/1995			0	0.0	0		0	0.0	116.2	0.0	21250	18063
1995/1996			0	0.0	0		0	0.0	119.5	0.0	22250	18690
1996/1997			6000	2.3	0		6000	2.3	123.4	2.5	33250	28263
1997/1998			9000	2.3	0		9000	2.3	126.9	2.4	39000	33540
1998/1999			12110	3.4	0		12110	3.4	130.6	3.5	47500	41325
1999/2000			15540	4.5	0		15540	4.5	133.9	4.5	58750	51700
2000/2001	10620				32538		43158		136.7	12.8	75632	68069
2001/2002	21240				32538		53778		140.1	16.0	103505	93155

Notes:

Numbers shown shaded in grey are estimates determined as follows:

Home Energy Efficiency Scheme figure in 2001/2002 taken to be 58% of the 36620 homes that received gas central heating under HEES in that year. (58% is a figure provided by defra representing the known proportion of installations that used condensing boilers between June 2000 and September 2002)

Home Energy Efficiency Scheme figure in 2000/2001 taken to be half of that in 2001/2002 (based on the fact that the new scheme did not start until well into 2000/2001 [June] and it would inevitably have taken some time to reach its normal operating level for this newly introduced measure)

Grant expenditures in 2000/2001 and 2001/2002 are estimated using the previous regression of grants against expenditures (which, by definition, refers to 1999/2000 money values).

Sales to existing homes in 2000/2001 and 2001/2002 are taken to be 90% of all sales (based on the observed ratios for earlier years)

Table B4. Summary of energy and carbon savings due to loft insulation grants

					Not allowing for free-riders								Allowing for free-riders							
	Cumulative acquisitions from start of grants	Cumulative grants	Cumulative non free-rider grants	Cumulative grant expenditure (£M 1999/2000)	Savings in that year (PJ)	Cumulative savings (PJ)	Savings in that year (MtC)	Cumulative savings (MtC)	Cumulative cost saving (£M 1999/2000)	Saving/ cost ratio	Cost per tonne of carbon saved (£/tC)	Net cost per tonne of carbon saved (£/tC)	Savings in that year (PJ)	Cumulative savings (PJ)	Savings in that year (MtC)	Cumulative savings (MtC)	Cumulative cost saving (£M 1999/2000)	Saving/ cost ratio	Cost per tonne of carbon saved (£/tC)	Net cost per tonne of carbon saved (£/tC)
1978	624000	233592	137157	31.5	3.3	3.3	0.07	0.07	19.5	0.62	451	172	1.9	1.9	0.04	0.04	11.5	0.36	768	489
1979	1415000	1287310	884041	171.2	17.9	21.2	0.38	0.45	114.7	0.67	378	125	12.3	14.2	0.26	0.30	76.8	0.45	564	311
1980	2059000	2074607	1364504	277.7	28.5	49.8	0.58	1.03	261.9	0.94	269	15	18.8	33.0	0.38	0.69	173.7	0.63	405	152
1981	2922000	2627874	1683664	354.1	36.1	85.9	0.71	1.74	472.9	1.34	203	-68	23.2	56.2	0.45	1.14	309.0	0.87	311	40
1982	3775000	3299845	2084773	442.5	45.9	131.8	0.88	2.62	785.8	1.78	169	-131	29.0	85.2	0.55	1.69	506.6	1.14	261	-38
1983	4384000	3950921	2429015	543.3	55.5	187.2	1.04	3.66	1190.1	2.19	149	-177	34.0	119.2	0.64	2.33	754.9	1.39	233	-91
1984	4901000	4448367	2691157	620.1	62.1	249.3	1.13	4.79	1636.8	2.64	130	-212	37.5	156.8	0.68	3.02	1025.0	1.65	206	-134
1985	5482000	4938407	2942403	698.0	67.5	316.8	1.27	6.06	2111.5	3.02	115	-233	40.3	197.1	0.76	3.77	1308.5	1.87	185	-162
1986	6146000	5418573	3224159	762.8	72.6	389.4	1.37	7.43	2612.1	3.42	103	-249	43.3	240.4	0.82	4.59	1607.2	2.11	166	-184
1987	6655000	5817577	3473491	811.6	77.1	466.5	1.45	8.88	3114.6	3.84	91	-259	46.1	286.5	0.87	5.46	1907.7	2.35	149	-201
1988	7013000	6021908	3563033	848.7	79.4	545.8	1.47	10.35	3605.4	4.25	82	-266	47.1	333.6	0.87	6.33	2199.0	2.59	134	-213
1989	7364000	6112780	3605579	864.3	80.5	626.3	1.47	11.82	4093.5	4.74	73	-273	47.6	381.2	0.87	7.20	2487.9	2.88	120	-225
1990	7633000	6145407	3621896	869.5	80.9	707.2	1.47	13.29	4580.6	5.27	65	-279	47.8	429.0	0.87	8.07	2775.9	3.19	108	-236
1991/92	8098000	6199358	3642949	880.2	81.5	788.7	1.48	14.77	5068.9	5.76	60	-284	48.1	477.1	0.87	8.95	3063.9	3.48	98	-244
1992/93	8482000	6261341	3664461	893.2	82.3	871.0	1.48	16.25	5540.9	6.20	55	-286	48.3	525.5	0.87	9.82	3341.3	3.74	91	-249
1993/94	8860000	6343369	3698150	908.8	83.2	954.1	1.44	17.70	6007.6	6.61	51	-288	48.7	574.2	0.85	10.66	3614.6	3.98	85	-254
1994/95	9292000	6489501	3743612	941.3	84.8	1039.0	1.48	19.18	6503.4	6.91	49	-290	49.2	623.4	0.86	11.52	3902.3	4.15	82	-257
1995/96	9728000	6690636	3807874	985.5	87.1	1126.1	1.52	20.70	7002.9	7.11	48	-291	49.9	673.3	0.87	12.39	4188.7	4.25	80	-258
1996/97	10156000	6850766	3868166	1017.8	88.8	1214.9	1.53	22.23	7466.7	7.34	46	-290	50.6	723.9	0.87	13.27	4452.9	4.38	77	-259
1997/98	10480000	6950178	3893581	1041.7	89.9	1304.8	1.53	23.76	7934.1	7.62	44	-290	50.9	774.8	0.87	14.13	4717.4	4.53	74	-260
1998/99	10837000	7039177	3915238	1063.4	90.9	1395.7	1.56	25.32	8371.7	7.87	42	-289	51.1	825.9	0.88	15.01	4963.5	4.67	71	-260
1999/00	11258000	7129432	3954000	1080.0	91.8	1487.5	1.56	26.88	8771.4	8.12	40	-286	51.5	877.5	0.87	15.88	5187.7	4.80	68	-259
2000/01	11700000	7253003	3998368	1105.6	93.0	1580.6	1.57	28.45	9146.6	8.27	39	-283	52.0	929.4	0.88	16.76	5397.3	4.88	66	-256
2001/02	12073000	7387491	4046655	1133.4	94.4	1674.9	1.64	30.09	9525.5	8.40	38	-279	52.4	981.8	0.91	17.67	5607.8	4.95	64	-253

Table B5. Summary of energy and carbon savings due to cavity wall insulation grants

					Not allowing for free-riders								Allowing for free-riders							
	Cumulative acquisitions from start of grants	Cumulative grants	Cumulative non free-rider grants	Cumulative grant expenditure (£M 1999/2000)	Savings in that year (PJ)	Cumulative savings (PJ)	Savings in that year (MtC)	Cumulative savings (MtC)	Cumulative cost saving (£M 1999/2000)	Saving/ cost ratio	Cost per tonne of carbon saved (£/tC)	Net cost per tonne of carbon saved (£/tC)	Savings in that year (PJ)	Cumulative savings (PJ)	Savings in that year (MtC)	Cumulative savings (MtC)	Cumulative cost saving (£M 1999/2000)	Saving/ cost ratio	Cost per tonne of carbon saved (£/tC)	Net cost per tonne of carbon saved (£/tC)
1994/95	122000	20784	18687	4.0	0.3	0.3	0.02	0.02	1.9	0.47	213	113	0.3	0.3	0.02	0.02	1.7	0.42	237	137
1995/96	249000	59374	53384	11.3	0.9	1.2	0.05	0.07	7.1	0.62	167	62	0.8	1.1	0.04	0.06	6.3	0.56	185	81
1996/97	444000	119579	106320	25.0	1.8	3.0	0.08	0.15	16.6	0.66	170	57	1.6	2.7	0.07	0.13	14.8	0.59	190	77
1997/98	631000	239185	212444	50.4	3.6	6.7	0.12	0.26	35.5	0.71	190	56	3.2	6.0	0.10	0.24	31.7	0.63	214	79
1998/99	849000	377336	330608	88.0	5.8	12.5	0.17	0.43	63.3	0.72	204	57	5.0	11.0	0.15	0.38	56.0	0.64	230	84
1999/00	1078000	540083	470498	131.1	8.2	20.7	0.21	0.64	99.1	0.76	205	50	7.2	18.2	0.18	0.56	87.2	0.67	232	78
2000/01	1310000	715137	621957	175.5	10.9	31.6	0.24	0.88	143.2	0.82	199	37	9.5	27.7	0.21	0.77	125.5	0.71	227	65
2001/02	1515000	869714	755698	214.8	13.3	44.9	0.27	1.15	196.4	0.91	187	16	11.5	39.2	0.23	1.01	171.8	0.80	213	43

Table B6. Summary of energy and carbon savings due to condensing boiler grants

					Not allowing for free-riders								Allowing for free-riders							
	Cumulative acquisitions from start of grants	Cumulative grants	Cumulative non free-rider grants	Cumulative grant expenditure (£M 1999/2000)	Savings in that year (PJ)	Cumulative savings (PJ)	Savings in that year (MtC)	Cumulative savings (MtC)	Cumulative cost saving (£M 1999/2000)	Saving/ cost ratio	Cost per tonne of carbon saved (£/tC)	Net cost per tonne of carbon saved (£/tC)	Savings in that year (PJ)	Cumulative savings (PJ)	Savings in that year (MtC)	Cumulative savings (MtC)	Cumulative cost saving (£M 1999/2000)	Saving/ cost ratio	Cost per tonne of carbon saved (£/tC)	Net cost per tonne of carbon saved (£/tC)
1996/97	28263	6000	2008	2.5	0.1	0.10	0.001	0.001	0.5	0.20	1750	1396	0.0	0.03	0.000	0.000	0.2	0.07	5229	4875
1997/98	61803	15000	7239	4.9	0.2	0.35	0.004	0.005	1.8	0.36	972	619	0.1	0.15	0.002	0.002	0.8	0.16	2208	1855
1998/99	103128	27110	13911	8.4	0.4	0.79	0.007	0.012	3.9	0.47	724	385	0.2	0.38	0.003	0.006	1.9	0.23	1505	1166
1999/00	154828	42650	22456	12.9	0.7	1.49	0.010	0.022	7.0	0.54	589	269	0.4	0.75	0.005	0.011	3.5	0.27	1173	854
2000/01	222897	85808	45442	25.7	1.4	2.90	0.021	0.042	12.7	0.49	607	307	0.7	1.50	0.011	0.022	6.5	0.25	1176	878
2001/02	316051	139585	74083	41.7	2.3	5.20	0.034	0.076	21.9	0.53	548	260	1.2	2.72	0.018	0.040	11.4	0.27	1050	763

Table B7. Summary of energy and carbon savings to 1999/2000 due to grants for loft insulation, cavity wall insulation and condensing boilers

					Not allowing for free-riders								Allowing for free-riders							
	Cumulative acquisitions from start of grants	Cumulative grants	Cumulative non free-rider grants	Cumulative grant expenditure (£M 1999/2000)	Savings in that year (PJ)	Cumulative savings (PJ)	Savings in that year (MtC)	Cumulative savings (MtC)	Cumulative cost saving (£M 1999/2000)	Saving/ cost ratio	Cost per tonne of carbon saved (£/tC)	Net cost per tonne of carbon saved (£/tC)	Savings in that year (PJ)	Cumulative savings (PJ)	Savings in that year (MtC)	Cumulative savings (MtC)	Cumulative cost saving (£M 1999/2000)	Saving/ cost ratio	Cost per tonne of carbon saved (£/tC)	Net cost per tonne of carbon saved (£/tC)
1978	624000	233592	137157	31.5	3.3	3.3	0.07	0.07	19.5	0.62	451	172	1.9	1.9	0.04	0.04	11.5	0.36	768	489
1979	1415000	1287310	884041	171.2	17.9	21.2	0.38	0.45	114.7	0.67	378	125	12.3	14.2	0.26	0.30	76.8	0.45	564	311
1980	2059000	2074607	1364504	277.7	28.5	49.8	0.58	1.03	261.9	0.94	269	15	18.8	33.0	0.38	0.69	173.7	0.63	405	152
1981	2922000	2627874	1683664	354.1	36.1	85.9	0.71	1.74	472.9	1.34	203	-68	23.2	56.2	0.45	1.14	309.0	0.87	311	40
1982	3775000	3299845	2084773	442.5	45.9	131.8	0.88	2.62	785.8	1.78	169	-131	29.0	85.2	0.55	1.69	506.6	1.14	261	-38
1983	4384000	3950921	2429015	543.3	55.5	187.2	1.04	3.66	1190.1	2.19	149	-177	34.0	119.2	0.64	2.33	754.9	1.39	233	-91
1984	4901000	4448367	2691157	620.1	62.1	249.3	1.13	4.79	1636.8	2.64	130	-212	37.5	156.8	0.68	3.02	1025.0	1.65	206	-134
1985	5482000	4938407	2942403	698.0	67.5	316.8	1.27	6.06	2111.5	3.02	115	-233	40.3	197.1	0.76	3.77	1308.5	1.87	185	-162
1986	6146000	5418573	3224159	762.8	72.6	389.4	1.37	7.43	2612.1	3.42	103	-249	43.3	240.4	0.82	4.59	1607.2	2.11	166	-184
1987	6655000	5817577	3473491	811.6	77.1	466.5	1.45	8.88	3114.6	3.84	91	-259	46.1	286.5	0.87	5.46	1907.7	2.35	149	-201
1988	7013000	6021908	3563033	848.7	79.4	545.8	1.47	10.35	3605.4	4.25	82	-266	47.1	333.6	0.87	6.33	2199.0	2.59	134	-213
1989	7364000	6112780	3605579	864.3	80.5	626.3	1.47	11.82	4093.5	4.74	73	-273	47.6	381.2	0.87	7.20	2487.9	2.88	120	-225
1990	7633000	6145407	3621896	869.5	80.9	707.2	1.47	13.29	4580.6	5.27	65	-279	47.8	429.0	0.87	8.07	2775.9	3.19	108	-236
1991/92	8098000	6199358	3642949	880.2	81.5	788.7	1.48	14.77	5068.9	5.76	60	-284	48.1	477.1	0.87	8.95	3063.9	3.48	98	-244
1992/93	8482000	6261341	3664461	893.2	82.3	871.0	1.48	16.25	5540.9	6.20	55	-286	48.3	525.5	0.87	9.82	3341.3	3.74	91	-249
1993/94	8860000	6343369	3698150	908.8	83.2	954.1	1.44	17.70	6007.6	6.61	51	-288	48.7	574.2	0.85	10.66	3614.6	3.98	85	-254
1994/95	9414000	6510285	3762299	945.3	85.1	1039.3	1.50	19.20	6505.2	6.88	49	-290	49.5	623.7	0.88	11.54	3903.9	4.13	82	-256
1995/96	9977000	6750010	3861258	996.8	88.0	1127.3	1.57	20.77	7010.0	7.03	48	-290	50.8	674.4	0.91	12.45	4195.1	4.21	80	-257
1996/97	10628263	6976345	3976495	1045.3	90.8	1218.0	1.61	22.38	7483.8	7.16	47	-288	52.3	726.7	0.94	13.40	4467.9	4.27	78	-255
1997/98	11172803	7204363	4113264	1097.0	93.8	1311.9	1.65	24.03	7971.5	7.27	46	-286	54.2	780.9	0.97	14.37	4749.8	4.33	76	-254
1998/99	11789128	7443623	4259757	1159.8	97.1	1409.0	1.73	25.77	8438.9	7.28	45	-282	56.4	837.3	1.03	15.40	5021.4	4.33	75	-251
1999/00	12490828	7712165	4446955	1224.0	100.8	1509.7	1.78	27.54	8877.5	7.25	44	-278	59.1	896.4	1.06	16.46	5278.4	4.31	74	-246
2000/01	13232897	8053948	4665766	1306.9	105.3	1615.1	1.83	29.38	9302.5	7.12	44	-272	62.2	958.6	1.10	17.56	5529.3	4.23	74	-240
2001/02	13904051	8396791	4876436	1390.0	109.9	1725.0	1.94	31.32	9743.8	7.01	44	-267	65.2	1023.8	1.16	18.72	5791.0	4.17	74	-235

Table B8. Sales of refrigerators by energy band and savings achieved due to labelling and minimum standards

TOTAL MARKET

VOLUME '000s	Q1 1996	Q2 1996	Q3 1996	Q4 1996	Q1 1997	Q2 1997	Q3 1997	Q4 1997	Q1 1998	Q2 1998	Q3 1998	Q4 1998	Q1 1999	Q2 1999	Q3 1999	Q4 1999	Q1 2000	Q2 2000	Q3 2000	Q4 2000	Q1 2001	Q2 2001	Q3 2001	Q4 2001
FRIDGES	**161.1**	**168**	**212.3**	**170.5**	**168.4**	**190**	**274.4**	**204.4**	**183.6**	**197.5**	**248.9**	**197.8**	**198.5**	**206.7**	**285**	**221.3**	**208.1**	**216.9**	**267.3**	**245.1**	**221.5**	**239**	**304.4**	**250.4**
ENERGY CLASS A	3.3	3.9	4.9	4.3	4.2	4.9	7.6	6.1	5.4	6	8	5.7	5.6	6.5	10.4	9.7	10.5	13	22.23	25.13	20.87	36.42	65.6	60.75
ENERGY CLASS B	13.6	18.3	14.8	20.6	17.9	19.6	27.5	23.3	30.1	40.8	62	44.8	42.9	52.1	79	68.1	70.3	86	97.49	88.9	82.81	95.74	133.85	107.45
ENERGY CLASS C	66.4	79.3	121.3	86.7	82.9	95	141.4	103.3	83.2	87.1	110.4	101.9	106	106.4	149.7	113.6	105.3	97.7	110.46	106.45	103.01	93.99	91.42	66.88
ENERGY CLASS D	47.7	39.1	55.4	43.1	48.3	59.7	75.4	53.8	51.9	51.6	48.5	34.4	31.7	31.7	32	19.9	13.3	9.9	5.86	4.79	3.91	3	3.91	4
ENERGY CLASS E	8.7	5.8	5.2	4.3	3.5	2.6	4.1	3.3	2.7	2.8	6.3	2.8	2.4	1.9	0.9	0.5	0.4	0.3	0.05	0.01	0.02	0.01	0.01	0.05
ENERGY CLASS F	0.4	0.7	1	0.6	0.5		0.1																	
ENERGY CLASS G	0.4	0.3	0.8		0.6	0.9	1.1	0.8	0.5	0.7	1.6	1	1.1	1.2	2.2	1.4	0.9	1	1.48	1.09	0.98	1.03	1.32	1.33
UNKNOWN	20.7	20.9	8.9	10.9	10.7	7.3	17.2	13.8	9.7	8.6	12.1	7.3	8.8	6.9	10.8	8	7.5	9	29.81	18.69	10.18	8.78	8.32	9.9
% C or better	59.3%	68.9%	69.3%	69.9%	66.5%	65.4%	68.6%	69.6%	68.3%	70.8%	76.2%	80.0%	81.4%	82.6%	87.2%	89.8%	92.7%	94.6%	96.9%	97.4%	97.7%	98.2%	98.2%	97.8%

Annual Sales	1996	1997	1998	1999	2000	2001
ENERGY CLASS A	16.4	22.8	25.1	32.2	70.9	183.6
ENERGY CLASS B	67.3	88.3	177.7	242.1	342.7	419.9
ENERGY CLASS C	353.7	422.6	382.6	475.7	419.9	355.3
ENERGY CLASS D	185.3	237.2	186.4	115.3	33.9	14.8
ENERGY CLASS E	24.0	13.5	14.6	5.7	0.8	0.1
ENERGY CLASS F	2.7	0.6	0.0	0.0	0.0	0.0
ENERGY CLASS G	1.5	3.4	3.8	5.9	4.5	4.7
UNKNOWN	61.4	49.0	37.7	34.5	65.0	37.2
TOTAL	712.3	837.4	827.9	911.4	937.5	1015.5
Pro rata of unknowns						
ENERGY CLASS A	17.95	24.22	26.30	33.47	76.14	190.62
ENERGY CLASS B	73.65	93.79	186.18	251.62	368.22	435.81
ENERGY CLASS C	387.06	448.87	400.85	494.42	451.19	368.80
ENERGY CLASS D	202.78	251.94	195.29	119.84	36.37	15.38
ENERGY CLASS E	26.26	14.34	15.30	5.92	0.82	0.09
ENERGY CLASS F	2.95	0.64	0.00	0.00	0.00	0.00
ENERGY CLASS G	1.64	3.61	3.98	6.13	4.80	4.84
TOTAL	712.3	837.4	827.9	911.4	937.5	1015.5

Relative energy use of the different energy classes (kWh/year)

ENERGY CLASS A	164
ENERGY CLASS B	213
ENERGY CLASS C	269
ENERGY CLASS D	312
ENERGY CLASS E	345
ENERGY CLASS F	384
ENERGY CLASS G	427

Hence average energy use per new appliance in each year (kWh/year)

1996	1997	1998	1999	2000	2001
276	275	265	257	241	227

Hence saving per new appliance in each year relative to 1996 (kWh/year)

1996	1997	1998	1999	2000	2001
0	2	11	19	35	50

Hence national saving due to new appliances in each year, relative to 1996

	1996	1997	1998	1999	2000	2001
In kWh/year	0	1460368	9122052	17727141	33059432	50368690
In GJ/year	0	5257	32839	63818	119014	181328
In PJ/year	0.000	0.005	0.033	0.064	0.119	0.181
In PJ/year cumulative	0.000	0.005	0.038	0.102	0.221	0.402
Carbon factor for elect.	0.03863	0.03517	0.03581	0.03502	0.03505	0.03905
In MtC/year	0	0.00018	0.00118	0.00223	0.00417	0.00708
In MtC/year cumulative	0	0.00018	0.00136	0.00357	0.00774	0.01571

Summed savings to end of stated year

	1996	1997	1998	1999	2000	2001
In PJ/year	0.000	0.005	0.043	0.145	0.366	0.768
In MtC/year	0.000	0.000	0.002	0.005	0.013	0.029

Table B9. Sales of fridge freezers by energy band and savings achieved due to labelling and minimum standards

TOTAL MARKET

VOLUME '000s	Q1 1996	Q2 1996	Q3 1996	Q4 1996	Q1 1997	Q2 1997	Q3 1997	Q4 1997	Q1 1998	Q2 1998	Q3 1998	Q4 1998
FRIDGE FREEZERS	**217.7**	**208.8**	**284.8**	**242.1**	**212.3**	**222.7**	**330.1**	**273.6**	**243.1**	**236.8**	**303.8**	**260.1**
ENERGY CLASS A	0.6	0.9	1.3	0.6	0.5	0.5	0.6	0.9	0.8	0.9	1.1	1.6
ENERGY CLASS B	7.6	8	10.9	9.5	9.1	11.8	16.9	15.8	16.8	18.4	28.6	23.8
ENERGY CLASS C	31.4	33	56.6	52.6	45.7	37.9	56.1	49.8	46.9	53.9	72.9	63.4
ENERGY CLASS D	78.5	72.4	95.8	75.8	68.4	81.3	118.7	98.3	83.3	76.6	94.6	82.4
ENERGY CLASS E	19.3	18.8	34.4	29.4	31.7	35.5	63	53.4	45.3	42.8	45.8	38.3
ENERGY CLASS F	15.6	16.7	29.9	19.5	18.5	20	22.4	15.5	14.5	11.5	15.4	12.9
ENERGY CLASS G	22.8	20.3	31.5	27.1	23.1	22.9	33.8	27	22.8	19.9	29.1	24.4
UNKNOWN	42.1	38.7	24.5	27.6	15.2	12.7	18.7	12.9	12.7	12.7	16.4	13.3
% C or better	22.5%	24.6%	26.4%	29.2%	28.1%	23.9%	23.6%	25.5%	28.0%	32.7%	35.7%	36.0%

VOLUME '000s	Q1 1999	Q2 1999	Q3 1999	Q4 1999	Q1 2000	Q2 2000	Q3 2000	Q4 2000	Q1 2001	Q2 2001	Q3 2001	Q4 2001
FRIDGE FREEZERS	**262.7**	**254.7**	**363.7**	**306**	**290.1**	**283.5**	**361**	**336.4**	**316.3**	**316.8**	**407.2**	**358.8**
ENERGY CLASS A	1.1	1.8	4.7	3.8	4.5	6.7	20.33	19.3	27.51	30.5	52.21	62.34
ENERGY CLASS B	27	48.5	85.3	70.3	70.1	76.4	94.54	90.66	82.57	110.55	181.14	156.56
ENERGY CLASS C	71.2	86.8	180.9	173	175.9	174	212.44	201.43	187.52	159.92	155.23	124.5
ENERGY CLASS D	77	46.9	43.8	30.8	15.4	7.1	6.46	3.87	3.34	3.84	5.91	7
ENERGY CLASS E	35	23	16.7	8.3	7	4.2	3.71	2.91	3.43	2.72	1.56	2.46
ENERGY CLASS F	11.2	7.3	6.4	1.8	4.9	4.7	4.87	3.98	1.67	1.05	1.48	1.02
ENERGY CLASS G	28.7	29.5	14.6	6.1	3.2	2.3	2.06	2.19	2.03	1.49	0.88	0.63
UNKNOWN	11.5	10.9	11.4	11.8	9.1	8.1	16.73	12.03	8.46	6.72	8.77	4.32
% C or better	39.5%	56.2%	76.9%	84.0%	89.1%	93.4%	95.0%	96.0%	96.6%	97.1%	97.5%	96.9%

Annual Sales	1996	1997	1998	1999	2000	2001
ENERGY CLASS A	3.4	2.5	4.4	11.4	50.8	172.6
ENERGY CLASS B	36.0	53.6	87.6	231.1	331.7	530.8
ENERGY CLASS C	173.6	189.5	237.1	511.9	763.8	627.2
ENERGY CLASS D	322.5	366.7	336.9	198.5	32.8	20.1
ENERGY CLASS E	101.9	183.6	172.2	83.0	17.8	10.2
ENERGY CLASS F	81.7	76.4	54.3	26.7	18.5	5.2
ENERGY CLASS G	101.7	106.8	96.2	78.9	9.8	5.0
UNKNOWN	132.9	59.5	55.1	45.6	46.0	28.3
TOTAL	953.7	1038.6	1043.8	1187.1	1271.1	1399.3
Pro rata of unknowns						
ENERGY CLASS A	3.95	2.65	4.65	11.86	52.74	176.12
ENERGY CLASS B	41.83	56.86	92.48	240.33	344.14	541.77
ENERGY CLASS C	201.71	201.02	250.31	532.35	792.42	640.10
ENERGY CLASS D	374.72	388.98	355.68	206.43	34.06	20.50
ENERGY CLASS E	118.40	194.76	181.80	86.32	18.49	10.38
ENERGY CLASS F	94.93	81.04	57.33	27.77	19.14	5.33
ENERGY CLASS G	118.17	113.29	101.56	82.05	10.12	5.13
TOTAL	953.7	1038.6	1043.8	1187.1	1271.1	1399.3

Relative energy use of the different energy classes (kWh/year)

ENERGY CLASS A	369
ENERGY CLASS B	479
ENERGY CLASS C	605
ENERGY CLASS D	700
ENERGY CLASS E	774
ENERGY CLASS F	863
ENERGY CLASS G	958

Hence average energy use per new appliance in each year (kWh/year)

1996	1997	1998	1999	2000	2001
726	724	703	636	573	531

Hence saving per new appliance in each year relative to 1996 (kWh/year)

1996	1997	1998	1999	2000	2001
0	3	23	90	154	195

Hence national saving due to new appliances in each year, relative to 1996

	1996	1997	1998	1999	2000	2001
In kWh/year	0	2908652	24138220	106846970	195438297	272931823
In GJ/year	0	10471	86898	384650	703580	982557
In PJ/year	0.000	0.010	0.087	0.385	0.704	0.983
In PJ/year cumulative	0.000	0.010	0.097	0.482	1.186	2.168
Carbon factor for elect.	0.038625	0.035172	0.035809	0.0350182	0.0350455	0.0390545
In MtC/year	0	0.000368	0.003112	0.0134697	0.0246573	0.0383733
In MtC/year cumulative	0	0.000368	0.003487	0.0168794	0.0415499	0.0846764

Summed savings to end of stated year

	1996	1997	1998	1999	2000	2001
In PJ/year	0.000	0.010	0.108	0.590	1.775	3.944
In MtC/year	0.000	0.000	0.004	0.021	0.062	0.147

Table B10. Sales of upright freezers by energy band and savings achieved due to labelling and minimum standards

TOTAL MARKET

VOLUME '000s	Q1 1996	Q2 1996	Q3 1996	Q4 1996	Q1 1997	Q2 1997	Q3 1997	Q4 1997	Q1 1998	Q2 1998	Q3 1998	Q4 1998	Q1 1999	Q2 1999	Q3 1999	Q4 1999	Q1 2000	Q2 2000	Q3 2000	Q4 2000	Q1 2001	Q2 2001	Q3 2001	Q4 2001
UPRIGHT FRZS.	**96.21**	**87.47**	**118.8**	**114.9**	**93.76**	**95.65**	**138.2**	**137.2**	**110.7**	**102.3**	**134.8**	**134.5**	**116.1**	**111.6**	**157.7**	**158.6**	**134.6**	**124**	**155.8**	**176.3**	**138**	**135.3**	**174.3**	**179.5**
ENERGY CLASS A	1.32	1.55	1.8	1.67	0.63	0.07	0.22	0.17	0.25	0.34	0.34	2.3	2.24	2.16	3.54	4.42	5.39	4.95	5.85	8.19	7.93	9.03	10.51	13.54
ENERGY CLASS B	2.84	3.11	4.31	4.21	3.4	4.14	7.66	7.88	7.25	7.11	8.97	6.62	6.28	17.03	31.04	28.4	24.22	24.54	33.03	40.79	30.68	38.74	63.46	72.52
ENERGY CLASS C	11.01	9.6	15.4	14.57	12.11	12.49	22.98	22.38	18.09	22.44	30.58	32.01	26.45	32.97	70.46	85.34	72.4	64.36	74.26	86.28	72.71	71.96	83.2	77.05
ENERGY CLASS D	22.1	20.7	44.42	44.95	37.79	33.98	44.6	45.49	35.3	36.33	45.41	49.18	45.08	30.64	25.53	18.99	13.32	10.98	13.87	9.95	4.11	2.1	1.94	2.69
ENERGY CLASS E	8.9	8.87	12.59	12.42	9.21	9.47	10.93	8.6	8.42	9.09	13.33	13.61	11.14	7.85	6.96	6.54	4.15	3.16	3.07	3.09	2.65	1.92	2.38	1.98
ENERGY CLASS F	3.44	3.34	5.34	5.43	5.7	4.61	6.74	6.91	6.11	3.94	5.14	6.64	5.61	4.91	5.67	5.42	5.88	4.96	5.2	4.29	3.27	2.61	3.39	2.91
ENERGY CLASS G	6.22	4.49	14.83	16.17	11.57	9.61	12.61	10.51	8.85	10.41	13.4	12.36	10.39	8.83	8.76	4.23	2.97	1.97	1.31	0.17	0.16	0.1	0.21	0.35
ALL OTHERS	40.38	35.8	20.16	15.51	13.36	21.28	32.47	35.21	26.39	12.66	17.66	11.81	8.87	7.24	5.78	5.22	6.29	9.08	19.24	23.51	16.52	8.81	9.22	8.49
% C or better	27.2%	27.6%	21.8%	20.6%	20.1%	22.5%	29.2%	29.9%	30.4%	33.3%	34.0%	33.4%	32.6%	50.0%	69.1%	77.1%	79.5%	81.7%	82.8%	88.5%	91.6%	94.7%	95.2%	95.4%

Annual Sales	1996	1997	1998	1999	2000	2001
ENERGY CLASS A	6.3	1.1	3.2	12.4	24.4	41.0
ENERGY CLASS B	14.5	23.1	30.0	82.8	122.6	205.4
ENERGY CLASS C	50.6	70.0	103.1	215.2	297.3	304.9
ENERGY CLASS D	132.2	161.9	166.2	120.2	48.1	10.8
ENERGY CLASS E	42.8	38.2	44.5	32.5	13.5	8.9
ENERGY CLASS F	17.6	24.0	21.8	21.6	20.3	12.2
ENERGY CLASS G	41.7	44.3	45.0	32.2	6.4	0.8
UNKNOWN	111.9	102.3	68.5	27.1	58.1	43.0
TOTAL	417.5	464.8	482.3	544.0	590.7	627.1
Pro rata of unknowns						
ENERGY CLASS A	8.66	1.40	3.76	13.01	27.04	44.03
ENERGY CLASS B	19.77	29.60	34.91	87.09	135.96	220.54
ENERGY CLASS C	69.09	89.71	120.19	226.51	329.74	327.39
ENERGY CLASS D	180.54	207.55	193.74	126.55	53.37	11.64
ENERGY CLASS E	58.44	49.00	51.81	34.19	14.94	9.59
ENERGY CLASS F	23.97	30.72	25.44	22.74	22.55	13.08
ENERGY CLASS G	56.98	56.81	52.47	33.90	7.12	0.88
TOTAL	417.5	464.8	482.3	544.0	590.7	627.1

Relative energy use of the different energy classes (kWh/year)

ENERGY CLASS A	234
ENERGY CLASS B	305
ENERGY CLASS C	384
ENERGY CLASS D	445
ENERGY CLASS E	492
ENERGY CLASS F	548
ENERGY CLASS G	609

Hence average energy use per new appliance in each year (kWh/year)

1996	1997	1998	1999	2000	2001
459	456	446	410	376	352

Hence saving per new appliance in each year relative to 1996 (kWh/year)

1996	1997	1998	1999	2000	2001
0	3	12	49	83	107

Hence national saving due to new appliances in each year, relative to 1996

	1996	1997	1998	1999	2000	2001
In kWh/year	0	1531420	5998590	26756463	48829230	66908942
In GJ/year	0	5513	21595	96324	175786	240873
In PJ/year	0.000	0.006	0.022	0.096	0.176	0.241
In PJ/year cumulative	0.000	0.006	0.027	0.123	0.299	0.540
Carbon factor for elect.	0.038625	0.035172	0.035809	0.035018	0.035045	0.039055
In MtC/year	0	0.000194	0.000773	0.003373	0.00616	0.009407
In MtC/year cumulative	0	0.000194	0.000971	0.004322	0.010486	0.021093

Summed savings to end of stated year

	1996	1997	1998	1999	2000	2001
In PJ/year	0.000	0.006	0.033	0.156	0.455	0.995
In MtC/year	0.000	0.000	0.001	0.005	0.016	0.037

Table B11. Sales of chest freezers by energy band and savings achieved due to labelling and minimum standards

TOTAL MARKET

VOLUME '000s	Q1 1996	Q2 1996	Q3 1996	Q4 1996	Q1 1997	Q2 1997	Q3 1997	Q4 1997	Q1 1998	Q2 1998	Q3 1998	Q4 1998
CHEST FREEZERS	**56.97**	**49.62**	**74.21**	**90.97**	**55.83**	**53.88**	**85.55**	**100.2**	**64.46**	**56.46**	**77.82**	**97.22**
ENERGY CLASS A			0.08	0.1	0.07	0.59	0.9	0.86	0.61	0.22	0.5	1
ENERGY CLASS B	0.36	0.29	0.82	1.29	0.84	0.9	1.48	1.39	0.78	0.71	0.99	1.18
ENERGY CLASS C	0.09	0.15	0.22	0.31	0.31	0.43	0.89	10.36	8.81	5.15	9.85	10.88
ENERGY CLASS D	0.12	0.12	2.19	5.15	3.57	3.26	4.06	5.82	3.24	3.49	4.2	5.7
ENERGY CLASS E	0.58	0.78	1.58	1.45	1.38	0.91	2	1.79	1.11	0.91	1.5	2.12
ENERGY CLASS F	2.8	2.68	6.94	14.69	11.86	15.26	22.96	19.39	13.06	13.52	17.69	19.48
ENERGY CLASS G	15.61	14.01	27.61	23.55	15.8	15.32	20.99	19.46	14.84	12.12	13.22	19.2
UNKNOWN	37.41	31.58	34.77	44.44	22	17.22	32.27	41.11	22	20.33	29.87	37.67
% E or better	5.9%	7.4%	12.4%	17.8%	18.2%	16.6%	17.5%	34.2%	34.3%	29.0%	35.5%	35.1%

VOLUME '000s	Q1 1999	Q2 1999	Q3 1999	Q4 1999	Q1 2000	Q2 2000	Q3 2000	Q4 2000	Q1 2001	Q2 2001	Q3 2001	Q4 2001
CHEST FREEZERS	**60.21**	**57.02**	**83.5**	**107.9**	**67.69**	**61.39**	**79.75**	**117.2**	**73.55**	**64.91**	**91.62**	**119.4**
ENERGY CLASS A	0.56	0.49	1.07	0.96	2.38	2.57	2.7	3.62	3.53	2.49	4.57	6.3
ENERGY CLASS B	1.16	1.12	1.99	2.2	1.08	0.86	1.47	1.67	1	1.15	1.85	1.68
ENERGY CLASS C	6.73	7.38	14.12	9.37	15.94	12.77	14.69	21.45	13.54	16.62	30.32	44.43
ENERGY CLASS D	9.17	8.91	15.28	26.5	19.52	17.88	24.22	32.05	25.14	21.25	29.48	35.33
ENERGY CLASS E	2.21	2.58	8.39	26.16	18.59	18.18	27.85	48.53	24.26	18.82	16.16	18.99
ENERGY CLASS F	9.27	10.24	11.66	18.99	3.11	2.48	3.28	4.14	2.38	1.88	3.7	6.19
ENERGY CLASS G	19.79	11.15	12.38	4.39	2.25	1.39	1.84	1.97	1.36	1.17	1.36	0.72
UNKNOWN	11.33	15.17	18.62	19.33	4.83	5.25	3.71	3.78	2.36	1.54	4.18	5.75
% E or better	40.6%	48.9%	63.0%	73.6%	91.5%	93.1%	93.3%	94.6%	94.7%	95.2%	94.2%	93.9%

Annual Sales	1996	1997	1998	1999	2000	2001
ENERGY CLASS A	0.2	2.4	2.3	3.1	11.3	16.9
ENERGY CLASS B	2.8	4.6	3.7	6.5	5.1	5.7
ENERGY CLASS C	0.8	12.0	34.7	37.6	64.9	104.9
ENERGY CLASS D	7.6	16.7	16.6	59.9	93.7	111.2
ENERGY CLASS E	4.4	6.1	5.6	39.3	113.2	78.2
ENERGY CLASS F	27.1	69.5	63.8	50.2	13.0	14.2
ENERGY CLASS G	80.8	71.6	59.4	47.7	7.5	4.6
UNKNOWN	148.2	112.6	109.9	64.5	17.6	13.8
TOTAL	271.8	295.5	296.0	308.7	326.1	349.5
Pro rata of unknowns						
ENERGY CLASS A	0.40	3.91	3.71	3.89	11.91	17.59
ENERGY CLASS B	6.07	7.45	5.82	8.18	5.37	5.91
ENERGY CLASS C	1.69	19.37	55.17	47.52	68.54	109.23
ENERGY CLASS D	16.67	27.00	26.45	75.66	99.01	115.78
ENERGY CLASS E	9.66	9.82	8.97	49.72	119.59	81.45
ENERGY CLASS F	59.62	112.25	101.39	63.40	13.75	14.73
ENERGY CLASS G	177.66	115.64	94.44	60.30	7.87	4.80
TOTAL	271.8	295.5	296.0	308.7	326.1	349.5

Relative energy use of the different energy classes (kWh/year)

ENERGY CLASS A	188
ENERGY CLASS B	245
ENERGY CLASS C	309
ENERGY CLASS D	358
ENERGY CLASS E	395
ENERGY CLASS F	441
ENERGY CLASS G	489

Hence average energy use per new appliance in each year (kWh/year)

1996	1997	1998	1999	2000	2001
460	434	416	394	360	346

Hence saving per new appliance in each year relative to 1996 (kWh/year)

1996	1997	1998	1999	2000	2001
0	27	44	66	100	114

Hence national saving due to new appliances in each year, relative to 1996

	1996	1997	1998	1999	2000	2001
In kWh/year	0	7853316	13164366	20504791	32749096	39929423
In GJ/year	0	28272	47392	73817	117897	143746
In PJ/year	0.000	0.028	0.047	0.074	0.118	0.144
In PJ/year cumulative	0.000	0.028	0.076	0.149	0.267	0.411
Carbon factor for elect.	0.0386252	0.035172	0.035809	0.035018	0.035045	0.039055
In MtC/year	0	0.000994	0.001697	0.002585	0.004132	0.005614
In MtC/year cumulative	0	0.000994	0.002709	0.005235	0.00937	0.016056

Summed savings to end of stated year

	1996	1997	1998	1999	2000	2001
In PJ/year	0.000	0.028	0.104	0.253	0.521	0.932
In MtC/year	0.000	0.001	0.004	0.009	0.018	0.034

Table B12. Sales of washing machines by energy band and savings achieved due to labelling and minimum standards

TOTAL MARKET

VOLUME '000s	Q1 1996	Q2 1996	Q3 1996	Q4 1996	Q1 1997	Q2 1997	Q3 1997	Q4 1997	Q1 1998	Q2 1998	Q3 1998	Q4 1998	Q1 1999	Q2 1999	Q3 1999	Q4 1999	Q1 2000	Q2 2000	Q3 2000	Q4 2000	Q1 2001	Q2 2001	Q3 2001	Q4 2001
AUTO WASHING MACHINE	**410.1**	**374.4**	**396.2**	**384.1**	**412.8**	**388.7**	**429.6**	**425.2**	**465**	**422.6**	**463.9**	**440.1**	**512.6**	**466.1**	**478.6**	**471.9**	**553.7**	**487.7**	**506.1**	**523.7**	**588.1**	**538.6**	**552.2**	**538**
ENERGY CLASS A						0.1	0.3	0.7	0.8	7.5	23.2	30.2	44.4	52	55.6	53.1	66.2	67.5	144.3	213.7	243.3	231.2	263.3	268
ENERGY CLASS B			85.5	93.7	99	143.8	154.1	161.8	164.3	158.5	159.5	167.6	200	185.6	196.9	190.9	224.6	228.9	191.9	182.9	225.4	230	217.7	184.7
ENERGY CLASS C			125	113.3	127.3	97.6	132.3	139.8	175.9	179.5	205.1	196	228.1	192.5	200.8	199.4	236.6	177.7	149.8	109	93.5	66.1	59.3	71.8
ENERGY CLASS D			21.4	39.1	37.7	27	10.7	5.1	5.1	7.2	8.2	5.2	1.3	3.9	5.4	7.5	1	0.7	0.8	0.3	0.3	0.1	1.1	0.9
ENERGY CLASS E												0.2	0.2										0.1	0.1
ENERGY CLASS F			2.7	2.6	4.9	2.3	0.4																	
ENERGY CLASS G			2.7	2.7	2.6	2.7	3.6	3	3.1	2.9	2.5	2.8	2.6	1.5	0.5	0.1	0.1			0.1			0.2	0.4
UNKNOWN	410.1	374.4	158.9	132.6	141.3	115.3	128.2	114.9	115.8	67	65.4	38	36	30.6	19.4	20.9	25.3	12.8	19.3	17.8	25.6	11.1	10.5	12
% C or better			88.7%	82.3%	83.4%	88.3%	95.1%	97.4%	97.7%	97.2%	97.3%	98.0%	99.1%	98.8%	98.7%	98.3%	99.8%	99.9%	99.8%	99.9%	99.9%	100.0%	99.7%	99.7%
% D or better			97.7%	97.9%	97.2%	98.2%	98.7%	99.0%	99.1%	99.2%	99.4%	99.3%	99.4%	99.7%	99.9%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	99.9%	99.9%

Annual Sales	1996	1997	1998	1999	2000	2001
ENERGY CLASS A	0.0	1.1	61.7	205.1	491.7	1005.8
ENERGY CLASS B	179.2	558.7	649.9	773.4	828.3	857.8
ENERGY CLASS C	238.3	497.0	756.5	820.8	673.1	290.7
ENERGY CLASS D	60.5	80.5	25.7	18.1	2.8	2.4
ENERGY CLASS E	0.0	0.0	0.2	0.2	0.0	0.2
ENERGY CLASS F	5.3	7.6	0.0	0.0	0.0	0.0
ENERGY CLASS G	5.4	11.9	11.3	4.7	0.2	0.6
UNKNOWN	1076.0	499.7	286.2	106.9	75.2	59.2
TOTAL	1564.7	1656.5	1791.5	1929.2	2071.3	2216.7
Pro rata of unknowns						
ENERGY CLASS A	0.00	1.58	73.43	217.13	510.22	1033.40
ENERGY CLASS B	573.76	800.04	773.46	818.77	859.50	881.34
ENERGY CLASS C	762.98	711.69	900.33	868.95	698.46	298.68
ENERGY CLASS D	193.71	115.27	30.59	19.16	2.91	2.47
ENERGY CLASS E	0.00	0.00	0.24	0.21	0.00	0.21
ENERGY CLASS F	16.97	10.88	0.00	0.00	0.00	0.00
ENERGY CLASS G	17.29	17.04	13.45	4.98	0.21	0.62
TOTAL	1564.7	1656.5	1791.5	1929.2	2071.3	2216.7

Relative energy use of the different energy classes (kWh/year)

ENERGY CLASS A	180
ENERGY CLASS B	223
ENERGY CLASS C	266
ENERGY CLASS D	307
ENERGY CLASS E	350
ENERGY CLASS F	393
ENERGY CLASS G	435

Hence average energy use per new appliance in each year (kWh/year)

1996	1997	1998	1999	2000	2001
258	250	246	239	227	209

Hence saving per new appliance in each year relative to 1996 (kWh/year)

1996	1997	1998	1999	2000	2001
0	8	13	20	32	50

Hence national saving due to new appliances in each year, relative to 1996

	1996	1997	1998	1999	2000	2001
In kWh/year	0	13251046	22795349	37954899	65274374	109897435
In GJ/year	0	47704	82063	136638	234988	395632
In PJ/year	0.000	0.048	0.082	0.137	0.235	0.396
In PJ/year cumulative	0.000	0.048	0.130	0.266	0.501	0.897
Carbon factor for elect.	0.038625	0.035172	0.035809	0.035018	0.035045	0.0390545
In MtC/year	0	0.001678	0.002939	0.004785	0.008235	0.0154512
In MtC/year cumulative	0	0.001678	0.004647	0.009329	0.017572	0.0350329

Summed savings to end of stated year

	1996	1997	1998	1999	2000	2001
In PJ/year	0.000	0.048	0.177	0.444	0.945	1.842
In MtC/year	0.000	0.002	0.006	0.016	0.033	0.068

Table B13. Sales of gas boilers by efficiency band (thousands) and the savings due to labelling and minimum standards

	A	B	C	D	E	F	G	TOTAL	% sales at D or better	% sales at B or better	% sales at F or better	Average new boiler efficiency	Average delivered energy (GJ)	Equivalent if efficiency remains at 1992 level	Saving relative to 1992 (GJ)	Savings of boilers sold in that year relative to 1992 (PJ)	Savings in that year of all boilers sold since 1992 (PJ)	Savings in that year of all boilers sold since 1992 (MtC)
1970	0	0	0	0	0	0	301	301	0.0%	0.0%	0.0%	69.0%	37.3					
1971	0	0	0	0	0	0	394	394	0.0%	0.0%	0.0%	69.0%	40.9					
1972	0	0	0	0	0	0	491	491	0.0%	0.0%	0.0%	69.0%	47.2					
1973	0	0	0	0	0	0	470	470	0.0%	0.0%	0.0%	69.0%	48.6					
1974	0	0	0	0	0	0	523	523	0.0%	0.0%	0.1%	69.0%	52.4					
1975	0	0	0	0	0	1	513	514	0.0%	0.0%	0.1%	69.0%	56.4					
1976	0	0	0	0	0	1	539	540	0.0%	0.0%	0.2%	69.0%	54.6					
1977	0	0	0	0	0	2	682	685	0.0%	0.0%	0.4%	69.0%	53.4					
1978	0	0	0	0	0	6	779	785	0.0%	0.0%	0.7%	69.0%	57.6					
1979	0	0	0	0	0	7	591	598	0.0%	0.0%	1.1%	69.0%	60.5					
1980	0	0	0	0	0	12	569	581	0.0%	0.0%	2.1%	69.1%	59.7					
1981	0	0	0	0	0	22	644	666	0.0%	0.0%	3.4%	69.1%	60.0					
1982	0	0	0	0	1	45	696	742	0.0%	0.0%	6.1%	69.2%	57.9					
1983	0	0	0	0	1	65	636	704	0.1%	0.0%	9.6%	69.3%	56.0					
1984	0	0	1	0	3	100	644	748	0.2%	0.1%	14.0%	69.4%	55.9					
1985	0	1	1	0	8	164	722	896	0.2%	0.1%	19.4%	69.6%	60.0					
1986	0	2	2	0	21	244	717	986	0.4%	0.2%	27.3%	69.9%	60.0					
1987	0	2	3	0	41	307	627	980	0.5%	0.2%	36.0%	70.3%	60.7					
1988	0	4	3	0	53	321	500	882	0.8%	0.4%	43.3%	70.6%	59.4					
1989	0	4	3	1	73	294	401	776	1.1%	0.5%	48.4%	70.9%	55.8					
1990	0	5	3	2	102	305	343	760	1.3%	0.6%	54.9%	71.2%	57.1					
1991	0	6	2	6	166	307	281	768	1.8%	0.8%	63.4%	71.9%	62.4					
1992	0	8	2	12	246	322	250	841	2.7%	1.0%	70.3%	72.4%	59.5	59.5	0.0	0.00	0.00	0.000
1993	0	17	3	24	335	325	191	897	5.0%	2.0%	78.7%	73.3%	60.0	60.6	0.7	0.61	0.61	0.009
1994	0	16	2	41	365	289	116	829	7.2%	2.0%	86.0%	73.9%	56.7	57.9	1.2	0.96	1.56	0.023
1995	1	27	3	74	440	270	66	881	11.9%	3.2%	92.5%	74.8%	55.1	56.9	1.8	1.58	3.15	0.046
1996	1	31	3	131	494	229	47	936	17.7%	3.4%	95.0%	75.5%	64.9	67.7	2.7	2.55	5.70	0.084
1997	1	40	5	203	532	215	31	1028	24.3%	4.0%	97.0%	76.1%	59.4	62.4	3.0	3.07	8.78	0.129
1998	3	48	7	258	574	192	28	1110	28.5%	4.6%	97.4%	76.5%	57.7	60.9	3.2	3.57	12.35	0.181
1999	21	34	18	319	608	177	13	1190	33.0%	4.7%	98.9%	77.0%	56.9	60.4	3.5	4.21	16.56	0.241
2000	19	26	18	399	566	145	17	1190	38.8%	3.8%	98.6%	77.2%	57.5	61.3	3.8	4.50	21.06	0.307
2001	56	22	13	676	387	88	7	1249	61.4%	6.2%	99.4%	78.6%	56.0	60.8	4.8	5.97	27.03	0.397
2002	132	8	12	1114	66	6	0	1337	94.7%	10.5%	100.0%	80.8%	54.1	60.4	6.2	8.34	35.37	0.519

Table B14. Completions of new dwellings in Great Britain and the savings due to improved Building Regulations

		Estimated total space and water heating consumptions (PJ/year) of homes built that year				Estimated total space and water heating consumptions (PJ/year) of homes built that year if they had been built to the 1965 Regulations				Savings due to Building Regulations improvements of homes built in that year (PJ/year)				Savings in that year due to Building Regulations improvements - for all homes built since the introduction of the 1976 Building Regulations (PJ/year)					Savings in that year due to Building Regulations improvements - for all homes built since the introduction of the 1976 Building Regulations (MtC/year)				
Year	Completions	Gas	Electric	Solid	Oil/other	Gas	Electric	Solid	Oil/other	Gas	Electric	Solid	Oil/other	Gas	Electric	Solid	Oil/other	Total	Gas	Electric	Solid	Oil/other	Total
1970	350,392	14.3	5.0	9.9	2.5	14.3	5.0	9.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
1971	350,559	14.4	5.2	9.2	2.6	14.4	5.2	9.2	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
1972	319,286	13.3	4.8	7.8	2.5	13.3	4.8	7.8	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
1973	294,080	12.5	4.5	6.6	2.3	12.5	4.5	6.6	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
1974	269,561	11.8	4.1	5.5	2.2	11.8	4.1	5.5	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
1975	313,084	13.9	4.9	5.8	2.5	13.9	4.9	5.8	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
1976	315,254	14.9	4.5	5.7	2.4	14.9	4.5	5.7	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
1977	303,398	15.4	3.9	4.7	2.3	15.4	3.9	4.7	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
1978	279,846	11.1	2.8	2.9	1.6	14.6	3.7	3.8	2.0	3.5	0.9	0.9	0.5	3.5	0.9	0.9	0.5	5.7	0.05	0.06	0.02	0.01	0.14
1979	244,570	10.4	2.2	2.2	1.2	13.7	2.9	2.9	1.6	3.2	0.7	0.7	0.4	6.7	1.5	1.6	0.9	10.7	0.10	0.11	0.04	0.02	0.27
1980	235,545	10.4	1.9	2.1	1.0	13.7	2.5	2.8	1.3	3.2	0.6	0.7	0.3	9.9	2.2	2.2	1.2	15.5	0.15	0.15	0.06	0.02	0.38
1981	199,805	9.1	1.5	1.7	0.8	11.9	2.0	2.2	1.0	2.8	0.5	0.5	0.2	12.8	2.6	2.8	1.4	19.6	0.19	0.19	0.07	0.03	0.47
1982	175,830	8.2	1.3	1.3	0.7	10.8	1.7	1.8	0.9	2.6	0.4	0.4	0.2	15.3	3.0	3.2	1.6	23.1	0.23	0.20	0.08	0.03	0.54
1983	199,320	9.7	1.3	1.3	0.7	12.7	1.7	1.8	0.9	3.0	0.4	0.4	0.2	18.3	3.4	3.6	1.8	27.2	0.27	0.23	0.09	0.04	0.62
1984	209,950	8.7	1.3	0.9	0.5	13.4	2.1	1.5	0.8	4.8	0.7	0.5	0.3	23.1	4.2	4.1	2.1	33.5	0.34	0.26	0.10	0.04	0.75
1985	196,695	8.2	1.2	0.9	0.5	12.7	1.8	1.4	0.8	4.5	0.6	0.5	0.3	27.6	4.8	4.6	2.4	39.4	0.41	0.30	0.12	0.05	0.87
1986	206,347	8.9	1.0	0.8	0.5	13.8	1.6	1.3	0.7	4.9	0.6	0.5	0.3	32.5	5.4	5.1	2.7	45.6	0.48	0.34	0.13	0.05	1.00
1987	216,439	9.4	1.1	0.7	0.6	14.5	1.7	1.1	0.9	5.2	0.6	0.4	0.3	37.7	6.0	5.5	3.0	52.1	0.55	0.37	0.14	0.06	1.12
1988	232,428	10.0	1.3	0.6	0.6	15.5	2.0	1.0	0.9	5.5	0.7	0.3	0.3	43.2	6.7	5.8	3.3	59.0	0.64	0.39	0.15	0.07	1.24
1989	211,180	9.1	1.2	0.4	0.5	14.1	1.9	0.6	0.8	5.0	0.7	0.2	0.3	48.2	7.4	6.0	3.6	65.2	0.71	0.42	0.15	0.07	1.36
1990	195,461	7.4	1.0	0.3	0.5	12.8	1.8	0.6	0.9	5.4	0.7	0.2	0.4	53.6	8.1	6.3	3.9	71.9	0.79	0.47	0.16	0.08	1.50
1991	184,726	6.9	1.0	0.3	0.4	12.0	1.8	0.6	0.7	5.0	0.8	0.2	0.3	58.6	8.9	6.5	4.2	78.2	0.86	0.48	0.17	0.09	1.60
1992	171,708	6.5	1.0	0.2	0.3	11.2	1.8	0.3	0.5	4.7	0.7	0.1	0.2	63.3	9.6	6.6	4.4	84.0	0.93	0.50	0.17	0.09	1.69
1993	178,813	6.8	1.1	0.1	0.3	11.7	1.9	0.2	0.5	4.9	0.8	0.1	0.2	68.2	10.4	6.7	4.6	90.0	1.00	0.48	0.15	0.09	1.73
1994	186,413	7.0	1.2	0.0	0.3	12.1	2.1	0.0	0.5	5.1	0.9	0.0	0.2	73.3	11.3	6.7	4.8	96.2	1.08	0.51	0.16	0.10	1.84
1995	191,278	7.2	1.3	0.0	0.3	12.5	2.2	0.0	0.5	5.2	0.9	0.0	0.2	78.6	12.3	6.7	5.0	102.6	1.16	0.53	0.15	0.10	1.94
1996	180,386	6.8	1.2	0.0	0.3	11.8	2.1	0.0	0.5	4.9	0.9	0.0	0.2	83.5	13.1	6.7	5.2	108.6	1.23	0.51	0.15	0.11	1.99
1997	180,906	6.8	1.2	0.0	0.3	11.8	2.1	0.0	0.4	5.0	0.9	0.0	0.2	88.5	14.0	6.7	5.4	114.6	1.30	0.49	0.15	0.11	2.05
1998	169,645	6.4	1.1	0.0	0.3	11.1	1.8	0.0	0.6	4.6	0.8	0.0	0.2	93.1	14.8	6.7	5.6	120.3	1.36	0.53	0.15	0.12	2.15
1999	172,633	6.5	1.1	0.0	0.3	11.2	1.9	0.0	0.6	4.7	0.8	0.0	0.2	97.8	15.6	6.7	5.9	126.0	1.42	0.55	0.15	0.12	2.23
2000	167,328	6.3	1.0	0.0	0.4	10.9	1.7	0.0	0.7	4.6	0.7	0.0	0.3	102.4	16.3	6.7	6.2	131.6	1.49	0.57	0.15	0.12	2.33
2001	162,032	6.1	1.0	0.0	0.4	10.6	1.7	0.0	0.6	4.4	0.7	0.0	0.3	106.9	17.0	6.7	6.4	137.0	1.57	0.66	0.14	0.13	2.50

Table B15. Summary of energy and carbon savings due to energy-efficiency policies

Savings in the stated year (PJ)	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Summation 1978 to 2001
Building Regulations	5.70	10.69	15.49	19.56	23.14	27.19	33.51	39.43	45.65	52.12	59.00	65.19	71.94	78.24	84.03	90.01	96.22	102.59	108.60	114.61	120.26	126.01	131.60	137.00	1657.8
Loft, cavity wall and condensing boiler grants	3.28	17.93	28.55	36.11	45.91	55.46	62.07	67.54	72.57	77.06	79.37	80.46	80.88	81.50	82.27	83.18	85.14	88.00	90.76	93.83	97.08	100.78	105.35	109.93	1725.0
Loft insulation grants	3.28	17.93	28.55	36.11	45.91	55.46	62.07	67.54	72.57	77.06	79.37	80.46	80.88	81.50	82.27	83.18	84.83	87.09	88.84	89.93	90.88	91.84	93.02	94.36	1674.9
Cavity wall insulation grants																	0.32	0.91	1.82	3.65	5.76	8.24	10.91	13.27	44.9
Condensing boiler grants																			0.10	0.25	0.45	0.70	1.41	2.30	5.2
Labelling and minimum standards for boilers (exc. effect of grants)																0.61	1.56	3.15	5.60	8.53	11.90	15.86	19.65	24.73	91.6
Labelling and minimum standards for boilers (inc. effect of grants)																0.61	1.56	3.15	5.70	8.78	12.35	16.56	21.06	27.03	96.8
Labelling and minimum standards for cold and wet appliances																				0.10	0.37	1.12	2.47	4.42	8.5
Labelling and minimum standards for refrigerators																				0.01	0.04	0.10	0.22	0.40	0.8
Labelling and minimum standards for fridge-freezers																				0.01	0.10	0.48	1.19	2.17	3.9
Labelling and minimum standards for upright freezers																				0.01	0.03	0.12	0.30	0.54	1.0
Labelling and minimum standards for chest freezers																				0.03	0.08	0.15	0.27	0.41	0.9
Labelling and minimum standards for washing machines																				0.05	0.13	0.27	0.50	0.90	1.8
Total savings of above energy efficiency policies	8.98	28.61	44.04	55.68	69.06	82.65	95.58	106.97	118.22	129.17	138.37	145.65	152.82	159.74	166.30	173.80	182.93	193.74	204.96	217.07	229.62	243.78	259.07	276.08	3482.9

Savings in the stated year (MtC)	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Summation 1978 to 2001
Building Regulations	0.144	0.267	0.381	0.472	0.543	0.625	0.748	0.874	0.996	1.124	1.243	1.356	1.504	1.596	1.689	1.731	1.843	1.943	1.995	2.055	2.153	2.233	2.331	2.499	32.34
Loft, cavity wall and condensing boiler grants	0.070	0.383	0.580	0.708	0.876	1.040	1.130	1.271	1.371	1.448	1.471	1.469	1.473	1.480	1.483	1.444	1.502	1.567	1.615	1.652	1.734	1.777	1.832	1.942	31.32
Loft insulation grants	0.070	0.383	0.580	0.708	0.876	1.040	1.130	1.271	1.371	1.448	1.471	1.469	1.473	1.480	1.483	1.444	1.483	1.518	1.534	1.531	1.560	1.558	1.571	1.638	30.09
Cavity wall insulation grants																	0.019	0.049	0.079	0.118	0.167	0.209	0.241	0.270	1.15
Condensing boiler grants																			0.001	0.004	0.007	0.010	0.021	0.034	0.08
Labelling and minimum standards for boilers (exc. effect of grants)																0.009	0.023	0.046	0.082	0.125	0.174	0.231	0.286	0.363	1.34
Labelling and minimum standards for boilers (inc. effect of grants)																0.009	0.023	0.046	0.084	0.129	0.181	0.241	0.307	0.397	1.42
Labelling and minimum standards for cold and wet appliances																				0.003	0.013	0.039	0.087	0.173	0.32
Labelling and minimum standards for refrigerators																				0.000	0.001	0.004	0.008	0.016	0.03
Labelling and minimum standards for fridge-freezers																				0.000	0.003	0.017	0.042	0.085	0.15
Labelling and minimum standards for upright freezers																				0.000	0.001	0.004	0.010	0.021	0.04
Labelling and minimum standards for chest freezers																				0.001	0.003	0.005	0.009	0.016	0.03
Labelling and minimum standards for washing machines																				0.002	0.005	0.009	0.018	0.035	0.07
Total savings of above energy efficiency policies	0.213	0.650	0.960	1.180	1.419	1.665	1.878	2.145	2.367	2.572	2.715	2.825	2.977	3.076	3.172	3.184	3.368	3.557	3.691	3.836	4.074	4.281	4.536	4.976	65.32

Part 3. Possible scenarios for future domestic energy use and carbon emissions to 2050

SUMMARY

This part of the report describes a set of scenarios showing energy consumption and carbon emissions from the domestic sector up to 2050.

Calculations are made using an Excel model linked to the BREHOMES model of housing stock energy use. S-curves developed from past data for the uptake of energy efficiency measures provide data for the model.

In order to further increase carbon savings in the domestic sector changes to heating systems to introduce low carbon technologies, use of solar panels and photovoltaics are considered. In addition it is assumed that grid electricity moves towards a greater proportion of low carbon generation.

Five scenarios are presented. A reference scenario describes what is likely to happen if the uptake of energy efficiency measures continues to follow historical trends. Although savings may be achieved for an individual dwelling due to increased insulation, overall levels of energy consumption will rise with the increasing number of households in this scenario.

The policy scenario includes known policies up to 2011. This gives a 0.1% energy saving in 2010 and a 19.6% energy increase in 2050 in the total stock compared to 2000. The corresponding carbon saving is 2.8% in 2010 and an increase of 10.7% in 2050.

The efficiency scenario increases the uptake of energy efficiency measures to the fastest rate that seems feasible (e.g. based on the fastest historical rates seen). This gives a 6.9% energy saving in 2010 and a 2.2% saving in 2050 in the total stock compared to 2000. The corresponding carbon saving is 10.1% in 2010 and 8% in 2050.

In order to increase the carbon saving a set of step change scenarios was developed. Two of them are presented. These follow the efficiency scenario up to 2015 and then introduce further low carbon technologies after this. Thus, it is assumed for the step change scenarios that low carbon options for heating and electricity generation could be developed and introduced by 2015, after which they would need to be rapidly deployed.

The step change 1 scenario gives a 6.9% energy saving in 2010 and 8.6% in 2050 compared to 2000. The corresponding carbon saving is 10.1% in 2010 and 26.8% in 2050.

In order to reach a carbon saving of 60% the step change 2 scenario considers a greater uptake of low carbon heating systems. This gives an energy saving in 2010 of 6.9% and 19.9% in 2050 compared to 2000. The corresponding carbon saving is 10.1% in 2010 and 60.7% in 2050.

The costs and savings of each of the scenarios, relative to the reference scenario, are examined. Overall cumulative costs are about £10bn for the policy scenario, £22bn for the efficiency scenario, £34bn for step change 1 scenario, and £55bn for step change 2 scenario. However, in all scenarios the cumulative savings outweigh the costs by about 2012 indicating that, considered as an entire package, each of the scenarios would be cost effective for society as a whole. Iterative calculation indicates that all the scenarios would be cost effective at a discount rate of 17.1% or less.

3.1 INTRODUCTION

Energy consumption in the average British dwelling in 2001 (80.8 GJ) was slightly lower than consumption in 1974 (82.2 GJ) [(1)]. This is despite a large increase in the number of dwellings with central heating. Increasing levels of insulation both for new homes and as additions in existing dwellings, together with improvements to heating efficiencies, have thus successfully contained the energy use of the average household. Changes to the Building Regulations and the existence of grant schemes for measures such as loft insulation and cavity wall insulation have clearly had an important effect, as discussed in Part 2 of this report.

In developing scenarios it is necessary to take into account the trends that have been seen in the past, as outlined above. These are projected forward with adjustments for known distinct changes such as increases in grant levels.

Since most insulation measures will have been installed in all possible existing dwellings before 2050 it is necessary to look in more detail at possible efficient, low carbon, heating systems that might be available in the future if further savings are to be made.

The ultimate goal is a carbon neutral dwelling. This can be achieved by a combination of measures. Firstly the energy consumption should be as low as possible. Heating is currently the main energy use so insulation to ensure that as little heat as possible is lost from the house is important. The type of fuel and efficiency of the heating system will determine the amount of carbon emitted.

The step change scenarios presented in this part of the report look at ways of achieving a 60% carbon saving by 2050. This has been achieved by an increasing use of solar panels, photovoltaics, heat pumps and biomass boilers together with an electricity supply increasingly generated by low carbon sources.

3.2 GENERAL ASSUMPTIONS

The uptake of a product or measure can be assumed to be proportional to time and the size of the remaining market. This can be described by an equation of the form:

$$L\%=S\%\{1-\exp(-k(t-t^0)^2\}$$

Where L% is the ownership level in a particular year
S% is the eventual saturation level
t is the time (i.e. the year)
t_0 is the year when the product or measure was first introduced
k is a constant that describes the rate of uptake (i.e. describes the shape of the s-curve)

This equation has the classic s-curve shape that is seen for most products as they go through the three stages of relatively slow initial uptake, followed by a much faster rate as they become mass market products and finally another slow uptake as the product approaches saturation level.

The reference, policy and efficiency scenarios have been built using s-curves for the uptake of insulation products. In the reference scenario these are assumed to follow current trends based on historical data up to 2001. The policy scenario includes known policies such as those described in the EEC consultation document [(2)], the Building Regulations consultation [(3)] and the Government's Energy Efficiency Action Plan [(4)].

These insulation improvements are modelled together with information on the efficiency of heating systems from the Market Transformation programme [(5)] and details of energy use for lights and appliances and cooking from DECADE [(6)].

Previous work for the Market Transformation Programme on windows [(7)] is used to determine savings due to glazing improvements through labelling initiatives, and work on cooling [(8)] provides the basis for the likely additional energy use for domestic cooling which is assumed to be the same in each scenario.

For the efficiency scenario solid wall insulation has also been included.

A mean internal temperature of 22°C maximum has been assumed. Although higher than the assumption for previous scenarios it is based on recent German research [(9)] that suggests this is the level at which people living in low energy 'passive' houses are comfortable. It thus seems reasonable to take this as representing the typical level at which people will probably stop taking heat loss savings as comfort increases.

External temperature has been allowed to rise by 1.5°C by 2050. This is consistent with current trends and with climate scenarios produced by the Hadley Centre.

Data from the Clear Skies grant scheme and various other sources have been used to estimate uptake of solar panels [(10)]. A variety of sources, including data from the DTI Solar PV programme have also been referred to in order to produce similar estimates for the uptake of photovoltaics [(11)].

Little information is available on policies beyond 2020. Efficiencies of heating systems have been assumed to continue at 2020 levels and carbon emission factors have been assumed to maintain their 2020 values in the policy and efficiency scenarios. Insulation levels generally saturate at this time or soon afterwards following the s-curves that have already been derived for the different scenarios.

A forward projection of ODPM figures for households has been used and is the same in all scenarios, as is the rate of new build and dwelling demolition.

3.3 STEP CHANGE SCENARIO ASSUMPTIONS

In order to achieve the carbon savings necessary to meet a 60% saving in 2050 radical changes to heating systems and electricity generation have been considered.

A series of step change scenarios has been developed. These are based on the insulation measures achieved under the efficiency scenario but replace conventional heating systems with low carbon options. Each step change gives more dwellings low carbon sources of heating and electricity. As these are not yet mass-market products a time delay has been introduced to allow for development of the market. Thus, the efficiency scenario is followed until 2015 by which time it is expected that new technologies such as heat pumps will be increasingly available and will then start to be taken up in significant numbers.

Step change 1 increases the number of solar panels to 50% of dwellings by 2050. It also has 50% of dwellings with photovoltaics by 2050. In dwellings with electric central heating 50% have heat pumps in 2050 and all use these to heat their water. Similarly, in dwellings with solid fuel central heating 50% use wood, which is considered to be carbon neutral, by 2050. 50% of electricity is also assumed to be generated by low carbon sources by 2050. The numbers of homes heating with conventional gas and oil systems remain as in the efficiency scenario, with the same efficiencies assumed.

Step change 2 builds on the previous scenario but now has 50% of all centrally heated homes using heat pumps by 2050. A further 50% of the remaining central heating systems use wood / biomass by 2050. The remainder use the conventional heating systems that they would have used under the efficiency scenario, with the same efficiencies.

These steps are chosen to represent a possible progression to a low carbon domestic sector. They use technologies that are currently available, introduced on a timescale that seems feasible given past experience of how quickly the heating market can be transformed given the necessary conditions.

3.4 SCENARIO DESCRIPTIONS

Reference scenario

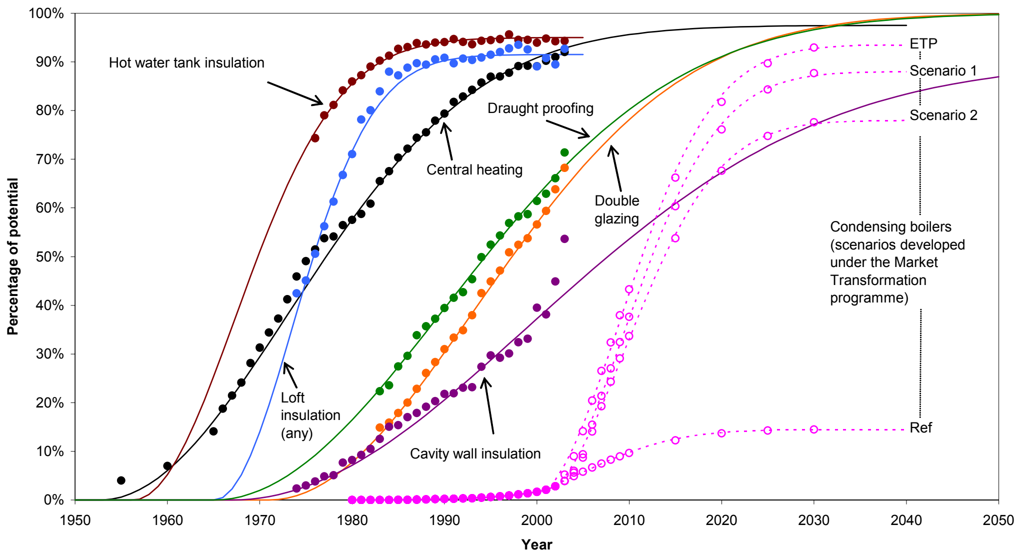
The reference scenario provides a base line for comparing scenarios. Figure 46 shows the s-curves used for the uptake of insulation and other energy efficiency measures. These are based on fitting curves to data collected over a number of years.

As can be seen in Figure 46 some measures such as hot water tank insulation are already close to saturation, whereas others such as cavity wall insulation will only be approaching saturation in 2050.

Policy scenario

Policies which have already been announced will change the rate of uptake of insulation measures shown in Figure 46. Figures from the documents referred to earlier [(2, 3, 4)] have been

Figure 46. Market penetration of home energy-efficiency related measures



used to derive new s-curves for existing dwellings and appropriate U-values for new dwellings. The figures for additional insulation measures in the 2005–2008 period and assumptions of similar measures in 2008–2011 have been used to increase the uptake rate of measures such as cavity wall and loft insulation in existing homes. For new dwellings typical U-values for 2005 and 2010, taken from the Building Regulations consultation, have been used.

Work under the Market Transformation Programme on the uptake of condensing boilers is illustrated in Figure 46. This shows the different uptake rates and saturation values that result from four different scenario assumptions. Three of the scenarios that are illustrated are used here. Scenario 2 assumes that it is possible for 80% of boiler sales to be condensing boilers, and this has been used for the policy scenario (similarly, Ref and ETP have been used for the reference and efficiency scenarios respectively).

Demand for lights and appliances and cooking have been taken from the DECADE scenario 1, which is a scenario that makes realistic assumptions about the rates at which energy efficient appliances might be taken up in practice (the DECADE reference and ETP scenarios have similarly been used for the reference and efficiency scenarios respectively).

Possible labelling-related improvements for double glazed windows have been taken from scenarios developed for the Market Transformation programme.

Data from the Clear Skies grant scheme and other sources has been used to estimate uptake rates for solar water heating panels. Various sources, including data from the DTI Solar PV programme, have been used to derive similar figures for photovoltaics. The resulting estimates suggest that by 2050 2.5% of roofs could have solar panels for water heating and 6.5% of dwellings could have photovoltaics to generate some of their electricity.

Efficiency scenario

The efficiency scenario looks at past uptake rates of insulation measures. It then uses the fastest rate of uptake that has been seen in the past as a guide to what could be achieved in future. It is assumed that if this rate of uptake has been possible before, the capacity is available to achieve that level of uptake again. It is then possible to derive a new s-curve for the future uptake.

By following this method cavity wall insulation reaches 100% of potential in about 2025 and most other insulation measures saturate before that.

For the efficiency scenario the ETP scenario for condensing boilers is used. This scenario is based on all that is economically and technically possible. Similarly for windows the fastest likely uptake scenario is used.

The DECADE model for lights and appliances and cooking also includes an ETP scenario which is used in the efficiency scenario.

Step change 1 scenario

The first step change scenario uses the uptake rates for insulation measures from the efficiency scenario. In order to provide further carbon savings low carbon and high efficiency heating systems are introduced. This approach is considered rather than radical measures like adding further external insulation to already insulated cavity walls, or demolishing large parts of the stock and replacing them with zero carbon dwellings, because it seems much more likely to be feasible, given that past experience has shown that the market for heating systems can be transformed dramatically in 30 years or so.

It is thus assumed that electric central heating is provided by heat pumps in 50% of dwellings with electric central heating by 2050. Similarly for solid fuel central heating 50% use wood or biomass boilers by 2050. For gas and oil heating the numbers of homes, and the efficiencies, are taken to be the same as in the efficiency scenario (i.e. this scenario assumes that there will be no change in the mix of generic forms of heating [gas, oil, solid and electric] as compared with the efficiency scenario, but it assumes that solid fuel and electric heating becomes less carbon intensive through the introduction of different appliances).

Heat pumps with an efficiency of 320% when used for heating and 160% when used for water heating have been assumed for the step change scenarios.

The step change scenarios also increase the uptake of solar water heating panels and photovoltaics. These increase to 50% of roofs having solar panels and 50% of dwellings having photovoltaics by 2050.

There are already targets for 20% of electricity to be generated by renewables in 2020. Technically it would be possible to generate 50% of electricity from low carbon sources by 2050 and this is also included in the step change scenarios.

Step change 2 scenario

Although the step change 1 scenario goes a long way towards using low carbon technologies it is not enough to achieve a 60% carbon saving. In order to achieve this it is necessary to increase the uptake of low carbon heating systems by fundamentally altering the mix of generic forms of heating from what is assumed in the efficiency scenario.

Thus, step change 2 increases the number of dwellings with heat pumps to 50% of dwellings that have central heating by 2050. Of those that do not have heat pumps for their central heating 50% use wood or biomass boilers by 2050. The remainder use the conventional heating systems that they would have had under the efficiency scenario.

Although heating systems are not replaced often it is possible over a period of 30 years or so to change a majority of heating systems. This is clearly demonstrated by the fact that in 1971 only 34% of dwellings had central heating but by 2001 this had risen to 90% (see Figure 46). Moreover, the bulk of this increase was accounted for by just one form of heating; namely gas central heating.

3.5 RESULTS

Figure 47 shows the energy consumption for each of the scenarios. The step change scenarios follow the efficiency scenario until 2015 but then lead to lower energy consumption. It is clear from the reference scenario that if no action is taken energy consumption will continue to rise and even the policy scenario only holds the consumption steady to about 2020, after which it begins to increase again.

Figure 48 shows the carbon emissions associated with the energy consumption in Figure 47. Step change 2 scenario diverges more rapidly from the efficiency scenario when considering carbon emissions. This is because the changes to heating systems and electricity generation have been aimed at saving carbon rather than energy.

Figure 48 also shows clearly that the only one of these scenarios that is going to reach the 60% saving by 2050 is step change 2. The others are either rising or decreasing at a rate that will not achieve the savings until much later than 2050.

Tables C1–C10 in Appendix C provide further details on the energy consumption and carbon emissions for each scenario by fuel and end use.

Figure 47. UK energy consumption for different scenarios

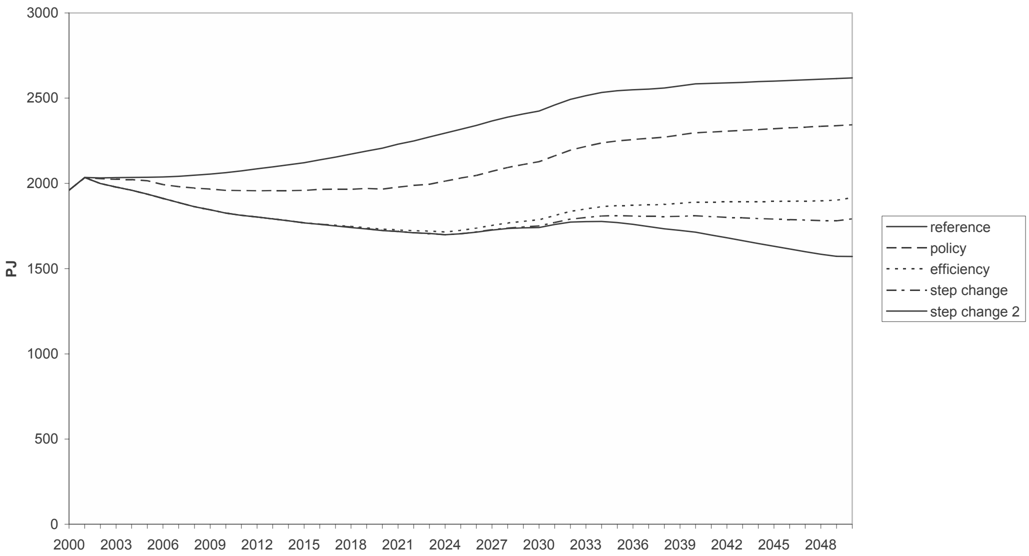


Figure 48. UK carbon emissions for different scenarios

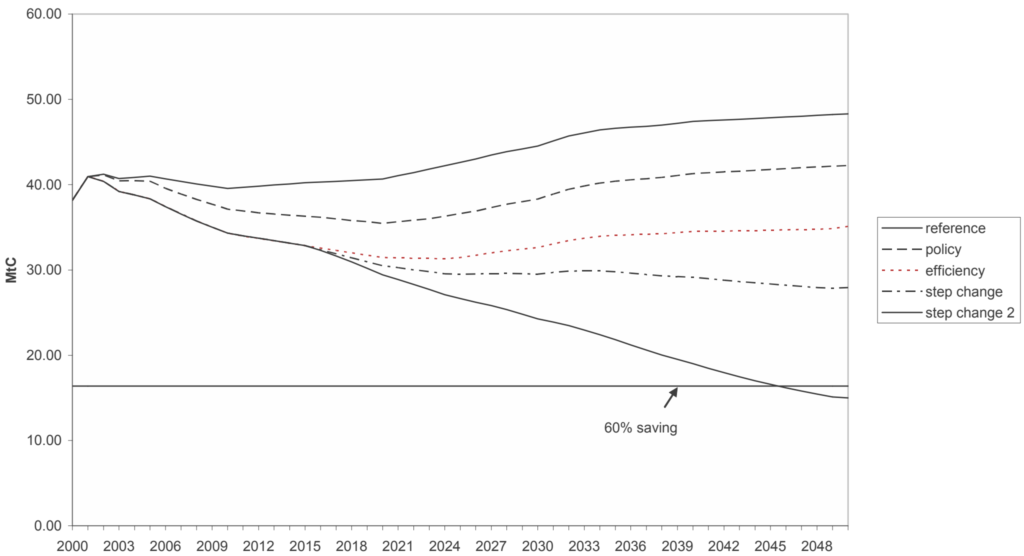


Table C1 shows increasing energy use and carbon emissions in the reference scenario. In general energy use for all end uses is rising. There is a slight fall in heating energy in 2045. This is due to the internal temperatures reaching saturation level. However by 2050 it is rising again due to an increase in the number of households. Carbon emissions remain at about 40 MtC until 2020 when they start to rise.

Table C3 shows energy use increasing to 2050 in the policy scenario after being held steady from 2010 to 2015. It is however 275 PJ lower than for the reference scenario in 2050. Carbon emissions are held to below 40 MtC until 2035 when they begin to rise. In 2050 they are 6 MtC less than the reference scenario.

Table C5 shows reducing energy consumption in the efficiency scenario until 2025 when it rises but by 2050 it has reached 603PJ less than the reference scenario in 2050 and 44 PJ less than the 2000 value. Carbon emissions are also less than in 2000 by 3 MtC.

Table C7 shows reducing energy consumption in the step change 1 scenario until 2025 and then rising to 2050. However by 2050 it is still 169PJ less than in 2000. For this scenario carbon emissions fall by 10 MtC between 2000 and 2050.

Table C9 for the step change 2 scenario also shows energy consumption reducing until 2025 when there is a small rise until it starts reducing again after about 2035. In 2050 it is 389 PJ less than in 2000. Carbon emissions between 2000 and 2050 fall by 23 MtC meeting a target of 60% reduction by 2050. More than half of this saving comes from heating systems. This comes with a change back to solid fuel and away from gas and oil. The solid fuel is no longer fossil fuel but sustainable biomass. Electricity consumption increases by 60 PJ between 2000 and 2050 but the carbon emissions decrease by 6 MtC as this is generated by an increasing proportion of low carbon sources.

Tables C11, C12 and C13 show the carbon emission factors used for each scenario. The reference, policy and efficiency scenarios all use the same emission factors. The electricity emission factors for the reference, policy and efficiency scenarios (Table C11) were provided by DTI up to 2020 [(12)]. The electricity emission factors after 2020 have been assumed to remain at the 2020 value for these scenarios. The electricity factors change for the step change scenarios where 50% of electricity is considered as generated by zero carbon sources in 2050. The solid fuel factors also change for the step change scenarios depending on the mix of biomass and fossil fuel.

The scenarios demonstrate the limit to current energy efficiency measures concentrating on insulation and condensing boilers. Growing household numbers mean total energy consumption in the domestic sector will increase even if individual household consumption decreases unless more extreme measures are taken.

The step change scenarios consider changes to heating systems and energy generation that are currently considered possible. These are already emerging technologies that, under the right conditions, in 30 years time could be mass-market products in the same way that loft insulation is now.

These are not the only solutions to achieving a 60% carbon reduction. New technologies may emerge but Figure 46 shows that it has taken many years for condensing boilers to reach the second mass market stage of uptake. Thus, it is clear that if measures are not taken soon to introduce low carbon technologies it will be extremely difficult to reach the 60% carbon reduction target by 2050.

3.6 COSTS AND SAVINGS OF THE SCENARIOS

Part 2 of this report looked at energy savings from energy efficiency policies including grants. This concluded that for each £1million of grant expenditure 0.033 PJ of energy is saved. This figure, converted into a cost per tonne of carbon using the average carbon emission factors implied by the reference scenario, has been used to estimate the costs and savings of the current scenarios. The savings have been worked out from applying current fuel prices taken from SAP 2005 (see Table C16) to the energy savings of each scenario relative to the reference scenario.

Policy scenario

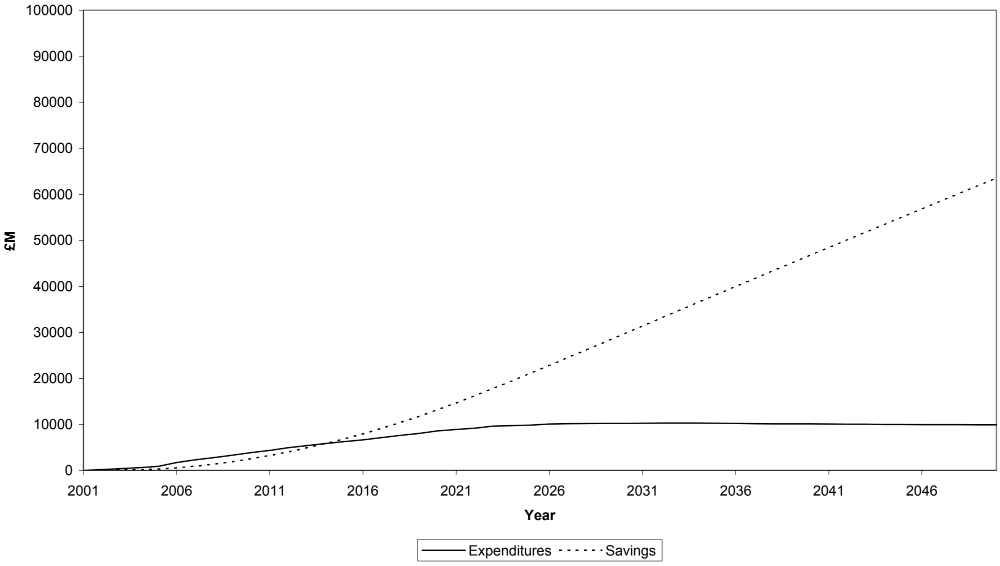
Figure 49 shows the cumulative expenditures for the policy scenario and the corresponding cumulative savings. These figures are also presented in Table C14, along with the corresponding figures for the efficiency scenario. The figures for the step change scenarios are shown in Table C15.

Figure 49 shows that initially costs outweigh savings but there is a break even point in about 2014. This implies that there is a discount rate below which the savings assessed over the period 2001 to 2050 will always be cost effective. In this case the discount rate is 19.2%. This is a relatively high figure and it suggests that the policy scenario taken as an entire package would be cost effective for society as a whole.

Efficiency scenario

Figure 50 shows the cost and savings for the efficiency scenario. This shows that savings outweigh costs slightly earlier than the policy scenario in about 2012. The discount rate at which this scenario is cost effective is similar to the policy scenario at 19.1%.

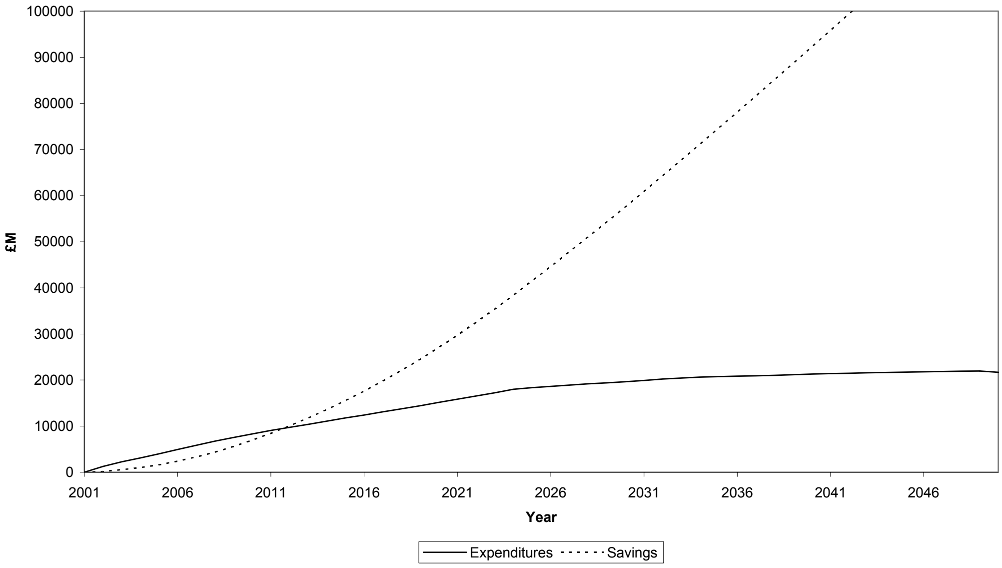
Figure 49. Cumulative expenditures and savings for the Policy scenario relative to the Reference scenario



It is interesting to note that the cumulative cost of this scenario is shown as being about £22bn (Table C14). This is very close to the figure derived from the work on the cost effectiveness of energy efficiency measures described in Part 1 of this report which indicated that exhausting all of the existing cost-effective potential for conventional energy efficiency measures would cost up to £21bn. Thus, the approximate method of estimating costs used in this part of the report matches the result of a detailed bottom-up approach to calculating costs extremely well.

This suggests that the figures obtained in the following for the step change scenarios should be broadly indicative of the likely costs, although it should be noted that there are likely to be costs associated with transforming the electricity supply system that the methodology does not fully capture (the fact that the methodology is based on carbon rather than energy does, however, mean that some cost is attributed to this). Such costs are, of course, not really anything directly to do with domestic energy efficiency policy and would generally be determined as a completely separate exercise.

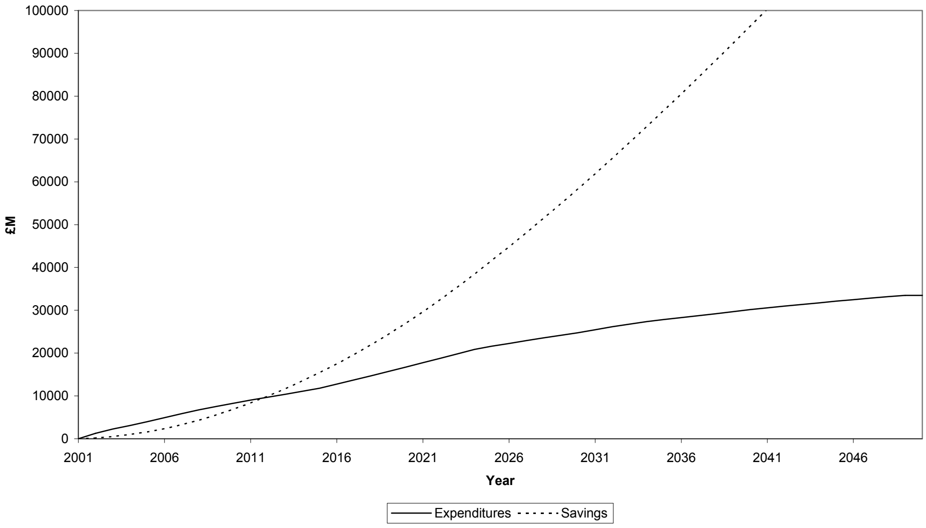
Figure 50. Cumulative expenditures and savings for the Efficiency scenario relative to the Reference scenario



Step change 1 scenario

Bearing in mind the caveats noted above, Figure 51 shows the likely costs and savings for step change 1 scenario. In this scenario savings also outweigh costs in about 2012. After 2025 costs start to rise more sharply in this scenario but savings still outweigh costs in the later years. The discount rate at which this scenario is cost effective is slightly lower at 18.6%.

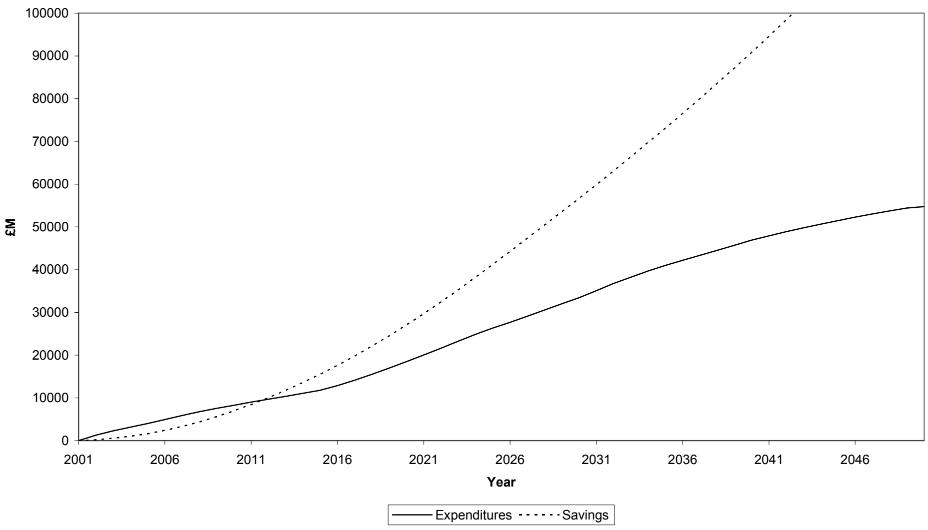
Figure 51. Cumulative expenditures and savings for Step change 1 scenario relative to the Reference scenario



Step change 2 scenario

Figure 52 shows the savings and costs for step change 2 scenario. This again shows that savings outweigh costs in 2012. It also shows that, although this is the highest cost scenario (cumulative costs of about £55bn), in the later years savings still continue to outweigh costs. The discount rate for this scenario is the lowest (17.1%) but this is still quite high, showing that all scenarios are likely to be cost effective for society when considered as entire packages.

Figure 52. Cumulative expenditures and savings for Step change 2 scenario relative to the Reference scenario



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10. A number of sources were consulted for information on solar water heating. These included savings figures quoted in the Digest of United Kingdom Energy Statistics, numerous websites that provided an indication of current ownership levels, and also, to check that uptake rate assumptions looked consistent, first year data on Clear Skies grant applications (personal communication Chris Roberts, BRE) was also checked.
11. Several sources were consulted for data on photovoltaics. These included the online information service of the British Photovoltaic Association (*www.pv-uk.org.uk*), the International Energy Agency website (*www.oja-services.nl/iea-pvps/statistics/index.htm*), the Digest of United Kingdom Energy Statistics, and, to check that uptake rate assumptions looked consistent, data on the DTI's Solar PV programme (*www.est.org.uk/solar/resources/agg_data.cfm*) was also checked.
12. Personal communication, David Wilson, DTI.

Appendix C: Tables

Table C1. Reference scenario summary by end use

Energy consumption by end use (PJ)

Year	Space heating	Water	Cooking	Lights and appliances	Cooling	Total
2000	1197.3	453.7	54.9	254.5	0.0	1960.4
2005	1259.7	447.7	54.6	273.2	0.2	2035.4
2010	1281.1	438.2	55.3	288.1	0.4	2063.1
2015	1329.9	437.6	56.0	297.5	0.8	2121.7
2020	1400.8	441.6	56.5	307.0	1.2	2207.1
2025	1492.6	447.6	58.4	317.1	1.7	2317.3
2030	1579.8	454.9	60.2	327.1	2.2	2424.2
2035	1679.9	461.9	62.1	337.2	2.9	2543.9
2040	1700.0	468.7	63.9	347.2	3.7	2583.4
2045	1697.8	474.8	65.8	357.2	4.5	2600.1
2050	1698.0	480.8	67.6	367.3	5.4	2619.1

Carbon emission by end use (MtC)

Year	Space heating	Water	Cooking	Lights and appliances	Cooling	Total
2000	20.0	7.9	1.3	8.9	0.0	38.2
2005	21.1	8.1	1.4	10.3	0.0	41.0
2010	21.0	7.8	1.3	9.5	0.0	39.6
2015	21.7	7.7	1.3	9.5	0.0	40.2
2020	22.7	7.7	1.2	9.0	0.0	40.7
2025	24.2	7.8	1.3	9.3	0.0	42.6
2030	25.6	7.9	1.3	9.6	0.1	44.5
2035	27.3	8.0	1.3	9.9	0.1	46.6
2040	27.6	8.2	1.4	10.2	0.1	47.4
2045	27.6	8.3	1.4	10.5	0.1	47.8
2050	27.6	8.4	1.5	10.8	0.2	48.3

Table C2. Reference scenario summary by fuel

Consumption by fuel (PJ)

Year	Solid	Gas	Electric	Oil	Total
2000	90.4	1331.7	402.7	135.6	1960.4
2005	89.6	1403.1	411.7	131.1	2035.4
2010	84.8	1424.9	423.8	129.5	2063.1
2015	86.3	1462.7	436.3	136.3	2121.7
2020	89.9	1522.1	450.2	144.9	2207.1
2025	94.1	1602.1	466.8	154.3	2317.3
2030	98.3	1679.7	483.2	163.0	2424.2
2035	103.0	1768.3	500.1	172.6	2543.9
2040	104.2	1790.3	513.3	175.7	2583.4
2045	104.3	1793.5	525.4	176.9	2600.1
2050	104.6	1798.5	537.7	178.3	2619.1

Carbon emission by fuel (MtC)

Year	Solid	Gas	Electric	Oil	Total
2000	2.0	19.4	14.1	2.7	38.2
2005	2.1	20.7	15.6	2.6	41.0
2010	2.0	21.0	14.0	2.6	39.6
2015	2.1	21.5	13.9	2.7	40.2
2020	2.2	22.4	13.2	2.9	40.7
2025	2.3	23.6	13.7	3.1	42.6
2030	2.4	24.7	14.2	3.3	44.5
2035	2.5	26.0	14.7	3.5	46.6
2040	2.5	26.4	15.0	3.5	47.4
2045	2.5	26.4	15.4	3.5	47.8
2050	2.5	26.5	15.8	3.6	48.3

Table C3. Policy scenario summary by end use

Energy consumption by end use (PJ)

Year	Space heating	Water	Cooking	Lights and appliances	Cooling	Total
2000	1197.3	453.7	54.9	254.5	0.0	1960.4
2005	1255.4	446.6	53.3	260.3	0.2	2015.8
2010	1238.2	428.7	51.9	240.0	0.4	1959.2
2015	1276.5	421.2	50.7	209.7	0.8	1958.8
2020	1300.8	420.4	49.5	195.6	1.2	1967.5
2025	1353.0	424.2	51.1	201.6	1.7	2031.5
2030	1433.9	430.9	52.8	207.4	2.2	2127.3
2035	1540.1	438.8	54.4	213.2	2.9	2249.4
2040	1572.5	446.5	56.0	218.8	3.7	2297.4
2045	1582.3	452.0	57.6	224.4	4.5	2320.8
2050	1590.5	458.9	59.2	229.9	5.4	2344.0

Carbon emission by end use (MtC)

Year	Space heating	Water	Cooking	Lights and appliances	Cooling	Total
2000	20.0	7.9	1.3	8.9	0.0	38.2
2005	21.1	8.1	1.3	9.8	0.0	40.4
2010	20.4	7.6	1.2	7.9	0.0	37.1
2015	21.0	7.5	1.1	6.7	0.0	36.3
2020	21.2	7.4	1.1	5.7	0.0	35.5
2025	22.1	7.5	1.1	5.9	0.0	36.6
2030	23.4	7.6	1.1	6.1	0.1	38.3
2035	25.2	7.7	1.2	6.2	0.1	40.4
2040	25.7	7.9	1.2	6.4	0.1	41.3
2045	25.9	7.9	1.2	6.6	0.1	41.8
2050	26.0	8.1	1.3	6.7	0.2	42.3

Table C4. Policy scenario summary by fuel

Consumption by fuel (PJ)

Year	Solid	Gas	Electric	Oil	Total
2000	90.4	1331.7	402.7	135.6	1960.4
2005	90.2	1396.4	397.7	131.5	2015.8
2010	86.0	1370.8	372.5	129.9	1959.2
2015	89.3	1386.1	344.7	138.7	1958.8
2020	92.6	1396.1	332.7	146.1	1967.5
2025	95.9	1437.8	344.1	153.7	2031.5
2030	100.5	1507.1	356.5	163.1	2127.3
2035	106.1	1599.6	369.8	173.9	2249.4
2040	108.1	1631.6	379.3	178.4	2297.4
2045	109.0	1643.6	387.4	180.8	2320.8
2050	109.9	1655.4	395.6	183.1	2344.0

Carbon emission by fuel (MtC)

Year	Solid	Gas	Electric	Oil	Total
2000	2.0	19.4	14.1	2.7	38.2
2005	2.2	20.6	15.0	2.6	40.4
2010	2.1	20.2	12.3	2.6	37.1
2015	2.1	20.4	11.0	2.8	36.3
2020	2.2	20.6	9.8	2.9	35.5
2025	2.3	21.2	10.1	3.1	36.6
2030	2.4	22.2	10.5	3.3	38.3
2035	2.5	23.5	10.8	3.5	40.4
2040	2.6	24.0	11.1	3.6	41.3
2045	2.6	24.2	11.4	3.6	41.8
2050	2.6	24.4	11.6	3.7	42.3

Table C5. Efficiency scenario summary by end use

Energy consumption by end use (PJ)

Year	Space heating	Water	Cooking	Lights and appliances	Cooling	Total
2000	1197.3	453.7	54.9	254.5	0.0	1960.4
2005	1217.6	441.9	53.1	224.3	0.2	1937.2
2010	1152.6	420.7	51.9	200.0	0.4	1825.7
2015	1123.5	409.4	50.7	184.2	0.8	1768.7
2020	1096.0	405.7	49.5	178.8	1.2	1731.2
2025	1079.7	407.3	51.1	184.2	1.7	1723.9
2030	1129.5	413.0	52.8	189.5	2.2	1787.0
2035	1196.9	420.5	54.4	194.7	2.9	1869.3
2040	1203.5	427.9	56.0	199.7	3.7	1890.8
2045	1194.7	432.7	57.6	204.8	4.5	1894.3
2050	1202.7	439.4	59.2	209.7	5.4	1916.4

Carbon emission by end use (MtC)

Year	Space heating	Water	Cooking	Lights and appliances	Cooling	Total
2000	20.0	7.9	1.3	8.9	0.0	38.2
2005	20.5	8.0	1.3	8.5	0.0	38.3
2010	19.0	7.5	1.2	6.6	0.0	34.3
2015	18.5	7.3	1.1	5.9	0.0	32.9
2020	18.0	7.2	1.1	5.2	0.0	31.5
2025	17.7	7.2	1.1	5.4	0.0	31.5
2030	18.5	7.3	1.1	5.6	0.1	32.6
2035	19.7	7.4	1.2	5.7	0.1	34.1
2040	19.8	7.6	1.2	5.9	0.1	34.5
2045	19.6	7.7	1.2	6.0	0.1	34.7
2050	19.8	7.8	1.3	6.1	0.2	35.1

Table C6. Efficiency scenario summary by fuel

Consumption by fuel (PJ)

Year	Solid	Gas	Electric	Oil	Total
2000	90.4	1331.7	402.7	135.6	1960.4
2005	88.6	1359.6	360.0	129.0	1937.2
2010	82.8	1288.8	329.2	124.8	1825.7
2015	83.4	1243.2	313.1	128.9	1768.7
2020	84.6	1207.0	307.2	132.4	1731.2
2025	84.9	1189.7	314.8	134.5	1723.9
2030	88.3	1232.1	325.3	141.3	1787.0
2035	92.2	1292.1	336.2	148.9	1869.3
2040	93.1	1302.8	343.8	151.1	1890.8
2045	93.0	1299.3	350.3	151.6	1894.3
2050	93.8	1311.1	357.9	153.6	1916.4

Carbon emission by fuel (MtC)

Year	Solid	Gas	Electric	Oil	Total
2000	2.0	19.4	14.1	2.7	38.2
2005	2.1	20.0	13.6	2.6	38.3
2010	2.0	19.0	10.8	2.5	34.3
2015	2.0	18.3	10.0	2.6	32.9
2020	2.0	17.8	9.0	2.6	31.5
2025	2.0	17.5	9.2	2.7	31.5
2030	2.1	18.1	9.5	2.8	32.6
2035	2.2	19.0	9.9	3.0	34.1
2040	2.2	19.2	10.1	3.0	34.5
2045	2.2	19.1	10.3	3.0	34.7
2050	2.3	19.3	10.5	3.1	35.1

Table C7. Step change 1 scenario by end use

Energy consumption by end use (PJ)

Year	Space heating	Water	Cooking	Lights and appliances	Cooling	Total
2000	1197.3	453.7	54.9	254.5	0.0	1960.4
2005	1217.6	441.9	53.1	224.3	0.2	1937.2
2010	1152.6	420.7	51.9	200.0	0.4	1825.7
2015	1123.5	409.4	50.7	184.2	0.8	1768.7
2020	1095.0	402.0	49.5	177.0	1.2	1724.7
2025	1076.4	396.6	51.1	179.0	1.7	1704.8
2030	1122.6	392.7	52.8	179.7	2.2	1749.9
2035	1185.5	388.7	54.4	179.3	2.9	1810.7
2040	1188.2	383.4	56.0	178.2	3.7	1809.5
2045	1176.1	375.6	57.6	176.7	4.5	1790.6
2050	1181.7	370.0	59.2	175.3	5.4	1791.7

Carbon emission by end use (MtC)

Year	Space heating	Water	Cooking	Lights and appliances	Cooling	Total
2000	20.0	7.9	1.3	8.9	0.0	38.2
2005	20.5	8.0	1.3	8.5	0.0	38.3
2010	19.0	7.5	1.2	6.6	0.0	34.3
2015	18.5	7.3	1.1	5.9	0.0	32.9
2020	17.7	6.9	1.0	4.8	0.0	30.5
2025	17.2	6.7	1.0	4.5	0.0	29.5
2030	17.8	6.5	1.0	4.2	0.1	29.5
2035	18.6	6.3	1.0	3.9	0.1	29.8
2040	18.4	6.1	1.0	3.6	0.1	29.2
2045	18.1	5.9	1.0	3.3	0.1	28.3
2050	18.1	5.8	1.0	3.1	0.1	27.9

Table C8. Step change 1 scenario by fuel

Consumption by fuel (PJ)

Year	Solid	Gas	Electric	Oil	Total
2000	90.4	1331.7	402.7	135.6	1960.4
2005	88.6	1359.6	360.0	129.0	1937.2
2010	82.8	1288.8	329.2	124.8	1825.7
2015	83.4	1243.2	313.1	128.9	1768.7
2020	84.6	1203.9	303.9	132.4	1724.7
2025	84.9	1180.9	304.4	134.5	1704.8
2030	88.3	1215.4	304.9	141.3	1749.9
2035	92.2	1265.9	303.7	148.9	1810.7
2040	93.1	1266.1	299.2	151.1	1809.5
2045	93.0	1251.7	294.3	151.6	1790.6
2050	93.8	1252.6	291.7	153.6	1791.7

Carbon emission by fuel (MtC)

Year	Solid	Gas	Electric	Oil	Total
2000	2.0	19.4	14.1	2.7	38.2
2005	2.1	20.0	13.6	2.6	38.3
2010	2.0	19.0	10.8	2.5	34.3
2015	2.0	18.3	10.0	2.6	32.9
2020	1.9	17.7	8.2	2.6	30.5
2025	1.8	17.4	7.7	2.7	29.5
2030	1.7	17.9	7.1	2.8	29.5
2035	1.6	18.6	6.5	3.0	29.8
2040	1.5	18.6	6.0	3.0	29.2
2045	1.4	18.4	5.5	3.0	28.3
2050	1.4	18.4	5.1	3.1	27.9

Table C9. Step change 2 scenario by end use

Energy consumption by end use (PJ)

Year	Space heating	Water	Cooking	Lights and appliances	Cooling	Total
2000	1197.3	453.7	54.9	254.5	0.0	1960.4
2005	1217.6	441.9	53.1	224.3	0.2	1937.2
2010	1152.6	420.7	51.9	200.0	0.4	1825.7
2015	1123.5	409.4	50.7	184.2	0.8	1768.7
2020	1099.4	395.7	49.5	177.0	1.2	1722.8
2025	1096.7	375.9	51.1	179.0	1.7	1704.4
2030	1155.2	351.6	52.8	179.7	2.2	1741.5
2035	1209.8	324.0	54.4	179.3	2.9	1770.4
2040	1181.2	295.4	56.0	178.2	3.7	1714.4
2045	1125.3	267.1	57.6	176.7	4.5	1631.3
2050	1086.4	244.6	59.2	175.3	5.4	1571.1

Carbon emission by end use (MtC)

Year	Space heating	Water	Cooking	Lights and appliances	Cooling	Total
2000	20.0	7.9	1.3	8.9	0.0	38.2
2005	20.5	8.0	1.3	8.5	0.0	38.3
2010	19.0	7.5	1.2	6.6	0.0	34.3
2015	18.5	7.3	1.1	5.9	0.0	32.9
2020	17.0	6.6	1.0	4.8	0.0	29.4
2025	15.1	6.1	0.9	4.5	0.0	26.6
2030	13.4	5.7	0.9	4.2	0.1	24.3
2035	11.8	5.2	0.9	3.9	0.1	21.8
2040	9.8	4.8	0.9	3.6	0.1	19.0
2045	8.1	4.3	0.9	3.3	0.1	16.6
2050	7.2	3.8	0.9	3.1	0.1	15.0

Table C10. Step change 2 scenario by fuel

Consumption by fuel (PJ)

Year	Solid	Gas	Electric	Oil	Total
2000	90.4	1331.7	402.7	135.6	1960.4
2005	88.6	1359.6	360.0	129.0	1937.2
2010	82.8	1288.8	329.2	124.8	1825.7
2015	83.4	1243.2	313.1	128.9	1768.7
2020	131.2	1153.2	311.7	126.6	1722.8
2025	244.4	1014.1	330.5	115.4	1704.4
2030	398.8	881.4	358.7	102.6	1741.5
2035	548.7	742.2	391.7	87.8	1770.4
2040	634.8	588.4	419.9	71.3	1714.4
2045	669.0	461.6	443.0	57.7	1631.3
2050	677.0	381.9	463.1	49.1	1571.1

Carbon emission by fuel (MtC)

Year	Solid	Gas	Electric	Oil	Total
2000	2.0	19.4	14.1	2.7	38.2
2005	2.1	20.0	13.6	2.6	38.3
2010	2.0	19.0	10.8	2.5	34.3
2015	2.0	18.3	10.0	2.6	32.9
2020	1.5	17.0	8.5	2.5	29.4
2025	1.1	14.9	8.3	2.3	26.6
2030	0.9	13.0	8.3	2.1	24.3
2035	0.7	10.9	8.4	1.8	21.8
2040	0.5	8.7	8.4	1.4	19.0
2045	0.4	6.8	8.2	1.2	16.6
2050	0.3	5.6	8.1	1.0	15.0

Table C11 Carbon emission factors for reference, policy and efficiency scenarios (kgC/GJ)

Year	Solid	Gas	Electric	Oil
2000	21.6	14.6	35.0	20.0
2005	24.0	14.7	37.8	20.0
2010	24.0	14.7	33.0	20.0
2015	24.0	14.7	31.9	20.0
2020	24.0	14.7	29.3	20.0
2025	24.0	14.7	29.3	20.0
2030	24.0	14.7	29.3	20.0
2035	24.0	14.7	29.3	20.0
2040	24.0	14.7	29.3	20.0
2045	24.0	14.7	29.3	20.0
2050	24.0	14.7	29.3	20.0

Table C12 Carbon emission factors for step change 1 scenario (kgC/GJ)

Year	Solid	Gas	Electric	Oil
2000	21.6	14.6	35.0	20.0
2005	24.0	14.7	37.8	20.0
2010	24.0	14.7	33.0	20.0
2015	24.0	14.7	31.9	20.0
2020	22.3	14.7	27.1	20.0
2025	20.7	14.7	25.2	20.0
2030	19.2	14.7	23.3	20.0
2035	17.8	14.7	21.5	20.0
2040	16.5	14.7	19.9	20.0
2045	15.3	14.7	18.6	20.0
2050	14.4	14.7	17.4	20.0

Table C13 Carbon emission factors for step change 2 scenario (kgC/GJ)

Year	Solid	Gas	Electric	Oil
2000	21.6	14.6	35.0	20.0
2005	24.0	14.7	37.8	20.0
2010	24.0	14.7	33.0	20.0
2015	24.0	14.7	31.9	20.0
2020	11.1	14.7	27.1	20.0
2025	4.4	14.7	25.2	20.0
2030	2.2	14.7	23.3	20.0
2035	1.3	14.7	21.5	20.0
2040	0.9	14.7	19.9	20.0
2045	0.6	14.7	18.6	20.0
2050	0.5	14.7	17.4	20.0

Table C14 Cumulative costs and savings for scenarios (£M)

	Policy scenario		Efficiency scenario	
	Costs	Savings	Costs	Savings
2001	0	0	0	0
2002	171	28	1265	197
2003	398	89	2283	543
2004	584	174	3115	1013
2005	908	307	4001	1620
2006	1703	573	4938	2384
2007	2299	935	5854	3304
2008	2816	1382	6755	4381
2009	3306	1911	7523	5594
2010	3875	2536	8317	6949
2011	4383	3244	9057	8429
2012	4954	4042	9731	10025
2013	5403	4915	10415	11738
2014	5849	5862	11101	13569
2015	6277	6881	11788	15519
2016	6634	7965	12441	17585
2017	7118	9137	13102	19769
2018	7604	10397	13772	22071
2019	8013	11734	14453	24495
2020	8571	13173	15145	27041
2021	8906	14668	15872	29709
2022	9163	16206	16539	32488
2023	9613	17820	17251	35387
2024	9749	19456	17973	38406
2025	9862	21110	18363	41489
2026	10083	22802	18616	44614
2027	10136	24502	18902	47786
2028	10171	26207	19169	51002
2029	10206	27918	19404	54257
2030	10230	29633	19626	57549
2031	10280	31355	19933	60889
2032	10312	33081	20233	64277
2033	10302	34805	20433	67698
2034	10291	36527	20624	71150
2035	10255	38244	20752	74624
2036	10207	39953	20843	78115
2037	10159	41655	20924	81621
2038	10122	43351	21020	85144
2039	10105	45045	21160	88691
2040	10093	46737	21301	92263
2041	10081	48427	21404	95853
2042	10051	50114	21480	99458
2043	10025	51796	21557	103077
2044	10002	53476	21635	106711
2045	9983	55154	21713	110360
2046	9968	56829	21792	114024
2047	9956	58504	21871	117703
2048	9948	60177	21950	121397
2049	9942	61851	21972	125097
2050	9939	63525	21683	128749

Table C15 Cumulative costs and savings for scenarios (£M)

	Step change 1 scenario		Step change 2 scenario	
	Costs	Savings	Costs	Savings
2001	0	0	0	0
2002	1265	197	1265	197
2003	2283	543	2283	543
2004	3115	1013	3115	1013
2005	4001	1620	4001	1620
2006	4938	2384	4938	2384
2007	5854	3304	5854	3304
2008	6755	4381	6755	4381
2009	7523	5594	7523	5594
2010	8317	6949	8317	6949
2011	9057	8429	9057	8429
2012	9731	10025	9731	10025
2013	10415	11738	10415	11738
2014	11101	13569	11101	13569
2015	11788	15519	11788	15519
2016	12761	17590	12884	17591
2017	13730	19785	14139	19780
2018	14711	22106	15513	22086
2019	15707	24558	16967	24506
2020	16718	27144	18483	27040
2021	17763	29865	20052	29683
2022	18755	32712	21595	32425
2023	19803	35693	23228	35271
2024	20867	38812	24901	38223
2025	21614	42014	26326	41223
2026	22233	45279	27678	44249
2027	22895	48611	29123	47306
2028	23541	52010	30575	50394
2029	24155	55472	31999	53512
2030	24756	58995	33421	56662
2031	25466	62593	35078	59858
2032	26170	66266	36746	63103
2033	26758	69998	38227	66391
2034	27333	73789	39685	69726
2035	27832	77630	40997	73107
2036	28284	81515	42203	76535
2037	28717	85444	43352	80016
2038	29164	89417	44502	83554
2039	29656	93443	45718	87160
2040	30146	97522	46906	90838
2041	30570	101647	47919	94588
2042	30965	105815	48867	98409
2043	31353	110024	49774	102302
2044	31735	114275	50642	106271
2045	32109	118567	51471	110316
2046	32477	122900	52261	114437
2047	32836	127274	53014	118635
2048	33188	131689	53731	122910
2049	33479	136134	54391	127250
2050	33470	140556	54726	131603

Table C16 Current fuel prices from SAP 2005

Fuel prices used to determine the savings (£/GJ)			
Solid	Gas	Electric	Oil
5.00	4.19	7.92	5.28