

Roadmap to 60%: eco-refurbishment of 1960s flats

An Energy Saving Trust report produced with
the support of Mears Group and Travis Perkins



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Executive summary

The Energy Saving Trust supported by Mears Group and Travis Perkins have produced this report, which investigates the real life costs of reaching a 60% reduction in carbon dioxide (CO₂) emissions from 1960s flats. It is aimed at all those involved in both the social and private rented housing sectors who wish to improve the environmental performance of their dwellings.

The report will be a key decision making tool for those seeking the most cost effective route to step change CO₂ reductions.

The Energy Saving Trust commissioned SAP modelling to investigate CO₂ reduction packages, using data from the English Housing Survey to ensure that representative scenarios were investigated. Measures were appraised by Mears and Travis Perkins for practicality, labour and materials costs. The measures were then divided into low, medium and high cost packages, with the goal of reaching a 60% reduction in CO₂ emissions.

The costs of reaching a 60% reduction varied widely between the scenarios, and a key finding is that the better the dwelling baseline performance, the more difficult and costly it is to achieve the 60% reduction. For housing associations and landlords, this factor is crucial, and the report highlights the most cost effective areas to target in order to maximise the 'easy wins'.

The report also highlights the associated increases in SAP scores, in order to clearly show the effect of CO₂ reduction measures on reducing the likelihood of fuel poverty.

Cover images courtesy
of the Mears Group

Executive forewords

Philip Sellwood

With all the emphasis currently being placed on delivering zero carbon new build by the year 2016, one could be forgiven for thinking that the existing 26 million homes are only of passing interest in the carbon emissions debate.

Let's put new build into context: even if the Government achieves its very ambitious and challenging new build targets, 70% of the homes that will be with us in 2050 are already here and many of them as we all know are in a pretty sorry state. I don't need to remind you that 2050 is the year we should reach the magic 60%, probably even 80% reduction in carbon.

Here at the Energy Saving Trust, we believe part of the problem is that there is just not enough evidence available regarding the practicalities of installing carbon reduction measures on a volume basis to persuade policy makers, politicians and local authorities - all of whom have an interest in this debate - how we might reach the carbon emission targets in a cost effective manner. Well that's why we decided, along with our partners to produce this report investigating exactly those cost efficient measures that can be carried out in existing housing stock.

In partnership with Mears Group and Travis Perkins, the Energy Saving Trust has been able to address the lack of credible information available to Housing Associations, Developers, Architects, and Professionals alike. I believe the three different scenarios of low, medium and high cost carbon reduction packages covered in this report sets the direction. This particular report focuses on purpose built 1960's flats which often fall under the "hard to treat" category. Well that is just a start, were all such dwellings UK wide to adopt some or all of the measures recommended in this report, then delivery of the 2050 target would at least in our view, be in sight.



Making People *Smile*

Bob Holt

Chairman, Mears Group

If we are to make a serious impact on carbon reduction from housing in this country, we must all put a greater emphasis on the existing housing stock. Enormous efforts have been put into improving the sustainability of new housing but this has not been replicated for the existing housing stock.

Mears is responsible for maintaining and improving over 500,000 social homes in the UK, working in partnership with local authorities and housing associations. We have been active in making the improvements necessary to raise these homes to the Decent Homes standard. Of course despite the huge investment in Decent Homes, we have gone nowhere near far enough to turn these homes into truly energy efficient housing. The benefit of doing so is of course not only reduced carbon. Social housing residents are those who have often been hit hardest by rising fuel costs and fuel poverty.

Mears recently held a Thought Leader Conference on the subject of reducing carbon emissions from the social housing stock. This brought together 70 senior figures involved in the Social Housing sector. It was apparent from this conference, that if we are to make improvements, help is needed. There is insufficient support for local authorities to help them make long term sensible decisions about how to tackle the issue. There is of course also the question of the funding required to make these improvements.

This need for direction has been a major driver for this report. Through the work done with the Energy Saving Trust, the Building Research Establishment and Travis Perkins, we have documented for one key social housing type, what different levels of investment can achieve in terms of carbon reduction. The analysis uses the very latest and commercially available building materials and products. We have demonstrated how it is possible to take 60% off the carbon emissions from a simple and typical flat. Even within this relatively small living space, this would also save the tenant over 50% per year from their bill.

It is important to note that even greater benefits can be achieved, if we are able to provide help for tenants on making small changes to the way they manage their homes and lives from an energy efficiency perspective. Mears is working with the Tenant Participation Advisory Service (TPAS), to provide extra help and training here.

This report is only a start, we expect to extend this to other property types and to directly help local authorities provide plans specifically for their stock.

This is important work for all concerned, there are few projects that can at the same time have a material impact on carbon reduction and a material impact on poverty.



Travis Perkins

John Carter

Chief Operating Officer, Travis Perkins

Travis Perkins is delighted to have been involved in this exciting research project. We service the product needs of an increasing number of social housing refurbishment projects, and are aware of the huge potential these offer in terms of both reducing demand for grid electricity and gas, through better insulation and in the micro-generation of energy. These improvements, through refurbishment, offer significant opportunities to both reduce fuel poverty and contribute to reducing carbon dioxide emissions and yet they have largely not been costed.

With contributions from the Mears Group and Travis Perkins, the Energy Saving Trust has been able to establish what the costs would be to achieve a 60% cut in emissions from one standard house type, as well as provide an indicative cost for graduated levels of reductions in carbon dioxide emissions per dwelling. More importantly perhaps, we have developed a methodology which can be applied to other standard house types to identify the costs of both cutting fuel bills and carbon dioxide reductions. We believe that this will be of considerable use to landlords and policy makers going forward.

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1. Introduction

Whilst the Code for Sustainable Homes is driving the new build sector forwards towards zero carbon construction by 2016, it is important to remember that the existing housing stock has an even bigger role to play in reducing carbon dioxide (CO₂) emissions. Current predictions estimate that in 2050, the existing (pre-2006) housing stock will still make up two thirds of the UK's housing. This stock is typically poorly-performing when measured by today's heightened energy efficiency standards, and hence it is essential that measures are taken to reduce its associated carbon emissions.

The Energy Saving Trust commissioned this report in order to investigate cost effective measures which can help to reduce the carbon emissions from the existing housing stock. Produced in partnership with Mears Group and Travis Perkins, the report gives low, medium and high cost dwelling carbon reduction packages, for a wide variety of scenarios. These packages are in line with the Energy Saving Trust's best practice in refurbishment standard, and have been appraised for both materials and labour costs by Travis Perkins and Mears Group respectively. The Government has set challenging carbon reduction targets for the UK, with the aim of achieving a 60% cut in emissions by 2050, and therefore for each scenario a method of reaching this 60% reduction is recommended.

These measures can also have a significant effect in reducing the likelihood of dwelling occupants suffering from fuel poverty, and can reduce fuel bills by over 50%.

Due to the breadth and complexity of the existing housing stock, tackling improvement packages for all dwelling types within one report was not feasible, and as a result this report focuses on purpose built 1960s flats. This focus was chosen as it was of particular interest to the project team and the stock they typically work with. In addition, the fit between the various data sources we drew upon in compiling this report was particularly good. Such dwellings often fall under the hard to treat category, and hence a wide variety of refurbishment measures required investigation – many of which could equally well be applied to flats which fall into other age brackets.

Table 1: The UK's housing stock by type¹

Dwelling type	Number (000s)	Percentage
Semi detached	7,052	28
Terraced	6,876	28
Flats	4,716	19
Detached	4,021	16
Bungalow	2,086	8
Other	74	1
Total	24,825	100

Across the UK, there are almost 25 million dwellings, of which flats make up almost 5 million – approximately 20% of the total UK housing stock. Therefore, were all such dwellings UK-wide to adopt the energy efficiency measures recommended in this report, the savings would be highly significant in driving the UK's housing stock emissions down towards the target 60% reduction.

1. Figures taken from the Domestic Energy Factfile [2006]; (BRE/EST/DEFRA)

2. Background information

2.1 Who this report is for

This report is aimed at all those involved in both the social and private rented housing sectors, who wish to improve the thermal performance of their dwellings. This has a wide variety of benefits:

- Reduced fuel bills for tenants, leading to a reduction in fuel poverty.
- A better standard of living, leading to greater tenant retention.
- Better performing buildings, leading to reduced incidences of damp and decay, and therefore giving a reduction in maintenance bills.
- Reduced impact on the environment, with lower CO₂ emissions.

2.2 What is the Energy Saving Trust's best practice in refurbishment standard?

All work specified within this report meets the Energy Saving Trust's best practice in refurbishment standard,² which has been designed to give the optimum balance of environmental performance and practicality. Using the best practice specification ensures that refurbishment work is carried out to the highest practical standard, and the maximum cost and carbon savings are realised for residents, and the environment. Figure 1 gives a summary of the best practice specification.

Area	Improvement
Walls	Where possible, walls should be insulated to achieve a maximum U-value of 0.30W/m ² K.
Roofs	For best practice, aim for a U-value of 0.16W/m ² K when installing insulation between the joists or rafters. Flat roofs should be insulated to achieve a U-value of 0.25W/m ² K or better.
Floors	Exposed floors should be insulated to achieve a maximum U-value of 0.20-0.25W/m ² K (depending upon floor geometry).
Windows	Replacement windows should have a BFRC rating in band C or above. Any retained windows should be draught-stripped.
Doors	Replacement doors should have a maximum U-value of 1.0W/m ² K if solid, or 1.5W/m ² K if half-glazed. All existing doors should be draught-stripped.
Space heating and hot water	Domestic wet central heating systems and hot water should be installed to meet 'Central Heating System Specifications (CHeSS) – Year 2008' standard HR6 or HC6. Where electricity is the only option, the recommendations contained within 'Domestic heating by electricity' (CE185/GPG345) should be followed.
Airtightness	Air leakage paths can be identified using a pressure test and removed by undertaking remedial sealing. The best practice recommendation is to aim for an air permeability of 5m ³ /(hm ²) at 50Pa.
Ventilation	A purpose-provided ventilation system should be installed.
Lights and appliances	When re-wiring dedicated lamp fittings should be installed which accept only low-energy bulbs. Ideally greater than 75% of all fixed luminaires should be dedicated low energy fittings. Low energy appliances should be specified which carry the Energy Saving Recommended certification mark.
Renewable and low-carbon technologies	After all basic energy efficiency improvements have been undertaken the specification of renewable technologies, such as solar hot water heating or photovoltaics, is encouraged where appropriate to further reduce environmental impact.

Figure 1: Summary of the Energy Saving Trust best practice in refurbishment standard

2. Note that in the modelling carried out for this report, where draught proofing measures were specified these were assumed to achieve an airtightness of 10m³/hr.m².

For further information on the Energy Saving Trust's best practice in refurbishment standard, please see Energy efficient refurbishment of existing housing (CE83), which can be downloaded from www.energysavingtrust.org.uk/housing.

2.3 What is Ecohomes XB?

Ecohomes XB is a stock modelling tool for housing associations, private landlords and local authorities. It allows users to establish the baseline energy performance of their stock and then set incremental improvement targets, which can be self-assessed. Ecohomes XB forms a useful counterpart to detailed CO₂ reduction advice, and could be used in conjunction with the recommendations within this report to track overall CO₂ reductions across your housing stock.

For more information on Ecohomes XB, please visit www.breeam.org/page.jsp?id=25

2.4 What is SAP?

SAP is the Government's Standard Assessment Procedure for the energy rating of dwellings, and is used to demonstrate compliance with the national building regulations. Dwellings are ranked on a scale of 1 to 100, with a higher rating indicating lower running costs. SAP software also produces annual CO₂ emissions figures, which have been used to calculate the CO₂ savings for this report.

A SAP rating of 65 is generally taken to indicate the level at which a dwelling will have a minimal risk of being in fuel poverty.

For more information on SAP, please visit <http://projects.bre.co.uk/sap2005/>

2.5 What about Passivhaus?

Passivhaus is a construction standard which applies to new build dwellings. There is also a Passivhaus refurbishment standard, which sets standards beyond the Energy Saving Trust's best practice in refurbishment standard. However, achieving the Passivhaus refurbishment standard may not be feasible or cost effective in many cases, and therefore it is recommended for flagship refurbishments or one off projects.

For more information on Passivhaus, please visit www.passivhaus.org.uk

2.6 Methodology overview

2.6.1 The baseline

The Government has an extensive Decent Homes programme in place in England, with comparable schemes operating in the devolved administrations, and therefore all dwellings investigated in this report meet the energy efficiency requirements of Decent Homes as a baseline.

2.6.2 The data

As highlighted above, the existing housing stock varies enormously based on age, construction type and configuration. This means that there is no one scenario which will represent the variety of situations occurring in real life accurately enough to be useful. To address this, we used real life data from the English Housing Survey (formerly known as the English House Condition Survey), and determined a variety of representative baseline scenarios (for example solid walled, cavity walled, etc). Each of these was treated as a separate entity, and each then had low, medium and high cost carbon reduction packages calculated for it.

2.6.3 The dwelling type

As data from the English Housing Survey was taken from a huge variety of actual dwellings, mapping this onto a computer model was challenging. Our solution was to use a best fit standard house type, which matched the source data with a suitable degree of accuracy. We chose to use one of the standard house types developed by the BRE to help them test the BREDEM (Building Research Establishment Domestic Energy Model) algorithm. These standard house types were specifically designed to be representative of the body of data gathered over the thirty year history of the English Housing Survey, and hence the fit between the data and the house type we chose was very good. A plan of the house type is shown below.

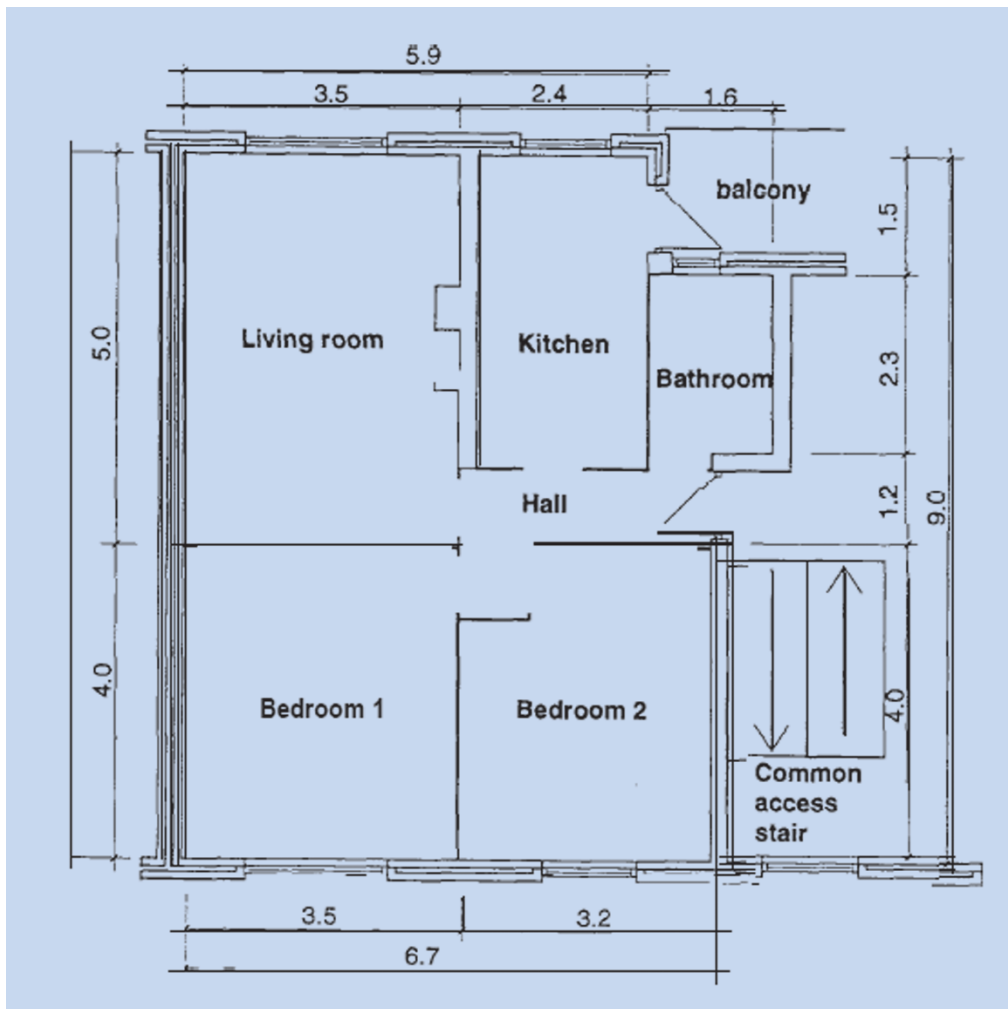


Figure 2: Plan view of dwelling layout

2.6.4 The scenarios

The chosen dwelling type could occupy several potential configurations within the building envelope, depending on storey and position within the terrace. In addition, construction type and other variables from the English Housing Survey data necessitated a number of baseline scenarios. To reflect this, we modelled the following variables:

- *Storey*
Ground, mid or top.
- *Wall construction*
Solid wall, unfilled cavity, filled cavity.
- *Heating system*
Gas combination boiler, gas combination boiler with electric secondary heating, electric storage heaters with electric immersion heater.
- *Window type*
Double glazed, no double glazing.

The various combinations of the above variables led to a total of 54 baseline scenarios. For each baseline scenario, we determined low, medium and high cost carbon reduction packages. Note that all flats were modelled as end of terrace.

The results on the following pages have been divided by storey, and then further subdivided by wall type before branching into the other variables.

3. Refurbishment packages

3.1 Low cost measures

A variety of measures were considered to fall under the low cost category, which was broadly set at around £1,000. These included:

- Low energy lighting
- Draught proofing
- Loft insulation
- Cavity wall insulation

A variety of further measures were considered, as follows:

- PIR sensors (motion detector)
- Smart metering
- Flush hippos (water reducers)
- Radiator panels

Unfortunately it was not possible to determine accurate carbon saving potentials for each of these products. As undertaking fresh research into the exact carbon savings from such measures was beyond the scope of this report, these measures are suggested for further investigation but have not been built into the packages recommended.

In general, securing robust, low cost carbon reduction improvement has limited scope for a social or private landlord. This is mainly due to the cost of labour – even improvements which are commonly regarded as inexpensive, for example loft insulation, can have considerable costs associated with them which are usually negated when self installed by individual householders.

Many of these benefits may be available free of charge to your tenants via the CERT scheme. For more information, please visit:

<http://www.defra.gov.uk/environment/climatechange/uk/household/supplier/cert.htm>

Turnaround time

The turnaround time of the low cost packages is estimated to be three to five days.

All low cost measures failed the 60% savings threshold.

Table 2: Top storey flats - solid walled: low cost carbon reduction packages

Wall construction	Heating system	Glazing type	Base case			Low cost package				
			fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)	fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
Solid wall	gas boiler	double glazing	363	60	3.6	321	42	65	3.2	0.4
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation Cost: £1,000				
Solid wall	gas boiler	single glazing	370	60	3.7	329	41	64	3.3	0.4
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation Cost: £1,000				
Solid wall	gas boiler, electric secondary	double glazing	411	55	3.7	365	46	60	3.4	0.3
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation Cost: £1,000				
Solid wall	gas boiler, electric secondary	single glazing	420	54	3.8	375	45	59	3.5	0.3
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation Cost: £1,000				
Solid wall	storage heaters	double glazing	560	39	6.0	494	66	45	5.4	0.6
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation Cost: £1,000				
Solid wall	storage heaters	single glazing	577	37	6.2	512	65	43	5.6	0.6
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation Cost: £1,000				

Table 3: Mid storey flats - solid walled: low cost carbon reduction packages

Wall construction	Heating system	Glazing type	Base case			Low cost package				
			fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)	fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
Solid wall	gas boiler	double glazing	317	66	3.0	295	22	69	2.9	0.1
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				
Solid wall	gas boiler	single glazing	325	65	3.2	303	22	68	3.0	0.2
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				
Solid wall	gas boiler, electric secondary	double glazing	355	61	3.2	333	22	64	3.0	0.2
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				
Solid wall	gas boiler, electric secondary	single glazing	365	60	3.3	344	21	63	3.2	0.1
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				
Solid wall	storage heaters	double glazing	471	48	5.0	448	23	50	4.9	0.1
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				
Solid wall	storage heaters	single glazing	488	46	5.2	465	23	48	5.1	0.1
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				

Table 4: Ground storey flats - solid walled: low cost carbon reduction packages

Wall construction	Heating system	Glazing type	Base case			Low cost package				
			fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)	fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
Solid wall	gas boiler	double glazing	349	62	3.5	320	29	66	3.1	0.4
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				
Solid wall	gas boiler	single glazing	357	61	3.6	328	29	65	3.2	0.4
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				
Solid wall	gas boiler, electric secondary	double glazing	399	56	3.7	359	40	61	3.2	0.5
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				
Solid wall	gas boiler, electric secondary	single glazing	408	55	3.8	369	39	60	3.3	0.5
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				
Solid wall	storage heaters	double glazing	558	39	6.2	471	87	48	5.0	1.2
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				
Solid wall	storage heaters	single glazing	575	38	6.4	488	87	46	5.2	1.2
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				

Table 5: Top storey flats - uninsulated cavity walled: low cost carbon reduction packages

Wall construction	Heating system	Glazing type	Base case			Low cost package				
			fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)	fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
Uninsulated cavity	gas boiler	double glazing	331	64	3.2	225	106	77	2.1	1.1
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, cavity wall insulation Cost: £1,600				
Uninsulated cavity	gas boiler	single glazing	339	63	3.3	234	105	76	2.2	1.1
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, cavity wall insulation Cost: £1,600				
Uninsulated cavity	gas boiler, electric secondary	double glazing	372	59	3.3	248	124	74	2.1	1.2
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, cavity wall insulation Cost: £1,600				
Uninsulated cavity	gas boiler, electric secondary	single glazing	382	58	3.4	259	123	73	2.3	1.1
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, cavity wall insulation Cost: £1,600				
Uninsulated cavity	storage heaters	double glazing	492	45	5.3	304	188	67	3.2	2.1
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, cavity wall insulation Cost: £1,600				
Uninsulated cavity	storage heaters	single glazing	510	44	5.5	322	188	65	3.4	2.1
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, cavity wall insulation Cost: £1,600				

Table 6: Mid storey flats - uninsulated cavity walled: low cost carbon reduction packages

Wall construction	Heating system	Glazing type	Base case			Low cost package				
			fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)	fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
Uninsulated cavity	gas boiler	double glazing	283	70	2.6	198	85	80	1.8	0.8
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation Cost: £1,150				
Uninsulated cavity	gas boiler	single glazing	291	69	2.8	207	84	79	1.9	0.9
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation Cost: £1,150				
Uninsulated cavity	gas boiler, electric secondary	double glazing	314	66	2.7	216	98	78	1.8	0.9
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation Cost: £1,150				
Uninsulated cavity	gas boiler, electric secondary	single glazing	325	65	2.9	227	98	77	1.9	1.0
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation Cost: £1,150				
Uninsulated cavity	storage heaters	double glazing	403	56	4.2	377	26	59	4.1	0.1
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation Cost: £1,150				
Uninsulated cavity	storage heaters	single glazing	421	54	4.4	395	26	57	4.3	0.1
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation Cost: £1,150				

Table 7: Ground storey flats - uninsulated cavity walled: low cost carbon reduction packages

Wall construction	Heating system	Glazing type	Base case			Low cost package				
			fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)	fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
Uninsulated cavity	gas boiler	double glazing	286	70	2.7	257	29	73	2.4	0.3
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation Cost: £1,150				
Uninsulated cavity	gas boiler	single glazing	295	69	2.8	266	29	72	2.6	0.2
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation Cost: £1,150				
Uninsulated cavity	gas boiler, electric secondary	double glazing	317	66	2.8	286	31	70	2.5	0.3
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation Cost: £1,150				
Uninsulated cavity	gas boiler, electric secondary	single glazing	328	65	2.9	298	30	68	2.7	0.2
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation Cost: £1,150				
Uninsulated cavity	storage heaters	double glazing	403	56	4.2	368	35	60	4.0	0.2
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation Cost: £1,150				
Uninsulated cavity	storage heaters	single glazing	421	54	4.4	386	35	58	4.2	0.2
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation Cost: £1,150				

Table 8: Top storey flats - insulated cavity walled: low cost carbon reduction packages

Wall construction	Heating system	Glazing type	Base case			Low cost package				
			fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)	fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
Insulated cavity	gas boiler	double glazing	270	72	2.5	225	45	77	2.1	0.4
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation Cost: £1,000				
Insulated cavity	gas boiler	single glazing	278	71	2.6	234	44	76	2.2	0.4
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation Cost: £1,000				
Insulated cavity	gas boiler, electric secondary	double glazing	297	68	2.6	248	49	74	2.1	0.5
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation Cost: £1,000				
Insulated cavity	gas boiler, electric secondary	single glazing	308	67	2.7	259	49	73	2.3	0.4
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation Cost: £1,000				
Insulated cavity	storage heaters	double glazing	372	59	3.9	304	68	67	3.2	0.7
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation Cost: £1,000				
Insulated cavity	storage heaters	single glazing	389	57	4.1	322	67	65	3.4	0.7
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation Cost: £1,000				

Table 9: Mid storey flats - insulated cavity walled: low cost carbon reduction packages

Wall construction	Heating system	Glazing type	Base case			Low cost package				
			fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)	fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
Insulated cavity	gas boiler	double glazing	221	77	1.9	198	23	80	1.8	0.1
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				
Insulated cavity	gas boiler	single glazing	230	76	2.0	207	23	79	1.9	0.1
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				
Insulated cavity	gas boiler, electric secondary	double glazing	239	75	2.0	216	23	78	1.8	0.2
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				
Insulated cavity	gas boiler, electric secondary	single glazing	249	74	2.1	227	22	77	1.9	0.2
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				
Insulated cavity	storage heaters	double glazing	284	70	2.9	259	25	73	2.7	0.2
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				
Insulated cavity	storage heaters	single glazing	301	68	3.1	277	24	71	2.9	0.2
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				

Table 10: Ground storey flats - insulated cavity walled: low cost carbon reduction packages

Wall construction	Heating system	Glazing type	Base case			Low cost package				
			fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)	fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
Insulated cavity	gas boiler	double glazing	257	73	2.4	224	33	77	1.9	0.5
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				
Insulated cavity	gas boiler	single glazing	266	72	2.6	233	33	76	2.0	0.6
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				
Insulated cavity	gas boiler, electric secondary	double glazing	286	70	2.5	242	44	75	2.0	0.5
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				
Insulated cavity	gas boiler, electric secondary	single glazing	298	68	2.7	253	45	74	2.1	0.6
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				
Insulated cavity	storage heaters	double glazing	368	60	4.0	316	52	66	3.3	0.7
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				
Insulated cavity	storage heaters	single glazing	386	58	4.2	333	53	64	3.5	0.7
						Improvements: dedicated low energy lighting, draught proofing throughout dwelling Cost: £550				

3.2 Medium cost measures

Measures falling under the medium cost bracket typically involve alterations to the building fabric itself. In addition, alterations to the dwelling's heating and hot water services were also possible. Measures considered for this category are in addition to the low cost measures previously recommended (shown in blue below). The medium cost category describes works to an approximate total value of £5,000 per dwelling.

- Low energy lighting
- Draught proofing
- Loft insulation
- Cavity wall insulation
- Internal wall insulation
- Replacement front door
- New boiler and controls
- New radiator system (electric heating only)

The measures in this category have been selected to ensure that the use of scaffolding is not necessary, thus reducing costs.

The measures recommended for the medium cost packages may require tenants to relocate whilst work is carried out (for example, whilst internal wall insulation is installed). Scenarios that met the criterion are highlighted in yellow.

Turnaround time

The turnaround time of the medium cost packages is estimated to be approximately two weeks.

Table 11: Top storey flats - solid walled: medium cost carbon reduction packages

Wall construction	Heating system	Glazing type	Base case			60% target	Medium cost package				
			fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
Solid wall	gas boiler	double glazing	363	60	3.6	1.4	183	180	82	1.5	2.1
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new boiler and controls, internal insulation throughout Cost: £4,950				
Solid wall	gas boiler	single glazing	370	60	3.7	1.5	191	179	81	1.6	2.1
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new boiler and controls, internal insulation throughout Cost: £4,950				
Solid wall	gas boiler, electric secondary	double glazing	411	55	3.7	1.5	183	228	82	1.5	2.2
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new boiler and controls, internal insulation throughout Cost: £4,950				
Solid wall	gas boiler, electric secondary	single glazing	420	54	3.8	1.5	191	229	81	2.6	2.2
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new boiler and controls, internal insulation throughout Cost: £4,950				
Solid wall	storage heaters	double glazing	560	39	6.0	2.4	258	302	73	2.6	3.4
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new storage heaters and controls, internal insulation throughout Cost: £4,950				
Solid wall	storage heaters	single glazing	577	37	6.2	2.5	275	302	71	2.8	3.4
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new storage heaters and controls, internal insulation throughout Cost: £4,950				

Table 12: Mid storey flats - solid walled: medium cost carbon reduction packages

Wall construction	Heating system	Glazing type	Base case				60% target	Medium cost package				
			fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)	fuel cost (£/yr)		cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)	
Solid wall	gas boiler	double glazing	317	66	3.0	1.2	158	159	85	1.3	1.7	
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, internal insulation throughout Cost: £4,500					
Solid wall	gas boiler	single glazing	325	65	3.2	1.3	165	160	84	1.4	1.8	
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, internal insulation throughout Cost: £4,500					
Solid wall	gas boiler, electric secondary	double glazing	355	61	3.2	1.3	158	197	85	1.3	1.9	
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, internal insulation throughout Cost: £4,500					
Solid wall	gas boiler, electric secondary	single glazing	365	60	3.3	1.3	165	200	84	1.4	1.9	
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, internal insulation throughout Cost: £4,500					
Solid wall	storage heaters	double glazing	471	48	5.0	2.0	214	57	78	2.2	2.8	
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new storage heaters and controls, internal insulation throughout Cost: £4,500					
Solid wall	storage heaters	single glazing	488	46	5.2	2.1	230	258	76	2.4	2.8	
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new storage heaters and controls, internal insulation throughout Cost: £4,500					

Table 13: Ground storey flats - solid walled: medium cost carbon reduction packages

Wall construction	Heating system	Glazing type	Base case			60% target	Medium cost package				
			fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
Solid wall	gas boiler	double glazing	349	62	3.5	1.4	208	141	79	1.9	1.6
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, internal insulation throughout Cost: £4,500				
Solid wall	gas boiler	single glazing	357	61	3.6	1.4	216	141	78	2.0	1.6
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, internal insulation throughout Cost: £4,500				
Solid wall	gas boiler, electric secondary	double glazing	399	56	3.7	1.5	208	191	79	1.9	1.8
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, internal insulation throughout Cost: £4,500				
Solid wall	gas boiler, electric secondary	single glazing	408	55	3.8	1.5	216	192	78	2.0	1.8
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, internal insulation throughout Cost: £4,500				
Solid wall	storage heaters	double glazing	558	39	6.2	2.5	316	242	66	3.3	2.9
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new storage heaters and controls, internal insulation throughout Cost: £4,500				
Solid wall	storage heaters	single glazing	575	38	6.4	2.6	333	242	64	3.5	2.9
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new storage heaters and controls, internal insulation throughout Cost: £4,500				

Table 14: Top storey flats - uninsulated cavity walled: medium cost carbon reduction packages

Wall construction	Heating system	Glazing type	Base case			60% target	Medium cost package				
			fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
Uninsulated cavity	gas boiler	double glazing	331	64	3.2	1.3	183	148	82	1.5	1.7
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, cavity wall insulation, new door, new boiler and controls, internal insulation throughout Cost: £5,150				
Uninsulated cavity	gas boiler	single glazing	339	63	3.3	1.3	191	148	81	1.6	1.7
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, cavity wall insulation, new door, new boiler and controls, internal insulation throughout Cost: £5,150				
Uninsulated cavity	gas boiler, electric secondary	double glazing	372	59	3.3	1.3	183	189	82	1.5	1.8
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, cavity wall insulation, new door, new boiler and controls, internal insulation throughout Cost: £5,150				
Uninsulated cavity	gas boiler, electric secondary	single glazing	382	58	3.4	1.4	191	191	81	1.6	1.8
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, cavity wall insulation, new door, new boiler and controls, internal insulation throughout Cost: £5,150				
Uninsulated cavity	storage heaters	double glazing	492	45	5.3	2.1	258	234	73	2.6	2.7
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, cavity wall insulation, new door, new storage heaters and controls, internal insulation throughout Cost: £5,150				
Uninsulated cavity	storage heaters	single glazing	510	44	5.5	2.2	275	235	71	2.8	2.7
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, cavity wall insulation, new door, new storage heaters and controls, internal insulation throughout Cost: £5,150				

Table 15: Mid storey flats - uninsulated cavity walled: medium cost carbon reduction packages

Wall construction	Heating system	Glazing type	Base case			60% target	Medium cost package				
			fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
Uninsulated cavity	gas boiler	double glazing	283	70	2.6	1.0	158	125	85	1.3	1.3
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new boiler and controls, internal insulation throughout Cost: £4,700				
Uninsulated cavity	gas boiler	single glazing	291	69	2.8	1.1	165	126	84	1.4	1.4
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new boiler and controls, internal insulation throughout Cost: £4,700				
Uninsulated cavity	gas boiler, electric secondary	double glazing	314	66	2.7	1.1	158	156	85	1.3	1.4
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new boiler and controls, internal insulation throughout Cost: £4,700				
Uninsulated cavity	gas boiler, electric secondary	single glazing	325	65	2.9	1.2	165	160	84	1.4	1.5
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new boiler and controls, internal insulation throughout Cost: £4,700				
Uninsulated cavity	storage heaters	double glazing	403	56	4.2	1.7	214	189	78	2.2	2.0
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new storage heaters and controls, internal insulation throughout Cost: £4,700				
Uninsulated cavity	storage heaters	single glazing	421	54	4.4	1.8	230	191	76	2.4	2.0
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new storage heaters and controls, internal insulation throughout Cost: £4,700				

Table 16: Ground storey flats - uninsulated cavity walled: medium cost carbon reduction packages

Wall construction	Heating system	Glazing type	Base case			60% target	Medium cost package				
			fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
Uninsulated cavity	gas boiler	double glazing	286	70	2.7	1.1	214	72	78	1.9	0.8
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new boiler and controls, internal insulation throughout Cost: £4,700				
Uninsulated cavity	gas boiler	single glazing	295	69	2.8	1.1	222	73	77	2.0	0.8
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new boiler and controls, internal insulation throughout Cost: £4,700				
Uninsulated cavity	gas boiler, electric secondary	double glazing	317	66	2.8	1.1	214	103	78	1.9	1.9
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new boiler and controls, internal insulation throughout Cost: £4,700				
Uninsulated cavity	gas boiler, electric secondary	single glazing	328	65	2.9	1.2	222	106	77	2.0	0.9
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new boiler and controls, internal insulation throughout Cost: £4,700				
Uninsulated cavity	storage heaters	double glazing	403	56	4.2	1.7	316	87	66	3.3	0.9
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new storage heaters and controls, internal insulation throughout Cost: £4,700				
Uninsulated cavity	storage heaters	single glazing	421	54	4.4	1.8	333	88	64	3.5	0.9
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new storage heaters and controls, internal insulation throughout Cost: £4,700				

Table 17: Top storey flats - insulated cavity walled: medium cost carbon reduction packages

Wall construction	Heating system	Glazing type	Base case			60% target	Medium cost package				
			fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
Insulated cavity	gas boiler	double glazing	270	72	2.5	1.0	183	87	82	1.5	1.0
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new boiler and controls, internal insulation throughout Cost: £4,550				
Insulated cavity	gas boiler	single glazing	278	71	2.6	1.0	191	87	81	1.6	1.0
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new boiler and controls, internal insulation throughout Cost: £4,550				
Insulated cavity	gas boiler, electric secondary	double glazing	297	68	2.6	1.0	183	114	82	1.5	1.1
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new boiler and controls, internal insulation throughout Cost: £4,550				
Insulated cavity	gas boiler, electric secondary	single glazing	308	67	2.7	1.1	191	117	81	1.6	1.1
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new boiler and controls, internal insulation throughout Cost: £4,550				
Insulated cavity	storage heaters	double glazing	372	59	3.9	1.6	258	114	73	2.6	1.3
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new storage heaters and controls, internal insulation throughout Cost: £4,550				
Insulated cavity	storage heaters	single glazing	389	57	4.1	1.6	275	114	71	2.8	1.3
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new storage heaters and controls, internal insulation throughout Cost: £4,550				

Table 18: Mid storey flats - insulated cavity walled: medium cost carbon reduction packages

Wall construction	Heating system	Glazing type	Base case			60% target	Medium cost package				
			fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
Insulated cavity	gas boiler	double glazing	221	77	1.9	0.8	158	63	85	1.3	0.6
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, internal insulation throughout Cost: £4,100				
Insulated cavity	gas boiler	single glazing	230	76	2.0	0.8	165	65	84	1.4	0.6
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, internal insulation throughout Cost: £4,100				
Insulated cavity	gas boiler, electric secondary	double glazing	239	75	2.0	0.8	158	81	85	1.3	0.7
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, internal insulation throughout Cost: £4,100				
Insulated cavity	gas boiler, electric secondary	single glazing	249	74	2.1	0.8	165	84	84	1.4	0.7
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, internal insulation throughout Cost: £4,100				
Insulated cavity	storage heaters	double glazing	284	70	2.9	1.2	214	70	78	2.2	0.7
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new storage heaters and controls, internal insulation throughout Cost: £4,100				
Insulated cavity	storage heaters	single glazing	301	68	3.1	1.2	230	71	76	2.4	0.7
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new storage heaters and controls, internal insulation throughout Cost: £4,100				

Table 19: Ground storey flats - insulated cavity walled: medium cost carbon reduction packages

Wall construction	Heating system	Glazing type	Base case			60% target	Medium cost package				
			fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
Insulated cavity	gas boiler	double glazing	257	73	2.4	1.0	214	43	78	1.9	0.5
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, internal insulation throughout Cost: £4,100				
Insulated cavity	gas boiler	single glazing	266	72	2.6	1.0	222	44	77	2.0	0.6
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, internal insulation throughout Cost: £4,100				
Insulated cavity	gas boiler, electric secondary	double glazing	286	70	2.5	1.0	214	72	78	1.9	0.6
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, internal insulation throughout Cost: £4,100				
Insulated cavity	gas boiler, electric secondary	single glazing	298	68	2.7	1.1	214	84	77	2.0	0.7
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, internal insulation throughout Cost: £4,100				
Insulated cavity	storage heaters	double glazing	368	60	4.0	1.6	284	84	70	2.9	1.1
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new storage heaters and controls, internal insulation throughout Cost: £4,100				
Insulated cavity	storage heaters	single glazing	386	58	4.2	1.7	301	85	68	3.1	1.1
							Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new storage heaters and controls, internal insulation throughout Cost: £4,100				

3.3 High cost measures

Measures falling under the high cost bracket typically include extensive work to the building fabric. Measures considered for this category are in addition to the low and medium cost measures already recommended above (shown in blue below). These packages include work to an approximate total value of £10,000 per dwelling.

- Low energy lighting
- Draught proofing
- Loft insulation
- Cavity wall insulation
- Replacement front door
- New boiler and controls
- New radiator system (electric heating only)
- External insulation
- Floor insulation
- New windows
- New hot water cylinder
- Renewable power – solar thermal water heating

The measures in this category require the use of scaffolding, and costs for this have been built into the total amount.

The measures recommended for the high cost packages may require tenants to relocate whilst work is carried out (for example, whilst floor insulation is installed).

These measures represent a comprehensive solution to reducing carbon emissions, and will substantially improve the quality of life for tenants. By adopting all measures listed, the entire thermal envelope will be enhanced, leading to fuel bills reductions of typically well over 50%, as well as thermal comfort benefits.

Due to this reduction in fuel bills, the high cost packages represent a way in which landlords can aim to confidently eradicate fuel poverty amongst tenants.

Other benefits include a maximisation of living space within the dwellings, due to the incorporation of additional insulation on the external surface of the building.

The stated goal of this report is to highlight eco refurbishment packages that lead to a 60% reduction in carbon emissions, and the high cost scenarios that meet this criterion are highlighted in yellow. Any scenarios which failed to achieve a 60% reduction have been addressed in the 'Getting to 60%' section.

Turnaround time

The turnaround time of the high cost packages is estimated to be six to eight weeks.

Table 20: Top storey flats - solid walled: high cost carbon reduction packages

Scenario	Wall construction	Heating system	Glazing type	Base case			60% target	High cost package					
				fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)	
1	Solid wall	gas boiler	double glazing	363	60	3.6	1.4	170	193	84	1.4	2.2	<p>Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new boiler and controls, full external insulation, new windows, 0.1kWp PV Cost: £9,300</p>
2	Solid wall	gas boiler	single glazing	370	60	3.7	1.5	178	192	83	1.5	2.2	
3	Solid wall	gas boiler, electric secondary	double glazing	411	55	3.7	1.5	178	233	83	1.5	2.2	
4	Solid wall	gas boiler, electric secondary	single glazing	420	54	3.8	1.5	178	242	83	1.5	2.3	
5	Solid wall	storage heaters	double glazing	560	39	6.0	2.4	210	350	79	2.1	3.9	
6	Solid wall	storage heaters	single glazing	577	37	6.2	2.5	210	367	79	2.1	4.1	

Table 21: Mid storey flats - solid walled: high cost carbon reduction packages

Scenario	Wall construction	Heating system	Glazing type	Base case			60% target	High cost package					
				fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)	
1	Solid wall	gas boiler	double glazing	317	66	3.0	1.2	147	170	86	1.1	1.9	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, full external insulation, new windows Cost: £7,050
2	Solid wall	gas boiler	single glazing	325	65	3.2	1.3	147	178	86	1.1	2.1	
3	Solid wall	gas boiler, electric secondary	double glazing	355	61	3.2	1.3	147	208	86	1.1	2.1	
4	Solid wall	gas boiler, electric secondary	single glazing	365	60	3.3	1.3	147	218	86	1.1	2.2	
5	Solid wall	storage heaters	double glazing	471	48	5.0	2.0	193	278	81	1.9	3.1	
6	Solid wall	storage heaters	single glazing	488	46	5.2	2.1	193	295	81	1.9	3.3	

Table 22: Ground storey flats - solid walled: high cost carbon reduction packages

Scenario	Wall construction	Heating system	Glazing type	Base case			60% target	High cost package					
				fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)	
1	Solid wall	gas boiler	double glazing	349	62	3.5	1.4	172	177	83	1.4	2.1	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, full external insulation, floor insulation, new windows Cost: £8,950
2	Solid wall	gas boiler	single glazing	357	61	3.6	1.4	172	185	83	1.4	2.2	
3	Solid wall	gas boiler, electric secondary	double glazing	399	56	3.7	1.5	172	227	83	1.4	2.3	
4	Solid wall	gas boiler, electric secondary	single glazing	408	55	3.8	1.5	172	236	83	1.4	2.4	
5	Solid wall	storage heaters	double glazing	558	39	6.2	2.5	234	324	76	2.4	3.8	
6	Solid wall	storage heaters	single glazing	575	38	6.4	2.6	234	341	76	2.4	4.0	

Table 23: Top storey flats - uninsulated cavity walled: high cost carbon reduction packages

Scenario	Wall construction	Heating system	Glazing type	Base case			60% target	High cost package				
				fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
7	Uninsulated cavity	gas boiler	double glazing	331	64	3.2	1.3	160	171	85	1.3	1.9
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, cavity wall insulation, new door, new boiler and controls, full external insulation, new windows, 0.3kWp PV Cost: £10,550				
8	Uninsulated cavity	gas boiler	single glazing	339	63	3.3	1.3	160	179	85	1.3	2.0
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, cavity wall insulation, new door, new boiler and controls, full external insulation, new windows, 0.3kWp PV Cost: £10,550				
9	Uninsulated cavity	gas boiler, electric secondary	double glazing	372	59	3.3	1.3	160	212	85	1.3	2.0
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, cavity wall insulation, new door, new boiler and controls, full external insulation, new windows, 0.3kWp PV Cost: £10,550				
10	Uninsulated cavity	gas boiler, electric secondary	single glazing	382	58	3.4	1.4	170	212	84	1.4	2.0
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, cavity wall insulation, new door, new boiler and controls, full external insulation, new windows, 0.1kWp PV Cost: £8,950				
11	Uninsulated cavity	storage heaters	double glazing	492	45	5.3	2.1	210	282	79	2.1	3.2
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, cavity wall insulation, new door, new storage heaters and controls, full external insulation, new windows, stand alone dual coil cylinder and solar water heating Cost: £10,300				
12	Uninsulated cavity	storage heaters	single glazing	510	44	5.5	2.2	210	300	79	2.1	3.4
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, cavity wall insulation, new door, new storage heaters and controls, full external insulation, new windows, stand alone dual coil cylinder and solar water heating Cost: £10,300				

Table 24: Mid storey flats - uninsulated cavity walled: high cost carbon reduction packages

Scenario	Wall construction	Heating system	Glazing type	Base case			60% target	High cost package					
				fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)	
7	Uninsulated cavity	gas boiler	double glazing	283	70	2.6	1.0	133	150	88	1.0	1.6	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new boiler and controls, full external insulation, new windows, 0.3kWp PV Cost: £10,100
8	Uninsulated cavity	gas boiler	single glazing	291	69	2.8	1.1	147	144	86	1.1	1.7	
9	Uninsulated cavity	gas boiler, electric secondary	double glazing	314	66	2.7	1.1	147	167	86	1.1	1.6	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new boiler and controls, full external insulation, new windows Cost: £6,700
10	Uninsulated cavity	gas boiler, electric secondary	single glazing	325	65	2.9	1.2	147	178	86	1.1	1.8	
11	Uninsulated cavity	storage heaters	double glazing	403	56	4.2	1.7	193	210	81	1.9	2.3	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new storage heaters and controls, full external insulation, new windows, new hot water cylinder Cost: £7,100
12	Uninsulated cavity	storage heaters	single glazing	421	54	4.4	1.8	173	248	83	1.8	2.6	

Table 25: Ground storey flats - uninsulated cavity walled: high cost carbon reduction packages

Scenario	Wall construction	Heating system	Glazing type	Base case			60% target	High cost package					
				fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)	
7	Uninsulated cavity	gas boiler	double glazing	286	70	2.7	1.1	172	114	83	1.4	1.3	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new boiler and controls, full external insulation, new windows, floor insulation Cost: £8,600
8	Uninsulated cavity	gas boiler	single glazing	295	69	2.8	1.1	172	123	83	1.4	1.4	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new boiler and controls, full external insulation, new windows, floor insulation Cost: £8,600
9	Uninsulated cavity	gas boiler, electric secondary	double glazing	317	66	2.8	1.1	172	145	83	1.4	1.4	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new boiler and controls, full external insulation, new windows, floor insulation Cost: £8,600
10	Uninsulated cavity	gas boiler, electric secondary	single glazing	328	65	2.9	1.2	172	156	83	1.4	1.5	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new boiler and controls, full external insulation, new windows, floor insulation Cost: £8,600
11	Uninsulated cavity	storage heaters	double glazing	403	56	4.2	1.7	234	169	76	2.4	1.8	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new boiler and controls, full external insulation, new windows, floor insulation Cost: £8,600
12	Uninsulated cavity	storage heaters	single glazing	421	54	4.4	1.8	234	187	76	2.4	2.0	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new boiler and controls, full external insulation, new windows, floor insulation Cost: £8,600

Table 26: Top storey flats - insulated cavity walled: high cost carbon reduction packages

Scenario	Wall construction	Heating system	Glazing type	Base case			60% target	High cost package					
				fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)	
13	Insulated cavity	gas boiler glazing	double	270	72	2.5	1.0	178	92	83	1.5	1.0	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new boiler and controls, full external insulation, new windows Cost: £6,550
14	Insulated cavity	gas boiler	single glazing	278	71	2.6	1.0	178	100	83	1.5	1.1	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new boiler and controls, full external insulation, new windows Cost: £6,550
15	Insulated cavity	gas boiler, electric secondary	double glazing	297	68	2.6	1.0	178	119	83	1.5	1.1	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new boiler and controls, full external insulation, new windows Cost: £6,550
16	Insulated cavity	gas boiler, electric secondary	single glazing	308	67	2.7	1.1	178	130	83	1.5	1.2	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new boiler and controls, full external insulation, new windows Cost: £6,550
17	Insulated cavity	storage heaters	double glazing	372	59	3.9	1.6	210	162	79	2.1	1.8	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new storage heaters and controls, full external insulation, new windows, stand alone dual coil cylinder and solar water heating Cost: £9,700
18	Insulated cavity	storage heaters	single glazing	389	57	4.1	1.6	210	179	79	2.1	2.0	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new storage heaters and controls, full external insulation, new windows, stand alone dual coil cylinder and solar water heating Cost: £9,700

Table 27: Mid storey flats - insulated cavity walled: high cost carbon reduction packages

Scenario	Wall construction	Heating system	Glazing type	Base case			60% target	High cost package					
				fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)	
13	Insulated cavity	gas boiler	double glazing	221	77	1.9	0.8	147	74	86	1.1	0.8	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, full external insulation, new windows Cost: £6,100
14	Insulated cavity	gas boiler	single glazing	230	76	2.0	0.8	147	83	86	1.1	0.9	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, full external insulation, new windows Cost: £6,100
15	Insulated cavity	gas boiler, electric secondary	double glazing	239	75	2.0	0.8	147	92	86	1.1	0.9	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, full external insulation, new windows Cost: £6,100
16	Insulated cavity	gas boiler, electric secondary	single glazing	249	74	2.1	0.8	147	102	86	1.1	1.0	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, full external insulation, new windows Cost: £6,100
17	Insulated cavity	storage heaters	double glazing	284	70	2.9	1.2	193	91	81	1.9	1.0	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new storage heaters and controls, full external insulation, new windows, new hot water cylinder Cost: £6,500
18	Insulated cavity	storage heaters	single glazing	301	68	3.1	1.2	193	108	81	1.9	1.2	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new storage heaters and controls, full external insulation, new windows, new hot water cylinder Cost: £6,500

Table 28: Ground storey flats - insulated cavity walled: high cost carbon reduction packages

Scenario	Wall construction	Heating system	Glazing type	Base case			60% target	High cost package					
				fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)	
13	Insulated cavity	gas boiler	double glazing	257	73	2.4	1.0	172	85	83	1.4	1.0	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, full external insulation, floor insulation, new windows Cost: £8,000
14	Insulated cavity	gas boiler	single glazing	266	72	2.6	1.0	172	94	83	1.4	1.2	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, full external insulation, floor insulation, new windows Cost: £8,000
15	Insulated cavity	gas boiler, electric secondary	double glazing	286	70	2.5	1.0	172	114	83	1.4	1.1	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, full external insulation, floor insulation, new windows Cost: £8,000
16	Insulated cavity	gas boiler, electric secondary	single glazing	298	68	2.7	1.1	172	126	83	1.4	1.3	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, full external insulation, floor insulation, new windows Cost: £8,000
17	Insulated cavity	storage heaters	double glazing	368	60	4.0	1.6	234	134	76	2.4	1.6	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new storage heaters and controls, full external insulation, floor insulation, new windows Cost: £8,000
18	Insulated cavity	storage heaters	single glazing	386	58	4.2	1.7	234	152	76	2.4	1.8	Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new storage heaters and controls, full external insulation, floor insulation, new windows Cost: £8,000

3.4 Getting to 60%

Several of the high cost packages failed to achieve a 60% reduction in carbon emissions, and therefore further packages of measures were necessary. Measures considered for this category are in addition to the low, medium and high cost measures already recommended above (shown in blue below). These packages nominally represent work to a total value of £10,000 and higher.

- Low energy lighting
- Draught proofing
- Loft insulation
- Cavity wall insulation
- Replacement front door
- New boiler and controls
- New radiator system (electric heating only)
- External insulation
- Floor insulation
- New windows
- New hot water cylinder
- Renewable power – solar thermal water heating
- New heating system – air source heat pump
- Renewable power – photovoltaic electricity generation

A variety of further options are also available, including wind power and ground source heat pumps. These options are worth investigating, but for both a detailed site analysis will be necessary. Further potential systems include gas or biomass communal heating systems or combined heat and power. To appraise the costs and practicalities of these systems was beyond the scope of this report. However, when planning to spend £10,000 and over per property, it is recommended that these options are also investigated.

100% of these packages achieve a 60% reduction in carbon emissions.

Note that scenarios which required further elements in order to reach the 60% target emissions are highlighted in yellow.

Scenarios which achieved a 60% reduction under the high cost packages previously are not shown below.

Table 29: Mid storey flats - uninsulated cavity walled: 60% carbon reduction packages

Scenario	Wall construction	Heating system	Glazing type	Base case			60% target	High cost package				
				fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
11	Uninsulated cavity	storage heaters	double glazing	403	56	4.2	1.7	169	234	84	1.7	2.5
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new storage heaters and controls, full external insulation, new windows, new hot water cylinder, 0.4kWp PV				
								Cost: £11,300				

Table 30: Ground storey flats - uninsulated cavity walled: 60% carbon reduction packages

Scenario	Wall construction	Heating system	Glazing type	Base case			60% target	High cost package				
				fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
7	Uninsulated cavity	gas boiler	double glazing	286	70	2.7	1.1	138	148	87	1.1	1.6
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new boiler and controls, full external insulation, new windows, floor insulation 0.7kWp PV				
								Cost: £15,200				
8	Uninsulated cavity	gas boiler	single glazing	295	69	2.8	1.1	138	157	87	1.1	1.7
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new boiler and controls, full external insulation, new windows, floor insulation 0.7kWp PV				
								Cost: £15,200				
9	Uninsulated cavity	gas boiler, electric secondary	double glazing	317	66	2.8	1.1	138	179	87	1.1	1.7
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new boiler and controls, full external insulation, new windows, floor insulation 0.7kWp PV				
								Cost: £15,200				
10	Uninsulated cavity	gas boiler, electric secondary	single glazing	328	65	2.9	1.2	148	180	86	1.2	1.7
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, new boiler and controls, full external insulation, new windows, floor insulation 0.5kWp PV				
								Cost: £13,600				
11	Uninsulated cavity	storage heaters	double glazing	403	56	4.2	1.7	234	169	76	1.4	2.8
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, full external insulation, new windows, floor insulation, air source heat pump with air distribution				
								Cost: £13,200				
12	Uninsulated cavity	storage heaters	single glazing	421	54	4.4	1.8	234	187	76	1.4	3.0
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, cavity wall insulation, new door, full external insulation, new windows, floor insulation, air source heat pump with air distribution				
								Cost: £13,200				

Table 31: Top storey flats - insulated cavity walled: 60% carbon reduction packages

Scenario	Wall construction	Heating system	Glazing type	Base case			60% target	High cost package				
				fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
13	Insulated cavity	gas boiler	double glazing	270	72	2.5	1.0	127	143	89	1.0	1.5
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new boiler and controls, full external insulation, new windows, 1kWp PV Cost: £15,500				
14	Insulated cavity	gas boiler	single glazing	278	71	2.6	1.0	127	151	89	1.0	1.6
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new boiler and controls, full external insulation, new windows, 1kWp PV Cost: £15,500				
15	Insulated cavity	gas boiler, electric secondary	double glazing	297	68	2.6	1.0	127	170	89	1.0	1.6
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new boiler and controls, full external insulation, new windows, 1kWp PV Cost: £15,500				
16	Insulated cavity	gas boiler, electric secondary	single glazing	308	67	2.7	1.1	148	180	86	1.2	1.6
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new boiler and controls, full external insulation, new windows, 0.8kWp PV Cost: £13,950				
17	Insulated cavity	storage heaters	double glazing	372	59	3.9	1.6	230	142	76	1.4	2.5
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new storage heaters and controls, full external insulation, new windows, stand alone dual coil cylinder and solar water heating 0.9kWp PV Cost: £17,900				
18	Insulated cavity	storage heaters	single glazing	389	57	4.1	1.6	230	159	76	1.4	2.7
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, loft insulation, new door, new storage heaters and controls, full external insulation, new windows, stand alone dual coil cylinder and solar water heating 0.9kWp PV Cost: £17,900				

Table 32: Mid storey flats - insulated cavity walled: 60% carbon reduction packages

Scenario	Wall construction	Heating system	Glazing type	Base case			60% target	High cost package				
				fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
13	Insulated cavity	gas boiler	double glazing	221	77	1.9	0.8	110	111	91	0.8	1.1
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, full external insulation, new windows, 0.8kWp PV Cost: £13,500				
14	Insulated cavity	gas boiler	single glazing	230	76	2.0	0.8	110	120	91	0.8	1.2
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, full external insulation, new windows, 0.8kWp PV Cost: £13,500				
15	Insulated cavity	gas boiler, electric secondary	double glazing	239	75	2.0	0.8	110	129	91	0.8	1.2
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, full external insulation, new windows, 0.8kWp PV Cost: £13,500				
16	Insulated cavity	gas boiler, electric secondary	single glazing	249	74	2.1	0.8	110	139	91	0.8	1.3
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, full external insulation, new windows, 0.8kWp PV Cost: £13,500				
17	Insulated cavity	storage heaters	double glazing	284	70	2.9	1.2	209	75	79	1.2	1.7
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, full external insulation, new windows, new hot water cylinder, air source heat pump with air distribution Cost: £11,300				
18	Insulated cavity	storage heaters	single glazing	301	68	3.1	1.2	209	92	79	1.2	1.9
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, full external insulation, new windows, new hot water cylinder, air source heat pump with air distribution Cost: £11,300				

Table 33: Ground storey flats - insulated cavity walled: 60% carbon reduction packages

Scenario	Wall construction	Heating system	Glazing type	Base case			60% target	High cost package				
				fuel cost (£/yr)	SAP rating	CO ₂ (t/yr)		fuel cost (£/yr)	cost saving (£/yr)	SAP rating	CO ₂ (t/yr)	CO ₂ saving (t/yr)
13	Insulated cavity	gas boiler	double glazing	257	73	2.4	1.0	105	152	91	0.8	1.6
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, full external insulation, floor insulation, new windows, 1.4kWp PV Cost: £20,200				
14	Insulated cavity	gas boiler	single glazing	266	72	2.6	1.0	105	161	91	0.8	1.8
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, full external insulation, floor insulation, new windows, 1.4kWp PV Cost: £20,200				
15	Insulated cavity	gas boiler, electric secondary	double glazing	286	70	2.5	1.0	105	181	91	0.8	1.7
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, full external insulation, floor insulation, new windows, 1.4kWp PV Cost: £20,200				
16	Insulated cavity	gas boiler, electric secondary	single glazing	298	68	2.7	1.1	105	193	91	0.8	1.9
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, new boiler and controls, full external insulation, floor insulation, new windows, 1.4kWp PV Cost: £20,200				
17	Insulated cavity	storage heaters	double glazing	368	60	4.0	1.6	215	153	78	1.2	2.8
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, full external insulation, floor insulation, new windows, air source heat pump, 0.4kWp PV Cost: £18,200				
18	Insulated cavity	storage heaters	single glazing	386	58	4.2	1.7	215	171	78	1.2	3.0
								Improvements: dedicated low energy lighting, draught proofing throughout dwelling, new door, full external insulation, floor insulation, new windows, air source heat pump, 0.4kWp PV Cost: £18,200				

4. Comparison

The following pages contain several graphs, which provide a comparison between the various scenarios outlined above. Note that all costs have been calculated based on achieving a 60% reduction in CO₂.

For simplicity the scenarios have been numbered 1 to 18, for each storey (ground, mid or top), and the distinction between storeys has been highlighted by colour coding – yellow for top, orange for mid and blue for ground. This was considered easier to understand than numbering all scenarios individually from 1 to 54.

The following parameters are presented:

Cost per tonne of CO₂ saved (comparative bar chart - all scenarios - page 50-51)

- This chart gives a visual representation of the comparative baseline performance of each scenario, as well as the reduction in CO₂ produced by the low, medium and high cost packages.
- The cost per tonne of CO₂ saved has also been presented, which has been calculated by dividing the total cost of measures by the annual reduction in tonnes of CO₂.

Cost per SAP point increase (comparative bar chart - all scenarios - page 52-53)

- This chart gives a visual representation of the comparative baseline performance of each scenario, as well as the increase in SAP rating produced by the low, medium and high cost packages.
- A SAP rating of 65 indicates the point at which there is minimal risk of a dwelling being in fuel poverty, and is marked by the red line on the chart.
- The cost per individual SAP point increase is also presented, which has been calculated by dividing the total cost of measures by the number of SAP points increase.

Cost per tonne of CO₂ saved (ranking on a storey by storey basis - page 54-55)

Cost per tonne of CO₂ saved (overall ranking - page 56)

- These tables rank the most cost effective scenarios for CO₂ reductions. The cost effectiveness has been calculated by dividing the total cost of measures by the annual reduction in tonnes of CO₂.
- They will be of interest to those seeking to make cost effective CO₂ reductions across their stock.
- Scenarios are ranked within the top, mid and ground storeys, as well as overall.

Cost per SAP point increase (ranking on a storey by storey basis - page 57-58)

Cost per SAP point increase (overall ranking - page 59)

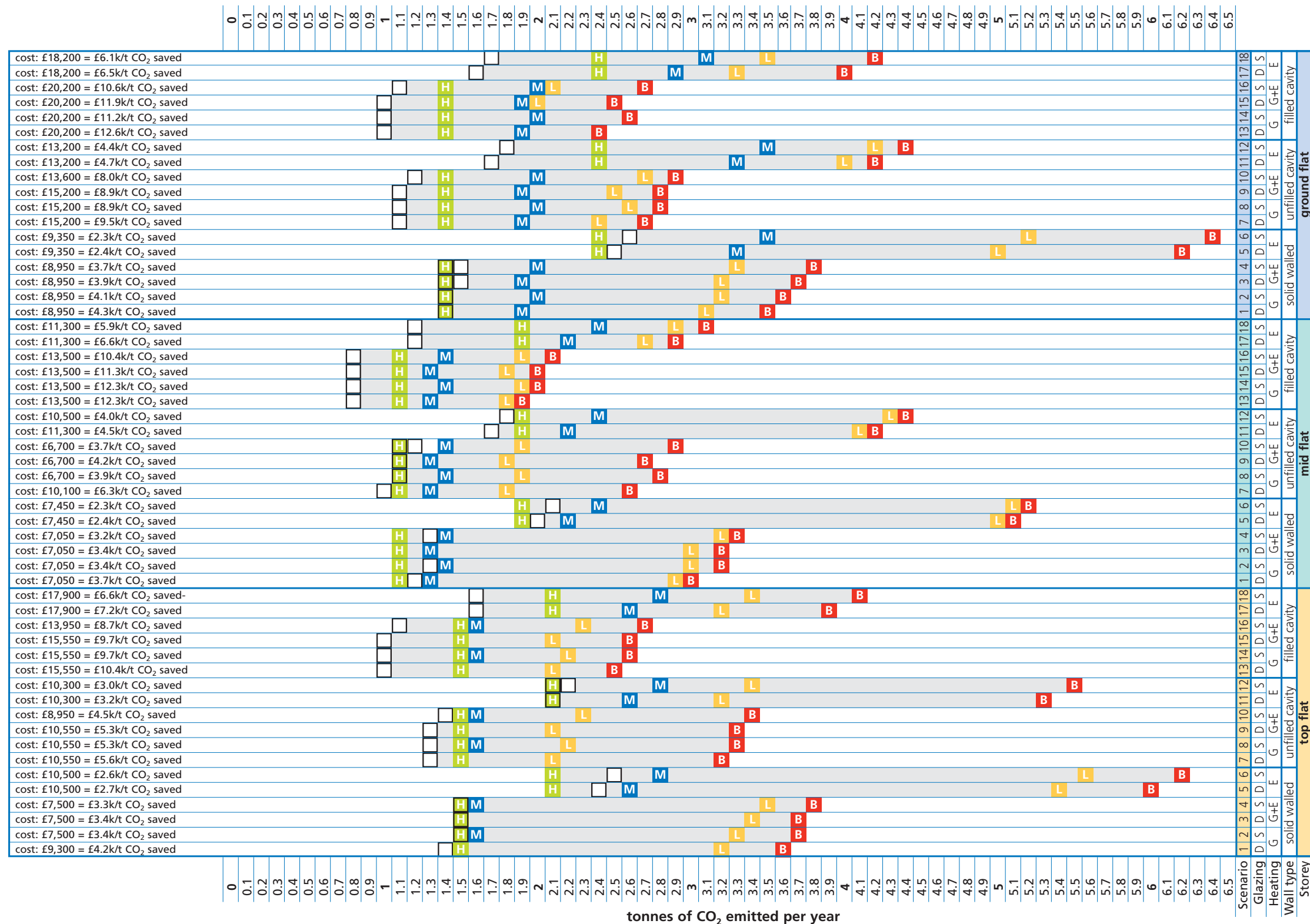
- These tables rank the most cost effective scenarios for increasing a dwelling's SAP rating. The cost effectiveness has been calculated by dividing the total cost of measures by the number of SAP points increase.
- They will be of interest to those seeking to reduce fuel poverty in the most cost effective way.
- Scenarios are ranked within the top, mid and ground storeys, as well as overall.

Combined costs per tonne of CO₂ saved + SAP point increase (ranking on a storey by storey basis - page 60-61)

Combined costs per tonne of CO₂ saved + SAP point increase (overall ranking - page 62)

- These tables rank the combined cost per tonne of CO₂ saved, and per SAP point increased, in order to provide one overall indicator of cost effectiveness.
- The tables will be of interest to those who wish to make CO₂ reductions across their stock, in combination with achieving cost effective reductions in fuel poverty.
- Scenarios are ranked within the top, mid and ground storeys, as well as overall.

Table 34: Cost per tonne of CO₂ saved – all scenarios



Key
 D = double glazed
 S = single glazed
 G = gas heating
 G+E = gas heating with electric secondary
 E = electric heating
 B = baseline CO₂ emissions (decent homes)
 L = low cost package CO₂ emissions
 M = medium cost package CO₂ emissions
 H = high cost package CO₂ emissions
 □ = 60% target CO₂ emissions

Table 36: Cost per tonne of CO₂ saved (ranking by storey) – top storey

Storey	Wall type	Scenario	Heating type	Glazing type	Costs to achieve 60% CO ₂ reduction (£)	Tonnes of CO ₂ saved per year	Cost per tonne of CO ₂ saved (£)	Ranking
Top flat	Solid	6	Electric	Single	10,500	4.1	2561	1
Top flat	Solid	5	Electric	Double	10,500	3.9	2692	2
Top flat	Unfilled	12	Electric	Single	10,300	3.4	3029	3
Top flat	Unfilled	11	Electric	Double	10,300	3.2	3219	4
Top flat	Solid	4	Gas & electric	Single	7,500	2.3	3261	5
Top flat	Solid	2	Gas	Single	7,500	2.2	3409	6
Top flat	Solid	3	Gas & electric	Double	7,500	2.2	3409	7
Top flat	Solid	1	Gas	Double	9,300	2.2	4227	8
Top flat	Unfilled	10	Gas & electric	Single	8,950	2.0	4475	9
Top flat	Unfilled	8	Gas	Single	10,550	2.0	5275	10
Top flat	Unfilled	9	Gas & electric	Double	10,550	2.0	5275	11
Top flat	Unfilled	7	Gas	Double	10,550	1.9	5553	12
Top flat	Filled	18	Electric	Single	17,900	2.7	6630	13
Top flat	Filled	17	Electric	Double	17,900	2.5	7160	14
Top flat	Filled	16	Gas & electric	Single	13,950	1.6	8719	15
Top flat	Filled	14	Gas	Single	15,550	1.6	9719	16
Top flat	Filled	15	Gas & electric	Double	15,550	1.6	9719	17
Top flat	Filled	13	Gas	Double	15,550	1.5	10367	18

Table 37: Cost per tonne of CO₂ saved (ranking by storey) – mid storey

Storey	Wall type	Scenario	Heating type	Glazing type	Costs to achieve 60% CO ₂ reduction (£)	Tonnes of CO ₂ saved per year	Cost per tonne of CO ₂ saved (£)	Ranking
Mid flat	Solid	6	Electric	Single	7,450	3.3	2258	1
Mid flat	Solid	5	Electric	Double	7,450	3.1	2403	2
Mid flat	Solid	4	Gas & electric	Single	7,050	2.2	3205	3
Mid flat	Solid	2	Gas	Single	7,050	2.1	3357	4
Mid flat	Solid	3	Gas & electric	Double	7,050	2.1	3357	5
Mid flat	Solid	1	Gas	Double	7,050	1.9	3711	6
Mid flat	Unfilled	10	Gas & electric	Single	6,700	1.8	3722	7
Mid flat	Unfilled	8	Gas	Single	6,700	1.7	3941	8
Mid flat	Unfilled	12	Electric	Single	10,500	2.6	4038	9
Mid flat	Unfilled	9	Gas & electric	Double	6,700	1.6	4188	10
Mid flat	Unfilled	11	Electric	Double	11,300	2.5	4520	11
Mid flat	Filled	18	Electric	Single	11,300	1.9	5947	12
Mid flat	Unfilled	7	Gas	Double	10,100	1.6	6313	13
Mid flat	Filled	17	Electric	Double	11,300	1.7	6647	14
Mid flat	Filled	16	Gas & electric	Single	13,500	1.3	10385	15
Mid flat	Filled	14	Gas	Single	13,500	1.2	11250	16
Mid flat	Filled	15	Gas & electric	Double	13,500	1.2	11250	17
Mid flat	Filled	13	Gas	Double	13,500	1.1	12273	18

Table 38: Cost per tonne of CO₂ saved (ranking by storey) – ground storey

Storey	Wall type	Scenario	Heating type	Glazing type	Costs to achieve 60% CO ₂ reduction (£)	Tonnes of CO ₂ saved per year	Cost per tonne of CO ₂ saved (£)	Ranking
Ground flat	Solid	6	Electric	Single	9,350	4.0	2338	1
Ground flat	Solid	5	Electric	Double	9,350	3.8	2461	2
Ground flat	Solid	4	Gas & electric	Single	8,950	2.4	3729	3
Ground flat	Solid	3	Gas & electric	Double	8,950	2.3	3891	4
Ground flat	Solid	2	Gas	Single	8,950	2.2	4068	5
Ground flat	Solid	1	Gas	Double	8,950	2.1	4262	6
Ground flat	Unfilled	12	Electric	Single	13,200	3.0	4400	7
Ground flat	Unfilled	11	Electric	Double	13,200	2.8	4714	8
Ground flat	Filled	18	Electric	Single	18,200	3.0	6067	9
Ground flat	Filled	17	Electric	Double	18,200	2.8	6500	10
Ground flat	Unfilled	10	Gas & electric	Single	13,600	1.7	8000	11
Ground flat	Unfilled	8	Gas	Single	15,200	1.7	8941	12
Ground flat	Unfilled	9	Gas & electric	Double	15,200	1.7	8941	13
Ground flat	Unfilled	7	Gas	Double	15,200	1.6	9500	14
Ground flat	Filled	16	Gas & electric	Single	20,200	1.9	10632	15
Ground flat	Filled	14	Gas	Single	20,200	1.8	11222	16
Ground flat	Filled	15	Gas & electric	Double	20,200	1.7	11882	17
Ground flat	Filled	13	Gas	Double	20,200	1.6	12625	18

Table 39: Cost per tonne of CO₂ saved (overall ranking)

Storey	Wall type	Scenario	Heating type	Glazing type	Costs to achieve 60% CO ₂ reduction (£)	Tonnes of CO ₂ saved per year	Cost per tonne of CO ₂ saved (£)	Ranking
Mid flat	Solid	6	Electric	Single	7,450	3.3	2258	1
Ground flat	Solid	6	Electric	Single	9,350	4.0	2338	2
Mid flat	Solid	5	Electric	Double	7,450	3.1	2403	3
Ground flat	Solid	5	Electric	Double	9,350	3.8	2461	4
Top flat	Solid	6	Electric	Single	10,500	4.1	2561	5
Top flat	Solid	5	Electric	Double	10,500	3.9	2692	6
Top flat	Unfilled	12	Electric	Single	10,300	3.4	3029	7
Mid flat	Solid	4	Gas & electric	Single	7,050	2.2	3205	8
Top flat	Unfilled	11	Electric	Double	10,300	3.2	3219	9
Top flat	Solid	4	Gas & electric	Single	7,500	2.3	3261	10
Mid flat	Solid	2	Gas	Single	7,050	2.1	3357	11
Mid flat	Solid	3	Gas & electric	Double	7,050	2.1	3357	12
Top flat	Solid	2	Gas	Single	7,500	2.2	3409	13
Top flat	Solid	3	Gas & electric	Double	7,500	2.2	3409	14
Mid flat	Solid	1	Gas	Double	7,050	1.9	3711	15
Mid flat	Unfilled	10	Gas & electric	Single	6,700	1.8	3722	16
Ground flat	Solid	4	Gas & electric	Single	8,950	2.4	3729	17
Ground flat	Solid	3	Gas & electric	Double	8,950	2.3	3891	18
Mid flat	Unfilled	8	Gas	Single	6,700	1.7	3941	19
Mid flat	Unfilled	12	Electric	Single	10,500	2.6	4038	20
Ground flat	Solid	2	Gas	Single	8,950	2.2	4068	21
Mid flat	Unfilled	9	Gas & electric	Double	6,700	1.6	4188	22
Top flat	Solid	1	Gas	Double	9,300	2.2	4227	23
Ground flat	Solid	1	Gas	Double	8,950	2.1	4262	24
Ground flat	Unfilled	12	Electric	Single	13,200	3.0	4400	25
Top flat	Unfilled	10	Gas & electric	Single	8,950	2.0	4475	26
Mid flat	Unfilled	11	Electric	Double	11,300	2.5	4520	27
Ground flat	Unfilled	11	Electric	Double	13,200	2.8	4714	28
Top flat	Unfilled	8	Gas	Single	10,550	2.0	5275	29
Top flat	Unfilled	9	Gas & electric	Double	10,550	2.0	5275	30
Top flat	Unfilled	7	Gas	Double	10,550	1.9	5553	31
Mid flat	Filled	18	Electric	Single	11,300	1.9	5947	32
Ground flat	Filled	18	Electric	Single	18,200	3.0	6067	33
Mid flat	Unfilled	7	Gas	Double	10,100	1.6	6313	34
Ground flat	Filled	17	Electric	Double	18,200	2.8	6500	35
Top flat	Filled	18	Electric	Single	17,900	2.7	6630	36
Mid flat	Filled	17	Electric	Double	11,300	1.7	6647	37
Top flat	Filled	17	Electric	Double	17,900	2.5	7160	38
Ground flat	Unfilled	10	Gas & electric	Single	13,600	1.7	8000	39
Top flat	Filled	16	Gas & electric	Single	13,950	1.6	8719	40
Ground flat	Unfilled	8	Gas	Single	15,200	1.7	8941	41
Ground flat	Unfilled	9	Gas & electric	Double	15,200	1.7	8941	42
Ground flat	Unfilled	7	Gas	Double	15,200	1.6	9500	43
Top flat	Filled	14	Gas	Single	15,550	1.6	9719	44
Top flat	Filled	15	Gas & electric	Double	15,550	1.6	9719	45
Top flat	Filled	13	Gas	Double	15,550	1.5	10367	46
Mid flat	Filled	16	Gas & electric	Single	13,500	1.3	10385	47
Ground flat	Filled	16	Gas & electric	Single	20,200	1.9	10632	48
Ground flat	Filled	14	Gas	Single	20,200	1.8	11222	49
Mid flat	Filled	14	Gas	Single	13,500	1.2	11250	50
Mid flat	Filled	15	Gas & electric	Double	13,500	1.2	11250	51
Ground flat	Filled	15	Gas & electric	Double	20,200	1.7	11882	52
Mid flat	Filled	13	Gas	Double	13,500	1.1	12273	53
Ground flat	Filled	13	Gas	Double	20,200	1.6	12625	54

Table 40: Cost per SAP point increase (ranking by storey) – top storey

Storey	Wall type	Scenario	Heating type	Glazing type	Costs to achieve 60% CO ₂ reduction (£)	SAP point increase	Cost per point (£)	Ranking
Top flat	Solid	6	Electric	Single	10,500	42	250	1
Top flat	Solid	4	Gas & electric	Single	7,500	29	259	2
Top flat	Solid	5	Electric	Double	10,500	40	263	3
Top flat	Solid	3	Gas & electric	Double	7,500	28	268	4
Top flat	Unfilled	12	Electric	Single	10,300	35	294	5
Top flat	Unfilled	11	Electric	Double	10,300	34	303	6
Top flat	Solid	2	Gas	Single	7,500	23	326	7
Top flat	Unfilled	10	Gas & electric	Single	8,950	26	344	8
Top flat	Solid	1	Gas	Double	9,300	24	388	9
Top flat	Unfilled	9	Gas & electric	Double	10,550	26	406	10
Top flat	Unfilled	8	Gas	Single	10,550	22	480	11
Top flat	Unfilled	7	Gas	Double	10,550	21	502	12
Top flat	Filled	18	Electric	Single	17,900	29	617	13
Top flat	Filled	17	Electric	Double	17,900	27	663	14
Top flat	Filled	16	Gas & electric	Single	13,950	21	664	15
Top flat	Filled	15	Gas & electric	Double	15,550	21	741	16
Top flat	Filled	14	Gas	Single	15,550	18	864	17
Top flat	Filled	13	Gas	Double	15,550	17	915	18

Table 41: Cost per SAP point increase (ranking by storey) – mid storey

Storey	Wall type	Scenario	Heating type	Glazing type	Costs to achieve 60% CO ₂ reduction (£)	SAP point increase	Cost per point (£)	Ranking
Mid flat	Solid	6	Electric	Single	7,450	35	213	1
Mid flat	Solid	5	Electric	Double	7,450	33	226	2
Mid flat	Solid	4	Gas & electric	Single	7,050	26	271	3
Mid flat	Solid	3	Gas & electric	Double	7,050	25	282	4
Mid flat	Unfilled	10	Gas & electric	Single	6,700	21	319	5
Mid flat	Unfilled	9	Gas & electric	Double	6,700	20	335	6
Mid flat	Solid	2	Gas	Single	7,050	21	336	7
Mid flat	Solid	1	Gas	Double	7,050	20	353	8
Mid flat	Unfilled	12	Electric	Single	10,500	29	362	9
Mid flat	Unfilled	8	Gas	Single	6,700	17	394	10
Mid flat	Unfilled	11	Electric	Double	11,300	28	404	11
Mid flat	Unfilled	7	Gas	Double	10,100	18	561	12
Mid flat	Filled	16	Gas & electric	Single	13,500	17	794	13
Mid flat	Filled	15	Gas & electric	Double	13,500	16	844	14
Mid flat	Filled	14	Gas	Single	13,500	15	900	15
Mid flat	Filled	13	Gas	Double	13,500	14	964	16
Mid flat	Filled	18	Electric	Single	11,300	11	1027	17
Mid flat	Filled	17	Electric	Double	11,300	9	1256	18

Table 42: Cost per SAP point increase (ranking by storey) – ground storey

Storey	Wall type	Scenario	Heating type	Glazing type	Costs to achieve 60% CO ₂ reduction (£)	SAP point increase	Cost per point (£)	Ranking
Ground flat	Solid	6	Electric	Single	9,350	38	246	1
Ground flat	Solid	5	Electric	Double	9,350	37	253	2
Ground flat	Solid	4	Gas & electric	Single	8,950	28	320	3
Ground flat	Solid	3	Gas & electric	Double	8,950	27	331	4
Ground flat	Solid	2	Gas	Single	8,950	22	407	5
Ground flat	Solid	1	Gas	Double	8,950	21	426	6
Ground flat	Unfilled	12	Electric	Single	13,200	22	600	7
Ground flat	Unfilled	10	Gas & electric	Single	13,600	21	648	8
Ground flat	Unfilled	11	Electric	Double	13,200	20	660	9
Ground flat	Unfilled	9	Gas & electric	Double	15,200	21	724	10
Ground flat	Unfilled	8	Gas	Single	15,200	18	844	11
Ground flat	Filled	16	Gas & electric	Single	20,200	23	878	12
Ground flat	Unfilled	7	Gas	Double	15,200	17	894	13
Ground flat	Filled	18	Electric	Single	18,200	20	910	14
Ground flat	Filled	15	Gas & electric	Double	20,200	21	962	15
Ground flat	Filled	17	Electric	Double	18,200	18	1011	16
Ground flat	Filled	14	Gas	Single	20,200	19	1063	17
Ground flat	Filled	13	Gas	Double	20,200	18	1122	18

Table 43: Cost per SAP point increase (overall ranking)

Storey	Wall type	Scenario	Heating type	Glazing type	Costs to achieve 60% CO ₂ reduction (£)	SAP point increase	Cost per point (£)	Ranking
Mid flat	Solid	6	Electric	Single	7,450	35	213	1
Mid flat	Solid	5	Electric	Double	7,450	33	226	2
Ground flat	Solid	6	Electric	Single	9,350	38	246	3
Top flat	Solid	6	Electric	Single	10,500	42	250	4
Ground flat	Solid	5	Electric	Double	9,350	37	253	5
Top flat	Solid	4	Gas & electric	Single	7,500	29	259	6
Top flat	Solid	5	Electric	Double	10,500	40	263	7
Top flat	Solid	3	Gas & electric	Double	7,500	28	268	8
Mid flat	Solid	4	Gas & electric	Single	7,050	26	271	9
Mid flat	Solid	3	Gas & electric	Double	7,050	25	282	10
Top flat	Unfilled	12	Electric	Single	10,300	35	294	11
Top flat	Unfilled	11	Electric	Double	10,300	34	303	12
Mid flat	Unfilled	10	Gas & electric	Single	6,700	21	319	13
Ground flat	Solid	4	Gas & electric	Single	8,950	28	320	14
Top flat	Solid	2	Gas	Single	7,500	23	326	15
Ground flat	Solid	3	Gas & electric	Double	8,950	27	331	16
Mid flat	Unfilled	9	Gas & electric	Double	6,700	20	335	17
Mid flat	Solid	2	Gas	Single	7,050	21	336	18
Top flat	Unfilled	10	Gas & electric	Single	8,950	26	344	19
Mid flat	Solid	1	Gas	Double	7,050	20	353	20
Mid flat	Unfilled	12	Electric	Single	10,500	29	362	21
Top flat	Solid	1	Gas	Double	9,300	24	388	22
Mid flat	Unfilled	8	Gas	Single	6,700	17	394	23
Mid flat	Unfilled	11	Electric	Double	11,300	28	404	24
Top flat	Unfilled	9	Gas & electric	Double	10,550	26	406	25
Ground flat	Solid	2	Gas	Single	8,950	22	407	26
Ground flat	Solid	1	Gas	Double	8,950	21	426	27
Top flat	Unfilled	8	Gas	Single	10,550	22	480	28
Top flat	Unfilled	7	Gas	Double	10,550	21	502	29
Mid flat	Unfilled	7	Gas	Double	10,100	18	561	30
Ground flat	Unfilled	12	Electric	Single	13,200	22	600	31
Top flat	Filled	18	Electric	Single	17,900	29	617	32
Ground flat	Unfilled	10	Gas & electric	Single	13,600	21	648	33
Ground flat	Unfilled	11	Electric	Double	13,200	20	660	34
Top flat	Filled	17	Electric	Double	17,900	27	663	35
Top flat	Filled	16	Gas & electric	Single	13,950	21	664	36
Ground flat	Unfilled	9	Gas & electric	Double	15,200	21	724	37
Top flat	Filled	15	Gas & electric	Double	15,550	21	741	38
Mid flat	Filled	16	Gas & electric	Single	13,500	17	794	39
Mid flat	Filled	15	Gas & electric	Double	13,500	16	844	40
Ground flat	Unfilled	8	Gas	Single	15,200	18	844	41
Top flat	Filled	14	Gas	Single	15,550	18	864	42
Ground flat	Filled	16	Gas & electric	Single	20,200	23	878	43
Ground flat	Unfilled	7	Gas	Double	15,200	17	894	44
Mid flat	Filled	14	Gas	Single	13,500	15	900	45
Ground flat	Filled	18	Electric	Single	18,200	20	910	46
Top flat	Filled	13	Gas	Double	15,550	17	915	47
Ground flat	Filled	15	Gas & electric	Double	20,200	21	962	48
Mid flat	Filled	13	Gas	Double	13,500	14	964	49
Ground flat	Filled	17	Electric	Double	18,200	18	1011	50
Mid flat	Filled	18	Electric	Single	11,300	11	1027	51
Ground flat	Filled	14	Gas	Single	20,200	19	1063	52
Ground flat	Filled	13	Gas	Double	20,200	18	1122	53
Mid flat	Filled	17	Electric	Double	11,300	9	1256	54

Table 44: Combined costs per tonne of CO₂ saved + SAP point increase (ranking by storey) – top storey

Storey	Wall type	Scenario	Heating type	Glazing type	Costs to achieve 60% CO ₂ reduction (£)	Cost per tonne of CO ₂ saved (£)	Cost per SAP point increase (£)	Combined cost (£)	Ranking
Top flat	Solid	6	Electric	Single	10,500	2561	250	2811	1
Top flat	Solid	5	Electric	Double	10,500	2692	263	2955	2
Top flat	Unfilled	12	Electric	Single	10,300	3029	294	3323	3
Top flat	Solid	4	Gas & electric	Single	7,500	3261	259	3520	4
Top flat	Unfilled	11	Electric	Double	10,300	3219	303	3522	5
Top flat	Solid	3	Gas & electric	Double	7,500	3409	268	3677	6
Top flat	Solid	2	Gas	Single	7,500	3409	326	3735	7
Top flat	Solid	1	Gas	Double	9,300	4227	388	4615	8
Top flat	Unfilled	10	Gas & electric	Single	8,950	4475	344	4819	9
Top flat	Unfilled	9	Gas & electric	Double	10,550	5275	406	5681	10
Top flat	Unfilled	8	Gas	Single	10,550	5275	480	5755	11
Top flat	Unfilled	7	Gas	Double	10,550	5553	502	6055	12
Top flat	Filled	18	Electric	Single	17,900	6630	617	7247	13
Top flat	Filled	17	Electric	Double	17,900	7160	663	7823	14
Top flat	Filled	16	Gas & electric	Single	13,950	8719	664	9383	15
Top flat	Filled	15	Gas & electric	Double	15,550	9719	741	10460	16
Top flat	Filled	14	Gas	Single	15,550	9719	864	10583	17
Top flat	Filled	13	Gas	Double	15,550	10367	915	11282	18

Table 45: Combined costs per tonne of CO₂ saved + SAP point increase (ranking by storey) – mid storey

Storey	Wall type	Scenario	Heating type	Glazing type	Costs to achieve 60% CO ₂ reduction (£)	Cost per tonne of CO ₂ saved (£)	Cost per SAP point increase (£)	Combined cost (£)	Ranking
Mid flat	Solid	6	Electric	Single	7,450	2258	213	2471	1
Mid flat	Solid	5	Electric	Double	7,450	2403	226	2629	2
Mid flat	Solid	4	Gas & electric	Single	7,050	3205	271	3476	3
Mid flat	Solid	3	Gas & electric	Double	7,050	3357	282	3639	4
Mid flat	Solid	2	Gas	Single	7,050	3357	336	3693	5
Mid flat	Unfilled	10	Gas & electric	Single	6,700	3722	319	4041	6
Mid flat	Solid	1	Gas	Double	7,050	3711	353	4064	7
Mid flat	Unfilled	8	Gas	Single	6,700	3941	394	4335	8
Mid flat	Unfilled	12	Electric	Single	10,500	4038	362	4400	9
Mid flat	Unfilled	9	Gas & electric	Double	6,700	4188	335	4523	10
Mid flat	Unfilled	11	Electric	Double	11,300	4520	404	4924	11
Mid flat	Unfilled	7	Gas	Double	10,100	6313	561	6874	12
Mid flat	Filled	18	Electric	Single	11,300	5947	1027	6974	13
Mid flat	Filled	17	Electric	Double	11,300	6647	1256	7903	14
Mid flat	Filled	16	Gas & electric	Single	13,500	10385	794	11179	15
Mid flat	Filled	15	Gas & electric	Double	13,500	11250	844	12094	16
Mid flat	Filled	14	Gas	Single	13,500	11250	900	12150	17
Mid flat	Filled	13	Gas	Double	13,500	12273	964	13237	18

Table 46: Combined costs per tonne of CO₂ saved + SAP point increase (ranking by storey) – ground storey

Storey	Wall type	Scenario	Heating type	Glazing type	Costs to achieve 60% CO ₂ reduction (£)	Cost per tonne of CO ₂ saved (£)	Cost per SAP point increase (£)	Combined cost (£)	Ranking
Ground flat	Solid	6	Electric	Single	9,350	2338	246	2584	1
Ground flat	Solid	5	Electric	Double	9,350	2461	253	2714	2
Ground flat	Solid	4	Gas & electric	Single	8,950	3729	320	4049	3
Ground flat	Solid	3	Gas & electric	Double	8,950	3891	331	4222	4
Ground flat	Solid	2	Gas	Single	8,950	4068	407	4475	5
Ground flat	Solid	1	Gas	Double	8,950	4262	426	4688	6
Ground flat	Unfilled	12	Electric	Single	13,200	4400	600	5000	7
Ground flat	Unfilled	11	Electric	Double	13,200	4714	660	5374	8
Ground flat	Filled	18	Electric	Single	18,200	6067	910	6977	9
Ground flat	Filled	17	Electric	Double	18,200	6500	1011	7511	10
Ground flat	Unfilled	10	Gas & electric	Single	13,600	8000	648	8648	11
Ground flat	Unfilled	9	Gas & electric	Double	15,200	8941	724	9665	12
Ground flat	Unfilled	8	Gas	Single	15,200	8941	844	9785	13
Ground flat	Unfilled	7	Gas	Double	15,200	9500	894	10394	14
Ground flat	Filled	16	Gas & electric	Single	20,200	10632	878	11510	15
Ground flat	Filled	14	Gas	Single	20,200	11222	1063	12285	16
Ground flat	Filled	15	Gas & electric	Double	20,200	11882	962	12844	17
Ground flat	Filled	13	Gas	Double	20,200	12625	1122	13747	18

Table 47: Combined costs per tonne of CO₂ saved + SAP point increase (overall ranking)

Storey	Wall type	Scenario	Heating type	Glazing type	Costs to achieve 60% CO ₂ reduction (£)	Cost per tonne of CO ₂ saved (£)	Cost (£) per SAP point increase	Combined cost (£)	Ranking
Mid flat	Solid	6	Electric	Single	7,450	2258	213	2471	1
Ground flat	Solid	6	Electric	Single	9,350	2338	246	2584	2
Mid flat	Solid	5	Electric	Double	7,450	2403	226	2629	3
Ground flat	Solid	5	Electric	Double	9,350	2461	253	2714	4
Top flat	Solid	6	Electric	Single	10,500	2561	250	2811	5
Top flat	Solid	5	Electric	Double	10,500	2692	263	2955	6
Top flat	Unfilled	12	Electric	Single	10,300	3029	294	3323	7
Mid flat	Solid	4	Gas & electric	Single	7,050	3205	271	3476	8
Top flat	Solid	4	Gas & electric	Single	7,500	3261	259	3520	9
Top flat	Unfilled	11	Electric	Double	10,300	3219	303	3522	10
Mid flat	Solid	3	Gas & electric	Double	7,050	3357	282	3639	11
Top flat	Solid	3	Gas & electric	Double	7,500	3409	268	3677	12
Mid flat	Solid	2	Gas	Single	7,050	3357	336	3693	13
Top flat	Solid	2	Gas	Single	7,500	3409	326	3735	14
Mid flat	Unfilled	10	Gas & electric	Single	6,700	3722	319	4041	15
Ground flat	Solid	4	Gas & electric	Single	8,950	3729	320	4049	16
Mid flat	Solid	1	Gas	Double	7,050	3711	353	4064	17
Ground flat	Solid	3	Gas & electric	Double	8,950	3891	331	4222	18
Mid flat	Unfilled	8	Gas	Single	6,700	3941	394	4335	19
Mid flat	Unfilled	12	Electric	Single	10,500	4038	362	4400	20
Ground flat	Solid	2	Gas	Single	8,950	4068	407	4475	21
Mid flat	Unfilled	9	Gas & electric	Double	6,700	4188	335	4523	22
Top flat	Solid	1	Gas	Double	9,300	4227	388	4615	23
Ground flat	Solid	1	Gas	Double	8,950	4262	426	4688	24
Top flat	Unfilled	10	Gas & electric	Single	8,950	4475	344	4819	25
Mid flat	Unfilled	11	Electric	Double	11,300	4520	404	4924	26
Ground flat	Unfilled	12	Electric	Single	13,200	4400	600	5000	27
Ground flat	Unfilled	11	Electric	Double	13,200	4714	660	5374	28
Top flat	Unfilled	9	Gas & electric	Double	10,550	5275	406	5681	29
Top flat	Unfilled	8	Gas	Single	10,550	5275	480	5755	30
Top flat	Unfilled	7	Gas	Double	10,550	5553	502	6055	31
Mid flat	Unfilled	7	Gas	Double	10,100	6313	561	6874	32
Mid flat	Filled	18	Electric	Single	11,300	5947	1027	6974	33
Ground flat	Filled	18	Electric	Single	18,200	6067	910	6977	34
Top flat	Filled	18	Electric	Single	17,900	6630	617	7247	35
Ground flat	Filled	17	Electric	Double	18,200	6500	1011	7511	36
Top flat	Filled	17	Electric	Double	17,900	7160	663	7823	37
Mid flat	Filled	17	Electric	Double	11,300	6647	1256	7903	38
Ground flat	Unfilled	10	Gas & electric	Single	13,600	8000	648	8648	39
Top flat	Filled	16	Gas & electric	Single	13,950	8719	664	9383	40
Ground flat	Unfilled	9	Gas & electric	Double	15,200	8941	724	9665	41
Ground flat	Unfilled	8	Gas	Single	15,200	8941	844	9785	42
Ground flat	Unfilled	7	Gas	Double	15,200	9500	894	10394	43
Top flat	Filled	15	Gas & electric	Double	15,550	9719	741	10460	44
Top flat	Filled	14	Gas	Single	15,550	9719	864	10583	45
Mid flat	Filled	16	Gas & electric	Single	13,500	10385	794	11179	46
Top flat	Filled	13	Gas	Double	15,550	10367	915	11282	47
Ground flat	Filled	16	Gas & electric	Single	20,200	10632	878	11510	48
Mid flat	Filled	15	Gas & electric	Double	13,500	11250	844	12094	49
Mid flat	Filled	14	Gas	Single	13,500	11250	900	12150	50
Ground flat	Filled	14	Gas	Single	20,200	11222	1063	12285	51
Ground flat	Filled	15	Gas & electric	Double	20,200	11882	962	12844	52
Mid flat	Filled	13	Gas	Double	13,500	12273	964	13237	53
Ground flat	Filled	13	Gas	Double	20,200	12625	1122	13747	54

5. Conclusions

This report has investigated the real life costs of reaching a 60% reduction in carbon emissions from the existing housing stock, and found these to vary from around £7,000 in the most favourable circumstances, up to over £20,000 in others. A key finding is that the better the dwelling baseline performance, the more difficult and costly it is to achieve the 60% reduction. For housing associations and landlords, this factor is crucial - rather than seeking a uniform 60% CO₂ reduction from all dwellings in their stock – which has been shown to be, in some cases, highly expensive – they can instead focus their attention and efforts on the ‘easy wins’. This report’s findings indicate that it may be more cost effective to aim for, say, an 80% reduction from dwellings that are easiest to target, and allow this greater saving to offset the remainder of the stock which is more costly to address.

In addition to overall costs, our investigation looked at the efficiency of spend from several angles. For those seeking to make cost effective CO₂ reductions across a variety of dwellings, the cost per tonne of CO₂ saved was calculated for each scenario, and the results were ranked in order to highlight the most efficient situations to target. These costs varied from approximately £2,000 per tonne, right up to £13,000, so choosing wisely from a property portfolio will help to maximise spending efficiency.

The report also looked at SAP point increases in order to determine the costs associated with a reduction in the likelihood of fuel poverty. These were shown to vary between approximately £200, up to £1,200 per point. As fuel poverty should be reduced or eradicated across all dwellings, these costs are solely provided as information for comparative purposes, rather than to indicate any kind of priority between individual dwellings.

Finally, for those equally interested in making CO₂ reductions whilst also reducing fuel poverty, the report combined the cost per tonne of CO₂ saved with the cost per SAP point increased, to provide an overall indicator of spending efficiency. These costs varied from approximately £2,500 to £14,000.



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