Department for
Communities and
Local Government

English Housing Survey
ENERGY EFFICIENCY OF ENGLISH HOUSING 2012

ENGLISH
HOUSING
SURVEY

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Department for Communities and Local Government

English Housing Survey:

ENERGY EFFICIENCY OF ENGLISH HOUSING

Annual report on England's housing stock, 2012

July 2014
Department for Communities and Local Government

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Content

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- The Building Research Establishment (BRE) who managed the physical survey of properties and led the production of the 2012-13 Profile of English Housing Report, the 2012-13 Energy and Energy Efficiency Report and the 2012-13 Fire and Fire Safety Report.
- The NatCen interviewers who conducted the household interviews and the CADS Housing Surveys surveyors who carried out the visual inspections of properties.
- And finally, the team at DCLG who worked on the survey and who were involved in the production of this report.

Introduction

1. The English Housing Survey (EHS) is a national survey of people's housing circumstances and the condition and energy efficiency of housing in England. In its current form, it was first run in 2008-09. Prior to then, the survey was run as two standalone surveys: the English House Condition Survey and the Survey of English Housing. This report provides the findings from the 2012 survey.

2. The report focuses on the energy efficiency of the English housing stock and is split into two sections. The first provides a comprehensive profile of the energy performance of English housing stock in 2012 while the second section focuses on the feasibility and costs associated with improving the energy efficiency of the stock.

3. The report builds on findings first released in the 2012-13 English Housing Survey Headline Report, which was published on the Department for Communities and Local Government (DCLG) website in February 2014[1].

4. Results are presented for '2012' and are based on fieldwork carried out between April 2011 and March 2013 (a mid-point of April 2012). The sample comprises 12,763 occupied or vacant dwellings where a physical inspection was carried out. Throughout the report, this is referred to as the 'dwelling sample'.

5. In tables, where the numbers of cases in the sample are too small for any inference to be drawn about the national picture, the cell contents are replaced with an asterisk. This happens when the cell is based on sample of less than five cases. Where cell contents are in italics this indicates a total sample size of less than 30, and the results should be treated with caution.

6. Where comparative statements have been made in the text, these have been significance tested to a 95% confidence level. This means we are 95% confident that the statements we are making are true.

7. Additional annex tables, including the data underlying the figures and charts, are published on the DCLG website: https://www.gov.uk/government/organisations/department-for-communities-and-local-government/series/english-housing-survey alongside many

[1] https://www.gov.uk/government/publications/english-housing-survey-2012-to-2013-headline-report

supplementary tables, which are updated each year but are too numerous to include in our reports. Further information on the technical details of the survey, and information and past reports on the Survey of English Housing and the English House Condition Survey can also be accessed via this link.

8. If you have any queries about this report, would like any further information or have suggestions for analyses you would like to see included in future EHS reports, please contact ehs@communities.gsi.gov.uk

9. The responsible statistician for this report is: Jeremy Barton, English Housing Survey Team, Strategic Statistics Division, DCLG. Contact via ehs@communities.gsi.gov.uk

Key findings

Social rented dwellings, purpose-built flats and newer properties were found to be more energy efficient, while detached houses, bungalows and pre-war dwellings were found to be least energy efficient.

- Energy efficiency as measured by average SAP rating was higher for social sector homes (65 compared with 57 in the private sector). Purpose built flats had the highest average SAP (67 to 68) whilst converted flats performed the least well (average SAP rating of 54).

- Newer homes were found to have lower average levels of CO2 emissions; post-1990 dwellings having half as many emissions on average compared with pre-1919 homes (3.6 and 7.2 tonnes per dwelling).

In general, the most energy efficient dwellings had condensing or condensing-combination boilers, gas fired systems, cavity wall insulation or loft insulation of 150mm or more.

- Energy efficiency for all tenure groups have increased between 2001 and 2012 (from an average SAP of 47 to 59) with the largest increases seen in private rented and local authority sectors. Housing association properties were the most energy efficient overall throughout this period.

- Most properties were centrally heated in 2012 (91%) with only 7% heated by storage heaters and 3% by individual room heaters. However only 73% of flats were centrally heated with 22% using storage heaters. Dwellings built after 1981, housing association and private rented dwellings were also more likely to use storage heaters.

- Changes to Building Regulations in 2005 has led to a large increase in the proportion of dwellings installed with energy efficient condensing or condensing-combination boilers from 2% in 2001 to 44% in 2012.

- Approximately 9.1 million (66%) of dwellings with cavity walls were insulated, up from 5.8 million in 2001. Homes in the private rented sector were the least likely to have this insulation (52%), as landlords may have less incentive to undertake the improvement. Of the remaining dwellings that could potentially benefit from the installation of cavity wall insulation, 77% were assessed to have standard fillable walls.

Three-quarters of the housing stock could have benefitted from energy improvement measures, most notably from boiler and loft upgrades and cavity wall insulation.

- In 2012, 16.6 million dwellings (73% of the housing stock) could potentially have benefitted from at least one form of the energy improvement measures covered by an Energy Performance Certificate (EPC). The energy improvement measures that could benefit most dwellings were the installation of a condensing boiler (9.7 million), installing cavity wall insulation (5.6 million) and installing or upgrading loft insulation (5.6 million).

- If all the potential cost effective improvement measures covered by EPCs were installed in all eligible dwellings, this could result in:

    - a potential 14% reduction in heating, lighting and ventilation costs of average fuel bills for all households

    - average CO_2 emissions falling by almost 1 tonne/year per dwelling across the whole stock - a total saving of 21.2 million tonnes/year of CO_2 emissions (18% of total current emissions).

The overall proportion least energy efficient dwellings has fallen significantly since 1996. Detached dwellings, bungalows and pre-1919 homes were most likely to be energy inefficient.

- In 1996, dwellings with the worst energy efficiency (energy efficiency rating bands F and G) comprised 29% of the total housing stock, but this proportion had decreased to 6% (1.4 million) by 2012. Detached dwellings (28%), bungalows (13%) and converted flats (9%) were also over represented among the worst energy efficient homes whilst purpose built flats were under represented (6%), Table 2.1. Over half of the worst energy efficient homes were built before 1919 (52%).

- Approximately 21% of the worst energy efficient dwellings (in SAP bands F and G) would move up to band C or D if both low and high cost energy improvement measures were applied, and almost half (44%) would move up to band E.

Chapter 1
Energy performance

Reducing energy consumed within the home can both reduce household energy bills, and lower greenhouse gas emissions. Consequently, successive governments have introduced a number of policy measures and funding initiatives aimed at reducing the amount of energy used in the housing stock.

This chapter examines energy efficiency and carbon dioxide emissions in 2012 by various dwelling characteristics. It then looks at presence of energy efficiency measures in 2012 and how these have improved over time for the whole stock and by tenure. The chapter then explores the potential for making further improvements to the housing stock.

It is important to emphasise that this assessment of the housing stock is not based on actual energy consumption and emissions, but on the consumption (and resulting emissions) assumed under a standard occupancy and standard heating pattern for each dwelling[1]. This enables the performance of the housing stock to be assessed on a comparable basis (between types of stock and over time).

Using data from the household interview survey, the chapter includes an analysis of the characteristics of households who undertake changes to their home in order to improve its energy efficiency. It also investigates the characteristics of households who are unable to heat their homes satisfactorily. Finally, it examines how the energy performance of the housing stock would change if the potential for improvement were fulfilled.

Additional findings relating to energy performance, heating and insulation can be found in the web tables, DA6101 to DA7104.

[1] These standard assumptions are those consistent with SAP 2009 (see chapter 5 of the 2013 Technical Report). These differ from the energy consumption assumptions used under the BREDEM model used for fuel poverty calculations. The BREDEM model, for example, uses actual information about dwelling location and occupants, and includes energy used in cooking, whereas SAP 2009 does not.

Energy efficiency

1.1. The key measures of energy performance of the housing stock used throughout this chapter are the energy efficiency (SAP) rating and carbon dioxide (CO2) emissions, Box 1.1.

Box 1.1: Key measures of energy performance

Energy efficiency rating: The SAP rating is based on each dwelling's energy costs per square metre and is calculated using a simplified form of the Standard Assessment Procedure (SAP) under the 2009 methodology. The energy costs take into account the costs of space and water heating, ventilation, and lighting, less any cost savings from energy generation technologies. The rating is expressed on a scale of 1-100 where a dwelling with a rating of 1 has poor energy efficiency (high costs) and a dwelling with a rating of 100 represents a completely energy efficient dwelling (zero net energy costs per year).

The energy efficiency rating is also presented in an A to G banding system for an Energy Performance Certificate, where Energy Efficiency Rating (EER) Band A represents low energy costs (i.e. the most efficient band) and EER Band G represents high energy costs (i.e. the least energy efficient band).

Carbon dioxide emissions: The carbon dioxide (CO_2) emissions are derived from space heating, water heating, ventilation and lighting, less any emissions saved by energy generation, and are measured in tonnes per year. Unlike the SAP rating, CO_2 emissions are not standardised for the size of the dwelling and are therefore likely to be higher for larger homes. This chapter deals with the average emissions per dwelling and the total emissions for different sub-sections of the stock.

1.2. In 2012, average SAP for all dwellings (including vacants) in England was 59, although this varied by tenure and dwelling characteristics. For most dwelling types and for all ages of homes, the average SAP rating was higher for social sector homes. Similarly, CO_2 emissions were generally lower for all categories of dwelling age in the social sector. This finding is due to a combination of reasons including the energy efficiency improvements undertaken as part of the Decent Homes programme, and the different profile of the social stock, which had a smaller proportion of the oldest homes and a higher proportion of flats[2], Table 1.1

1.3. Overall, purpose built flats had the highest average SAP (67 to 68) whilst converted flats performed the least well (average SAP rating of 54). The average CO_2 emissions also varied by dwelling type, with flats, particularly purpose built flats, generally having lower emissions than houses. Detached

[2] See chapter 1of the EHS Profile of English Housing Report, 2012

homes had the highest CO_2 emissions, with an average of 8.2 tonnes per dwelling, Table 1.1.

1.4. There was a correlation between dwelling age and average SAP, with the oldest homes built before 1919 having the lowest average SAP (50). In contrast homes built after 1990, which were generally better insulated, had an average SAP of 69. Similar trends were evident for dwelling age and CO_2 emissions, with lower average levels of emissions for newer homes, Table 1.1.

Table 1.1: SAP rating and CO2 emissions by dwelling characteristics, 2012

all dwellings

	private sector		social sector		all dwellings		
	mean SAP	**mean CO_2 (tonnes per dwelling)**	**mean SAP**	**mean CO_2 (tonnes per dwelling)**	**mean SAP**	**mean CO_2 (tonnes per dwelling)**	***sample size***
dwelling type							
small terraced	57.9	3.7	62.1	3.3	58.6	3.7	*1,323*
medium/large terraced	57.8	5.4	64.2	3.9	58.8	5.1	*2,356*
semi-detached	56.4	5.5	61.1	4.1	56.9	5.3	*2,985*
detached	55.9	8.2	58.4	5.3	55.9	8.2	*1,506*
bungalow	53.0	5.3	60.9	3.1	54.6	4.8	*1,189*
all houses	56.4	5.9	62.2	3.7	57.1	5.6	*9,359*
converted	52.9	4.8	58.5	3.7	53.7	4.6	*476*
purpose built, low rise	65.6	3.1	68.2	2.5	66.7	2.8	*2,550*
purpose built, high rise	68.2	3.2	67.8	2.9	68.0	3.0	*378*
all flats	62.2	3.5	67.4	2.6	64.2	3.2	*3,404*
dwelling age							
pre 1919	49.9	7.4	56.8	4.2	50.3	7.2	*2,109*
1919-44	54.1	5.8	59.7	3.8	54.7	5.6	*1,936*
1945-64	57.3	5.3	63.0	3.4	58.8	4.8	*3,044*
1965-80	58.4	5.1	65.9	3.0	60.1	4.6	*2,904*
1981-90	61.2	4.5	68.1	2.6	62.5	4.2	*1,096*
post 1990	68.9	3.9	71.4	2.5	69.3	3.6	*1,674*
all tenures	**57.3**	**5.5**	**64.6**	**3.2**	**58.5**	**5.1**	***12,763***

Source: English Housing Survey, dwelling sample

1.5. The SAP rating and CO_2 emissions varied by different heating and insulation characteristics. In general, the most energy efficient dwellings had condensing or condensing-combination boilers, gas fired systems, cavity wall insulation (including post-1990 homes in which insulation has been assumed, see Box 1.2) or loft insulation of 150mm or more. Conversely, homes using only fixed heaters[3] had significantly lower energy efficiency ratings than those with central heating or storage radiator systems (a mean SAP rating of 34 compared with 59).

1.6. The mean SAP ratings of social sector homes consistently outperformed those in the private sector for all heating and insulation characteristics. The difference was more pronounced for characteristics associated with poor energy efficiency such as the main heating from individual fixed heaters, low levels of loft insulation or walls without insulation, Table 1.2.

[3] This category most commonly includes individual heaters such as mains gas and solid fuel fires with chimneys or flues, decorative gas fires and electric panel or convector heaters, wired to the electricity supply.

Table 1.2: Mean SAP and mean CO2 by heating and insulation characteristics, 2012

all dwellings

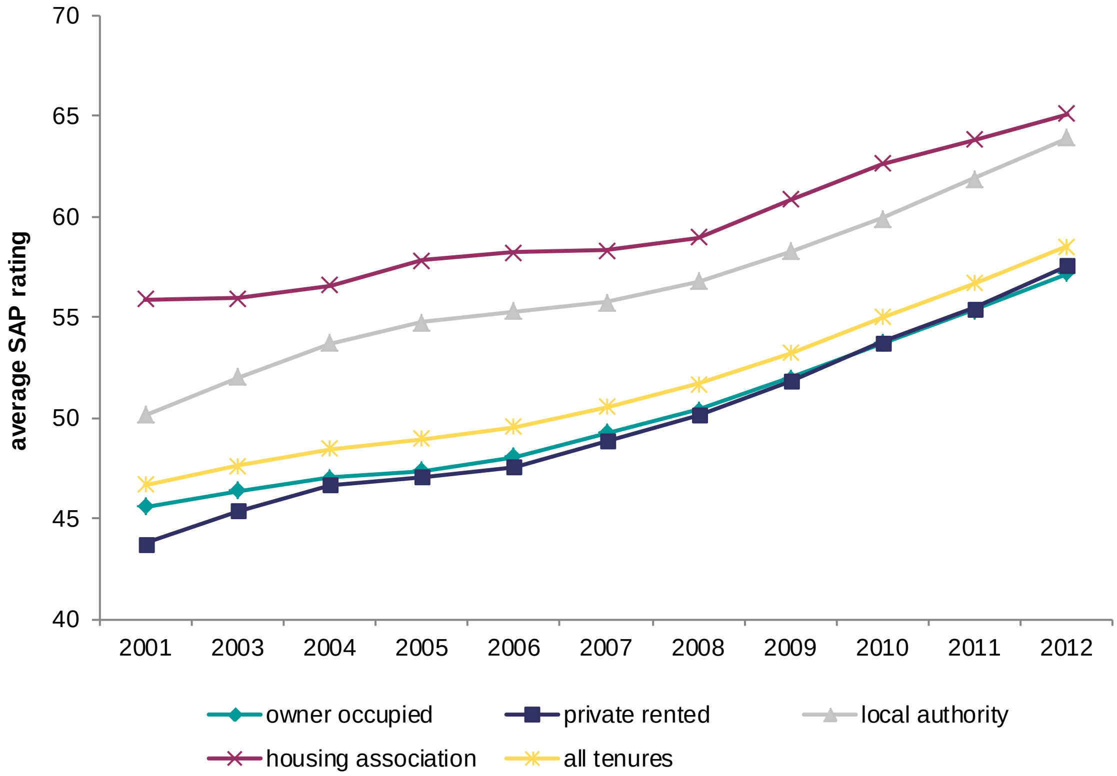
	private sector		social sector		all dwellings		
	mean SAP	mean CO_2 (tonnes per dwelling)	mean SAP	mean CO_2 (tonnes per dwelling)	mean SAP	mean CO_2 (tonnes per dwelling)	sample size
heating system							
central heating	58.1	5.5	65.0	3.0	59.2	5.1	11,482
storage heater	57.9	5.9	62.2	4.5	59.0	5.6	972
fixed room heating	33.5	7.3	42.0	4.9	33.9	7.2	309
type of boiler							
standard (floor or wall)	53.6	6.7	60.7	3.8	54.2	6.5	2,683
back (to fire or stove)	48.2	5.9	54.4	4.6	49.4	5.7	584
combination	56.7	5.0	63.3	3.1	57.7	4.8	2,057
condensing	62.2	5.9	66.9	3.1	63.0	5.4	1,377
condensing-combination	62.3	4.4	67.5	2.7	63.4	4.0	4,397
main fuel type							
gas fired system	58.5	5.2	65.0	3.0	59.6	4.8	10,672
oil fired system	49.2	11.0	55.1	6.3	49.4	10.9	367
solid fuel fired system	29.1	11.4	52.5	8.3	31.5	11.0	91
electrical system	50.9	6.2	60.6	4.5	52.9	5.9	1,246
loft insulation thickness							
none	39.9	9.4	51.2	4.9	40.4	9.2	231
less than 100mm	53.5	6.2	59.8	3.8	54.0	6.0	1,409
100 up to 150mm	55.9	5.8	61.4	3.7	56.5	5.6	2,220
150mm or more	59.3	5.4	64.4	3.3	60.1	5.1	5,712
type of wall							
cavity insulated	62.9	4.6	66.7	3.0	63.7	4.3	5,415
post-1990 - no CWI evidence	65.2	4.4	69.4	2.7	66.0	4.0	636
cavity uninsulated	54.8	5.7	62.3	3.3	56.0	5.4	2,965

Note: sample sizes will not add up to 100% of sample dwellings, as not all features are present in all homes
Source: English Housing Survey, dwelling sample

1.7. The average SAP rating for all dwellings increased from 47 in 2001 to 59 in 2012. The largest increases were in the private rented and local authority sectors, where SAP increased by 14 points. In 2001, the private rented sector had the lowest average SAP rating (44), but increased to be at a similar level to owner occupied homes from 2004 (47). This finding may be surprising given that, in 2012, the private rented sector generally had greater potential for installing energy efficiency measures (see paragraph 1.34). However, the similar SAP rating is most likely due to the different distribution of dwelling types within the owner occupied and private rented sectors, for example, the higher proportion of purpose built flats in the latter sector.

1.8. Housing association properties were the most energy efficient overall throughout this period, Figure 1.1.

Figure 1.1: Energy efficiency, average SAP rating by tenure, 2001-2012



Base: all dwellings
Note: underlying data are presented in Annex Table 1.1
Sources:
2001-2007: English House Condition Survey, dwelling sample;
2008 onwards: English Housing Survey, dwelling sample

Energy efficiency measures

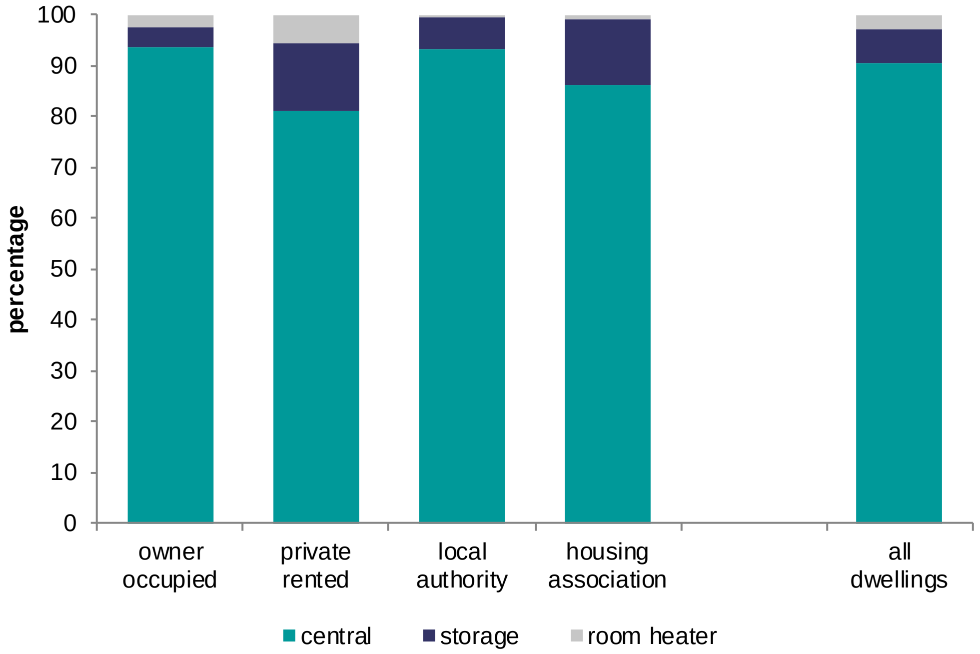
Heating systems

1.9. In 2012, 91% of homes had central heating, 7% had storage heaters and 3% had individual room heaters[4]. Central heating was the most common type of heating across all tenures, but more prevalent in the owner occupied and local authority sectors (94% and 93% respectively). Of the rented tenures, private rented and housing association dwellings were more likely to have storage heating than local authority homes, Figure 1.2. This is partly due to the age of stock found in each tenure, with local authority stock being greatly

[4] Percentages do not sum to 100% due to rounding.

underrepresented in homes built since 1990 (see EHS, Profile of English Housing report, chapter 1, Figure 1.1), a sector which has a higher than average proportion of dwellings using storage heaters, (see Annex Table 1.2).

Figure 1.2: Heating systems by tenure, 2012



Base: all dwellings
Note: underlying data are presented in Annex Table 1.2
Source: English Housing Survey, dwelling sample

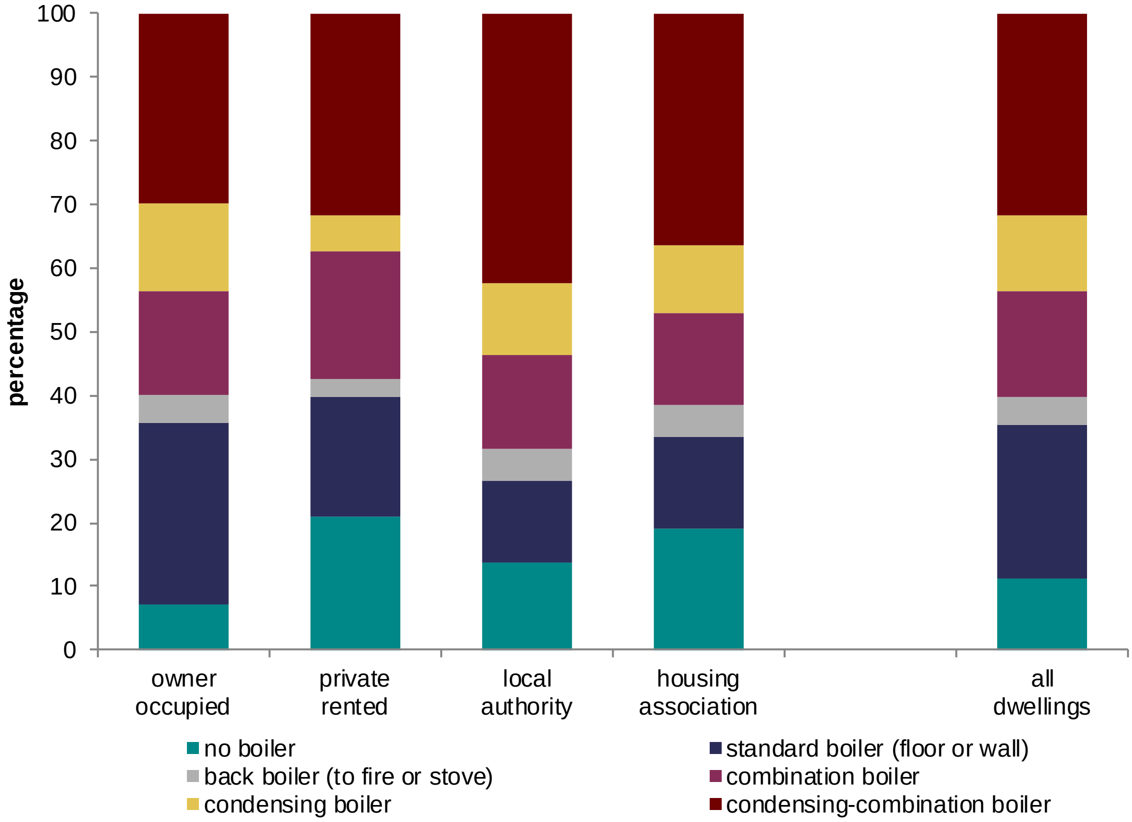
1.10. The vast majority of houses (95%) had central heating, compared with around three-quarters of flats (73%). Around a quarter (22%) of flats were heated using storage heaters, Annex Table 1.2.

Boiler systems

1.11. In 2012, condensing-combination boilers were the most common type of boiler across all tenures, present in 32% of all homes. Owner occupied homes had a similar proportion of condensing-combination boilers and standard boilers (30% and 29% respectively). The least common system was back boilers[5], present in just 4% of homes, Figure 1.3.

[5] These are located behind a room heater and are designed to provide hot water for space heating, and may also provide domestic hot water indirectly through a separate hot water storage cylinder

Figure 1.3: Dwellings with given boiler types by tenure, 2012



Base: all dwellings
Note: underlying data are presented in Annex Table 1.3
Source: English Housing Survey, dwelling sample

1.12. The proportion of dwellings with either a condensing or a condensing combination[6] boiler has increased considerably from 2% in 2001 to 44% in 2012. This increase corresponds to the changes to Building Regulations in 2005, which made it mandatory for replacement boilers to be of the more energy efficient condensing types (where feasible), Figure 1.4.

[6] Condensing boilers use a larger, or dual, heat exchanger to obtain more heat from burning fuel than an ordinary boiler, and are generally the most efficient boiler type. Combination boilers provide hot water instantaneously and tend to be installed in smaller houses and flats in preference to standard boilers (with a hot water cylinder), at least partly to reduce future maintenance or replacement of hot water cylinders and associated piping

Cavity wall insulation

Box 1.2: Cavity wall insulation

During the EHS physical survey, surveyors examine the dwelling for evidence of insulation. External walls of cavity construction normally provide greater energy efficiency than solid walls by reducing heat loss. From around 1930 onwards this type of construction became more prevalent. Prior to 1990, the space between the two leaves of cavity walls was generally left uninsulated at the time of construction. Many of these walls have, however, been insulated retrospectively by injecting insulating material into this space.

For compliance with Building Regulations, an increasing proportion of dwellings built since 1990 with cavity walls had cavity wall insulation fitted at the time of construction (known as “as built” insulation), although compliance could also be achieved through other techniques.

The EHS attempts to provide the best estimate of the total level of cavity wall insulation in the housing stock. However, the prevalence of “as built” insulation in the post-1990 stock creates additional uncertainty in the results for this age band. Retrospective cavity wall insulation often leaves some evidence that would be recognised by an EHS surveyor, however, “as built” insulation can be impossible to identify with a non-intrusive survey. For reporting purposes therefore, all cavity-walled, post-1990 dwellings where there is no evidence of insulation identified by the surveyor are included with those that have some evidence of insulation.

Combining these two categories provides the most reliable estimate of the total number of homes with cavity wall insulation because, although there will be some post 1990 dwellings without cavity wall insulation, there will also be some dwellings built with insulated cavity walls in the 1980s but where there is no visible evidence of this. Further details of the difficulties in providing an estimate are given in chapter 5 of the Technical Report.

1.13. In 2012, there were 9.1 million dwellings with clear evidence of cavity wall insulation and 1.2 million in the post-1990 category (see Box 1.2), many of which may have “as built” insulation installed. Under the assumption that all of this group were filled, 66% of dwellings with cavity walls were insulated, Annex Table 1.5.

1.14. The proportion of insulated cavity walls varied by tenure. Housing association homes were more likely to have cavity wall insulation (74%), likely because of the higher proportion of new builds in this tenure. Homes in the private rented sector were least likely to have cavity wall insulation (52%), Annex Table 1.5.

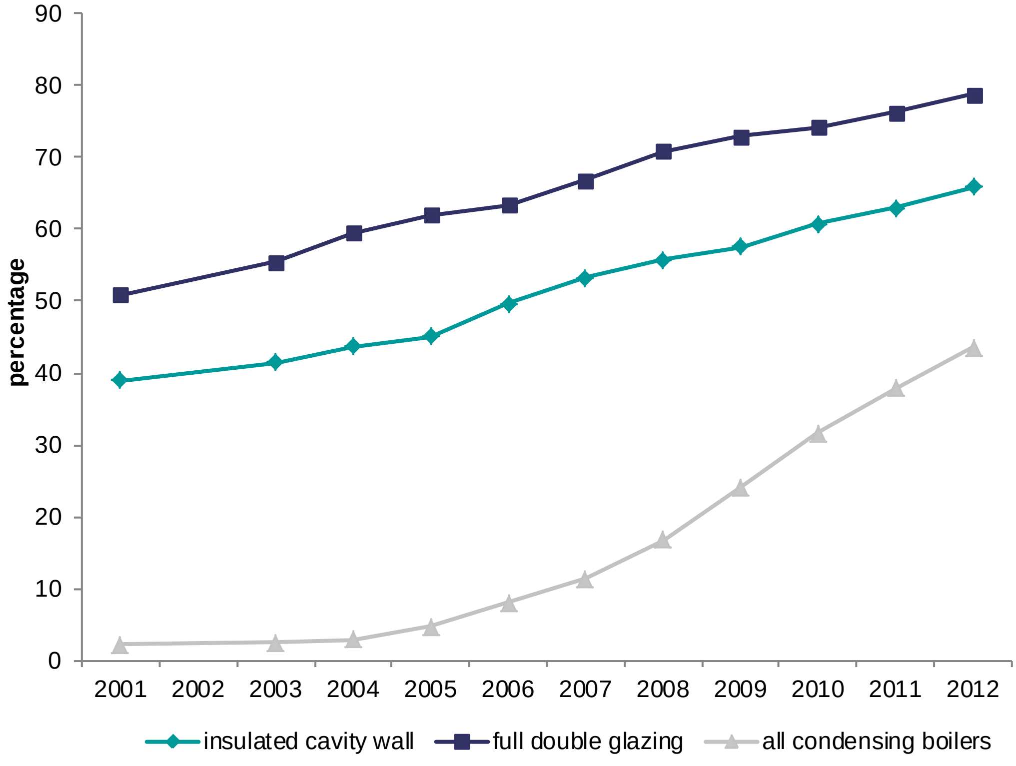
This may be due to private sector landlords having less incentive to install cavity wall insulation.[7]

1.15. The number and proportion of dwellings with insulated cavity walls has increased markedly over time, from around 5.8 million (39%) in 2001 to 10.3 million (66%) in 2012, Figure 1.4.

Double glazing

1.16. Since 2006, Building Regulations have stipulated that all windows in new dwellings and any that are replaced in older dwellings are double glazed. Although the installation of double glazing is relatively cost inefficient as an energy improvement measure, it has been very popular from the 1990s onwards. The proportion of homes that were fully double glazed has increased from 51% in 2001 to 79% 2012, Figure 1.4.

Figure 1.4: Key energy efficiency indicators, 2001-2012



Base: all applicable dwellings
Note: underlying data are presented in Annex Table 1.4
Sources:
2001-2007: English House Condition Survey, dwelling sample;
2008 onwards: English Housing Survey, dwelling sample

[7] For further discussion see DECC's research report *Green Deal and the Private Rented Sector available from* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/43019/3506-green-deal-consumer-research-prs.pdf

Solid wall insulation

Box 1.3: Solid wall insulation

One common method of solid wall insulation (external wall insulation) involves fixing insulation boards or material to the outside walls and rendering over the top. Consequently, this means that the presence of projections such as bays or conservatories will affect the complexity and cost of the work as will the type and condition of the existing wall finish at the dwelling. Additional factors are likely to increase costs and technical complexity of installation and these are explored in greater detail in both Chapter 7 of the 2010 EHS Homes report, and in Chapter 2 of this report.

1.17. It is estimated there were 7.1 million homes with solid walls in 2012, of which 350,000 (5%) already had insulation applied (either internally or externally) to the majority of their walls, Annex Table 1.6. In social rented homes with non-cavity walls, 16% have solid wall insulation compared with only 3% of private homes.

Loft insulation

1.18. Current Building Regulations require new dwellings to have around 270mm of loft insulation. In 2012, 52% of dwellings with a loft space above had at least 150mm of insulation. In the private rented sector, only 37% of homes with loft space had this level of insulation. Private rented homes were also more likely to have no insulation (5%). The potential for improvement in this sector is somewhat complex, given that 18% of the homes had flat roofs or the information on loft space was not known, Annex Table 1.8. The difficulties of improving energy performance through installing or increasing loft insulation in some homes is analysed in chapter 2 of this report.

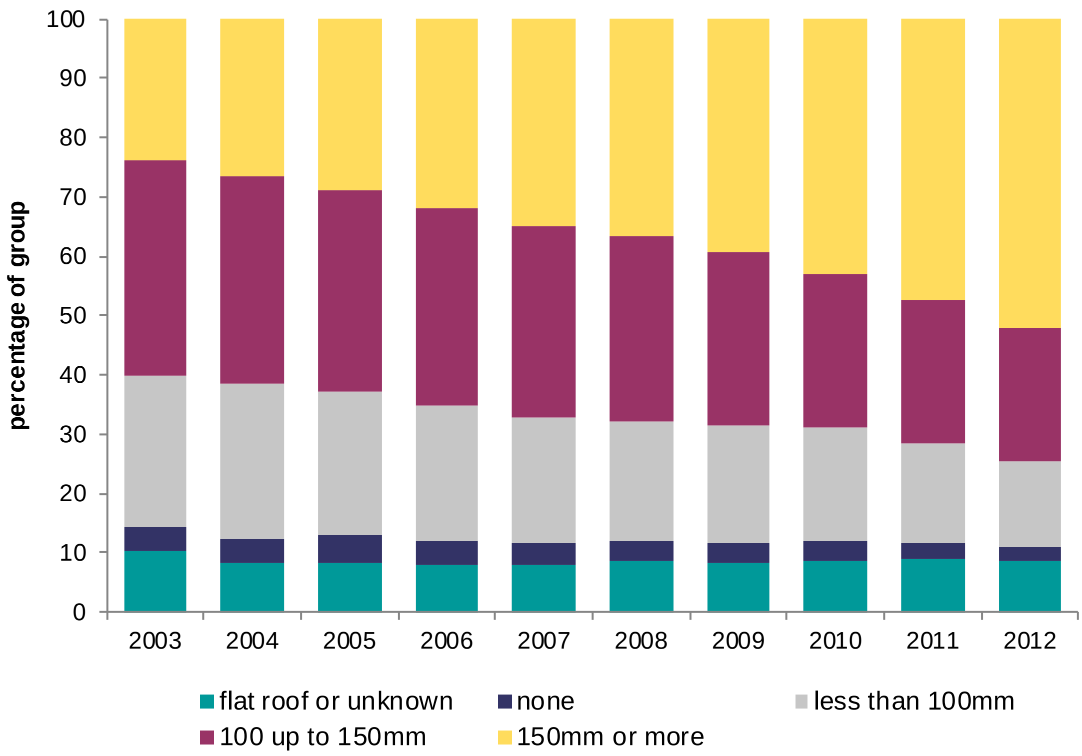
1.19. There was a marked improvement in the proportion of homes with the thickest levels of insulation (150mm or more) from 24% in 2003[8] to 52% in 2012. Over the same period, there was a relatively consistent proportion of homes with no insulation, although the number of these dwellings was lower in 2012 than in any other year during this period, Figure 1.5.

1.20. EHS surveyors collect information on levels of loft insulation through inspection of the loft space. In some cases, however, they are unable to collect this information e.g. where the loft hatch was inaccessible or where the roof had a very shallow pitch with no access point. Furthermore, some dwellings have flat roofs above and these do not have a loft space. These inaccessible or unknown cases, which have formed a consistent 8-10% of

[8] It is not possible to give equivalent 2001 figures for loft insulation as the English House Condition Survey only surveyed lofts in houses built before 1980

homes over time[9], are included in the analysis on potential for improving energy efficiency, detailed later in this chapter, Annex Table 1.7.

Figure 1.5: Dwellings with different amounts of loft insulation, 2003-2012



Base: all houses and top floor flats
Note: underlying data are presented in Annex Table 1.7
Sources:
2003- 2007: English House Condition Survey, dwelling sample;
2008 onwards: English Housing Survey, dwelling sample

Renewable energy

1.21. The EHS collects basic information on the presence of solar panels for hot water, solar photovoltaic panels or a domestic wind turbine contributing to electricity production. Data for solar photovoltaic panels and domestic wind turbines has only been collected since 2009 and sample sizes are small[10]. Consequently, any conclusions drawn from the data require careful consideration as longer term validation is needed.

1.22. It is estimated that about 420,000 dwellings had either a solar panel for hot water or photovoltaic panels in 2012, Table 1.3. This represents an increase of around 120,000 from 2011, with the majority of these new installations being photovoltaic panels. This increase may be at least partly due to the Feed-in Tariffs (FITs) scheme introduced in 2010, rewarding investment in low-carbon technology. Some 83% of these two renewable features were

[9] Like dwellings with flat roofs, these homes may be suitable for some roof insulation by either fitting insulated board below the current ceiling or lifting the roof cover and fitting insulation between the timbers.
[10] The sample numbers of dwellings with wind turbines are too small to provide robust estimates.

estimated to be in the private sector, although the social sector has seen the highest proportional increase since 2011.

Table 1.3: Renewable energy measures by tenure, 2011 and 2012

all dwellings

	2011				2012			
	private sector	**social sector**	**all dwellings**	**sample size**	**private sector**	**social sector**	**all dwellings**	**sample size**
	thousands of dwellings				*thousands of dwellings*			
solar hot water	137	11	148	*89*	140	16	156	*81*
photovoltaic	143	26	168	*94*	237	55	293	*152*
any solar panel	**260**	**35**	**295**	***173***	**347**	**71**	**419**	***222***
	percentage within type				*percentage within type*			
solar hot water	92.4	7.6	100.0		89.7	10.3	100.0	
photovoltaic	84.8	15.2	100.0		81.1	18.9	100.0	
any solar panel	**88.1**	**11.9**	**100.0**		**82.9**	**17.1**	**100.0**	

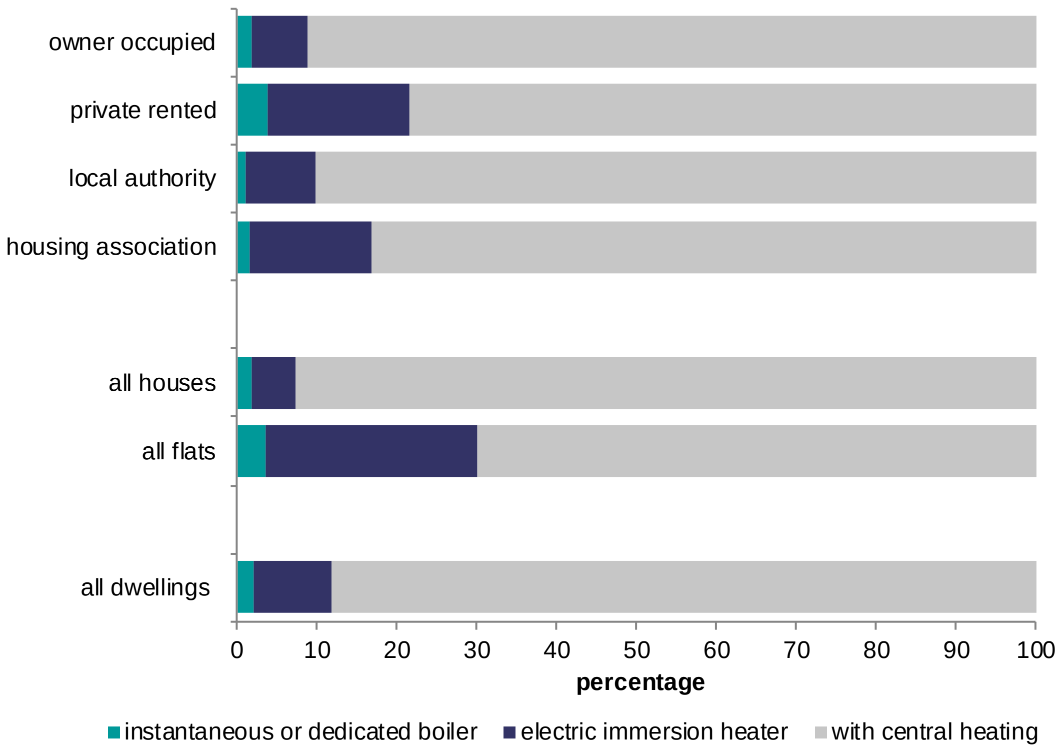
Note: some dwellings included both measures
Base: dwellings with a renewable energy measure
Source: English Housing Survey, dwelling sample

Water heating

1.23. In 2012, the majority of homes (88%) obtained their main source of hot water via the central heating system. Most of the remaining homes (10%) had an immersion heater as the primary source of hot water, with relatively few having instantaneous water heaters or a dedicated boiler, Annex Table 1.9.

1.24. There was, however, some variation by tenure and between houses and flats. Private rented homes were more likely to have an immersion heater as the main source of hot water than owner occupied homes (18% compared with 7%), whilst local authority dwellings included a higher proportion of centrally heated hot water systems than housing association stock (90% compared with 83%). Flats were more likely to use electric immersion heaters, dedicated water boilers or instantaneous water heaters, which corresponds with the significantly lower proportion of central heating found in flats than in houses and bungalows, Figure 1.6.

Figure 1.6: Main water heating types by tenure and dwelling type, 2012



Base: all dwellings
Note: underlying data are presented in Annex Table 1.9
Source: English Housing Survey, dwelling sample

Secondary heating

1.26. In 2012, 15 million (66%) dwellings had some form of secondary heating present, a decrease of around 600,000 since 2011, Annex Table 1.10. This is likely to be due to some new and extended central heating systems being installed which cover the whole house and the corresponding removal of secondary systems such as electric room heaters.

1.27. Owner occupied homes were more likely to have secondary heating than all rented dwellings (74% compared with 51%). The majority of flats (59%) had only a single source of space heating, partly due to the typically smaller size of flats than houses, Annex Table 1.10.

1.28. Where secondary heating was present, 96% were individual fixed room heaters, with the remainder being single electric storage heaters or portable heaters. Portable heaters were more common as a secondary heating source in private rented homes (12%) than other tenures, Annex Table 1.11.

1.29. Gas was the most common fuel used in secondary heating systems (49%), 33% of homes used electricity and 18% used solid fuel. Electric secondary heating was most frequently used in rented dwellings, whilst gas more commonly used by owner occupiers. Portable heaters and electric secondary heating were much more likely to be used in flats than in houses, Annex Table 11.1.

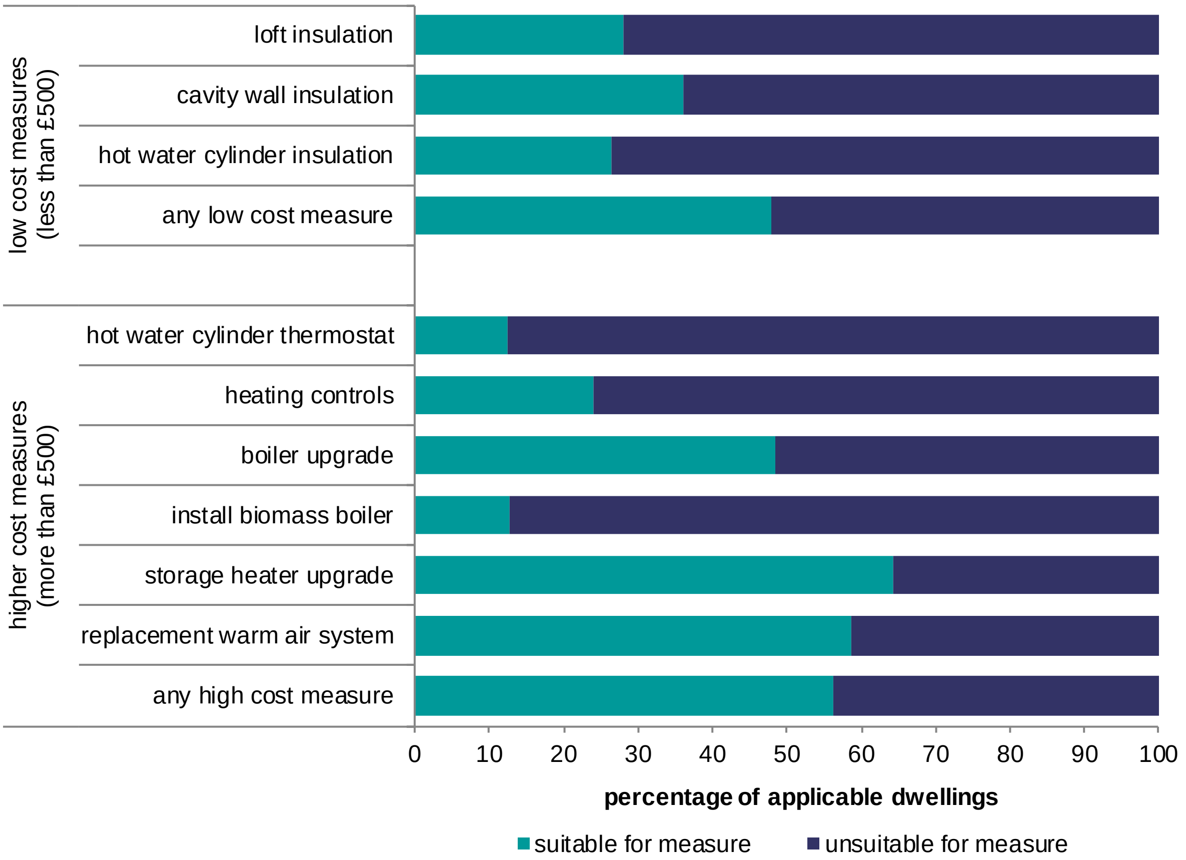
Potential for energy improvements

1.30. This section considers the potential for energy efficiency improvements in the housing stock. The measures described as low and higher cost in this analysis are based on recommendations covered by the EPC[11].

1.31. In 2012, 16.6 million dwellings (73% of the housing stock) could potentially have benefitted from at least one form of the energy improvement measures covered by an EPC (listed in Annex Table 1.12)[12]. The energy improvement measures that could benefit most dwellings were the installation of a condensing boiler (9.7 million, 48%), installing cavity wall insulation (5.6 million,36%) and installing or upgrading loft insulation (5.6 million,28%), Figure 1.7.

[11] See Glossary for further information. Details of the modelling are described in chapter 5 of the Technical Report.
[12] For other dwellings, either these improvements were not required or the implementation of each measure alone would not result in the SAP rating increasing by at least 0.95 SAP points (see chapter 5 of the Technical Report for further details)

Figure 1.7: EPC recommended energy efficiency measures, 2012



Base: all dwellings
Notes:
1) figures show the proportion of dwellings where this improvement might be possible, e.g. for cavity wall insulation this is the number of dwellings with cavity walls
2) biomass installation is applied to homes with solid fuel heating
3) improvement costs at 2012 prices
4) underlying data are presented in Annex Table 1.12
Source: English Housing Survey, dwelling sample

1.32. Of the 11.5 million dwellings with hot water cylinders, 26% could be improved by upgrading the hot water cylinder insulation and 12% would benefit by having a cylinder thermostat fitted. Around 24% of the 20.2 million dwellings that had boiler systems with radiators or warm air systems, could benefit by having heating controls installed, Annex Table 1.12.

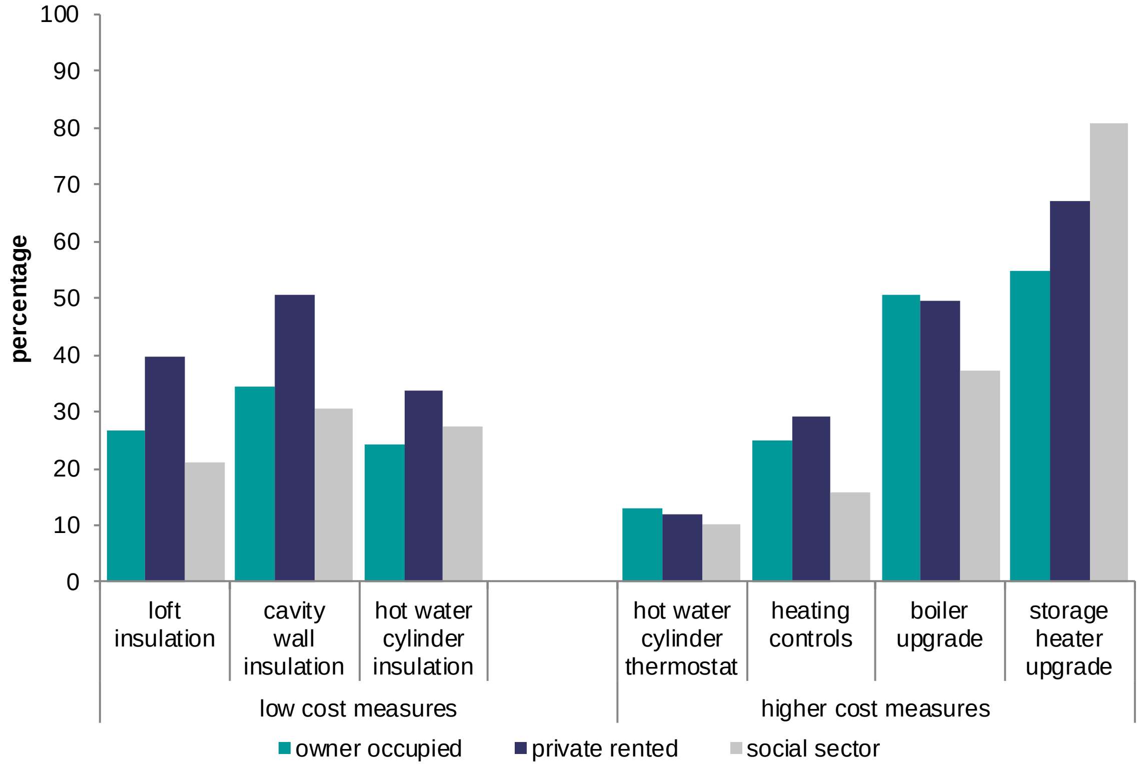
1.33. There were 2.2 million dwellings with storage radiators or other non-central electric heating systems and 64% of these could be replaced with more modern slim-line storage heaters, which generally cost less to run[13], Annex Table 1.12.

1.34. The recommended energy efficiency measures varied by tenure, with the private rented dwellings most likely to benefit from low cost measures.

[13] Modern, slim-line storage heaters often have a charge control (or an automatic charge control) which can adjust the amount of heat stored overnight. If the temperature is milder it stores less heat, saving money in the process.

Approximately half of private rented dwellings with cavity walls could potentially benefit from insulation (51%) and loft insulation would improve 40% of these homes where loft space existed. The social sector generally had less potential for energy improvement measures[14], which is likely due to work already done for the Decent Homes programme, Figure 1.8.

Figure 1.8: Eligible dwellings that would benefit from EPC recommended energy efficiency measures by tenure, 2012



Base: number of dwellings where this improvement might be possible, e.g. for cavity wall insulation the base is the number of dwellings with cavity walls
Notes:
1) replacement warm air systems and installation of biomass systems have been omitted due to the small numbers of dwellings that would benefit
2) underlying data are presented in Annex Table 1.13
Source: English Housing Survey, dwelling sample

1.35. There was more potential for flats to benefit from installing low cost energy efficiency measures and from upgrading storage heating systems (79% of applicable homes). Houses were more likely to benefit from the installation of a hot water cylinder thermostat, heating controls or upgrading the boiler, Annex Table 1.14.

1.36. Homes built after 1990 were generally least likely to benefit from energy efficiency measures, with the exception of boiler and storage heating upgrades. However, the oldest homes (pre-1919) did not always have the greatest potential for improvement. This may be due to many older homes

[14] For insulation and heating controls to the hot water cylinder, there was no significant difference between all social and private sector homes.

having already received improvements to bring them up to a modern standard, Annex Table 1.14.

Energy efficiency improvement work done

1.37. In the EHS interview survey for 2012-13, all households were asked about any energy improvement work either they or their landlord had done in the last 12 months. The most common job carried out by households or landlords was to service the central heating boiler (37%), Annex Table 1.15.

1.38. The most common energy improvement work was insulating or adding insulation to the loft (13%) and replacing the boiler (10%). Overall, 36% of households had energy improvement work done on their home (excluding boiler servicing[15]), Annex Table 1.15.

1.39. Owner occupiers (40%) were most likely to have energy improvement work done in the last 12 months compared with all renters (26% to 31%), but it should be noted that renters may be unaware of any improvements carried out by their landlord, especially if they have been living in the property less than 12 months. Private renters were least likely to have undertaken or received improvement works over this period, Annex Table 1.16.

Multivariate analysis for all households

1.40. Logistic regression has been used to assess which key factors (independent variables) are statistically related to households or landlords having carried out energy efficiency improvements in the last 12 months (the dependent variable). Although logistic regression can be used to explore associations between variables, it does not necessarily imply causation and results should be treated as indicative rather than conclusive. For further information on the methodology and the findings for this analysis see Appendix A of this chapter.

1.41. Firstly, for all households, logistic regression analysis explored the key household categories to ascertain the main predictors of energy efficiency improvement work done on the home. This analysis was subsequently repeated for owners and private renters. For all households, the most important factors in explaining a household's likelihood of carrying out an energy improvement measure were as follows (see Appendix A, Table 1).

Type of accommodation

1.42. The analysis suggests that the type of accommodation is the best predictor of energy improvement work done in the last 12 months. Households living in semi-detached houses had similar odds to those in the reference category

[15] Servicing work was considered more as maintenance measure rather than a specific upgrading of existing facilities and so excluded from this analysis and the multivariate analysis.

(detached houses and bungalows). Households living in terraced houses had lower odds of energy efficiency improvement work done. Occupiers of flats were the least likely to have had any energy improvement work done in the last 12 months. This finding is perhaps not surprising as occupiers of flats generally have less scope to carry out certain work, for example, loft insulation as there may be no loft to insulate. For some owners of flats, improvements may also be dependent on the agreement of other leaseholders.

Tenure

1.43. Owner occupiers were most likely to have had energy improvement work done. This finding may reflect that owner occupied households more likely to know if any energy efficiency improvement work done, as they would have had to organise, arrange and pay for them. In addition, owner occupiers were far more likely to be living in a house or bungalow than a flat, which was the strongest predictor of having energy improvement work done.

Household composition

1.44. Single households of all ages had the lowest odds of having carried out any energy efficiency improvements in the last 12 months.

Income

1.45. Households in the highest income band were most likely to have had energy efficiency work done. Households in the lower income bands had lower odds, with those households in the lowest income band having the lowest odds.

Age

1.46. Relative to households with an HRP aged 35-44, households with an HRP under 34 years and over 65 years had lower odds of energy efficiency improvement work done in the last 12 months.

Employment status

1.47. Relative to households with a full-time working HRP, households in full time education had the lowest odds of energy efficiency improvement work done in the last 12 months.

Ethnicity

1.48. The ethnicity of a household is not a good predictor of a household having energy efficiency improvement work done.

Multivariate analysis for owner occupiers

1.49. The strongest predictors are listed first (see Appendix A, Table 2):

Household composition

1.50. Single person households in all age categories and couples with no dependent children aged over sixty were much less likely than any other households to have energy improvement work done to their home in the last 12 months.

Dwelling type

1.51. Households living in flats were less likely to have energy efficiency work done compared with households in detached houses, bungalows, semi-detached houses and terraced houses.

Age, employment status and income

1.52. The age of the HRP, employment status of HRP and household income were similar predictors of whether energy improvement works done on the home. Households of 60 years and over and retired households were the least likely to have completed energy improvement works in the last 12 months, as were households in the lowest two income bands.

Multivariate analysis for private renters

1.53. The strongest predictors are listed first (see Appendix A, Table 3).

Household composition

1.54. Single households under 60 years and couples under 60 years with no dependents were much less likely to have had energy improvement work done on their home in the last 12 months.

Dwelling type

1.55. Households in flats were less likely to have had energy improvement work done to their homes compared with households living in houses or bungalows.

Employment status and age

1.56. The age and employment status of HRP were similar predictors of whether energy improvement measures had been carried out. Households in part-time employment or economically inactive were most likely to have had energy efficiency work done to their homes in the last 12 months. Households aged

16-24 were least likely to have had energy efficiency work done to their homes compared with older households.

Income level

1.57. Income level was not a predictor of household energy efficiency improvements among private renters.

Households unable to heat their homes adequately

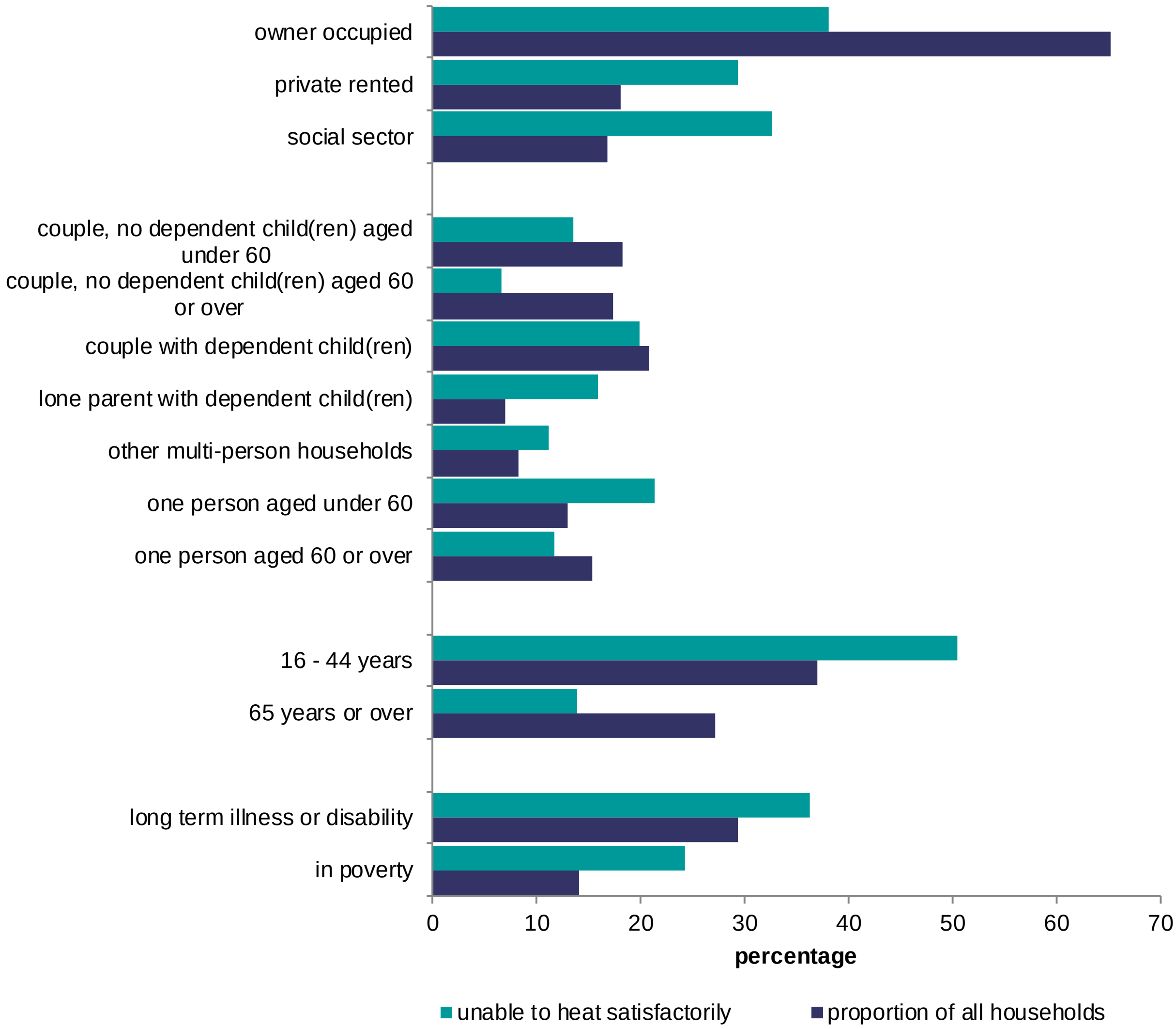
1.58. From the information collected for the 2012-13 EHS interview survey, 2.4 million households (11%) that stated that they were unable to keep their living room comfortably warm during cold winter weather. Some 29% of private renters and 33% of those living in the social sector stated that there were unable to keep their living room comfortably warm at this time, far higher than the proportion of these household types within all households (18% and 17% respectively), Annex Table 1.17.

1.59. Of households unable to heat their homes adequately, 20% were couples with dependent children, which was a similar proportion to this household type in all households (21%). In contrast, lone parents were over represented at 15% of households unable to heat their homes adequately, despite making up only 7% of all households.

1.60. The proportion of households with a person who had a long term illness or disability (36%) and households in poverty (24%) were also over represented compared with these household types in all households (29% and 14% respectively), Annex Table 1.17.

1.61. Though households aged 65 years or over make up 27% of all households, only 14% of households unable to adequately heat their home were in this age group. Half of households unable to heat their homes adequately were aged 16-44, Figure 1.9.

Figure 1.9: Households under heating by their home compared to the overall distribution of households, 2012



Base: all households
Note: underlying data are presented in Annex Table 1.17
Source: English Housing Survey 2012-13, full household sample

1.63. Of the 2.4 million households that were unable to heat their living room comfortably in the winter, 38% said that it was because it costs too much to keep the heating on, 34% said that it was not possible to heat their room to a comfortable standard and 22% said it was due to both of these reasons. These reasons varied by tenure. For private renters, the most common reason given was that it was not possible to heat a room to a comfortable level (37%), which may suggest that the property condition and/or energy performance may be a having a greater impact on these households than social renters or owners, Annex Table 1.18.

1.64. Overall, 58% of all households found it very easy or fairly easy to meet their heating costs and 20% found it either fairly difficult or very difficult to meet heating costs, Annex Table 1.19.

Post-improvement performance

1.65. If all the potential cost effective improvement measures[16] covered by EPCs were installed in all eligible dwellings, the mean SAP rating for the stock would rise from 59 to 64. Under the standard occupancy and heating patterns used by SAP to assess stock performance, this could result in the following (Annex Table 1.20):

- a potential 14% reduction in average fuel bills for all households (from £919 to £787 at 2012 standard energy prices)
- average CO_2 emissions per dwelling falling by almost 1 tonne/year across the whole stock (from 5.1 to 4.2 tonnes/year)
- a total saving of 21.2 million tonnes/year of CO_2 emissions (18% of total current emissions).

1.66. The improvements in the average SAP rating would be greater for owner occupied and private rented dwellings (up 6-7 points) than for social sector homes (up by 4 points). Falls in the average CO_2 emissions would be less for social sector homes, at around 0.5 tonnes per year compared with around 1 tonne in the private sector. Private sector homes would see a much larger potential reduction in annual energy costs than social sector homes (saving an average of £145 per annum from the notional SAP based energy costs, compared with £70), Annex Table 1.20.

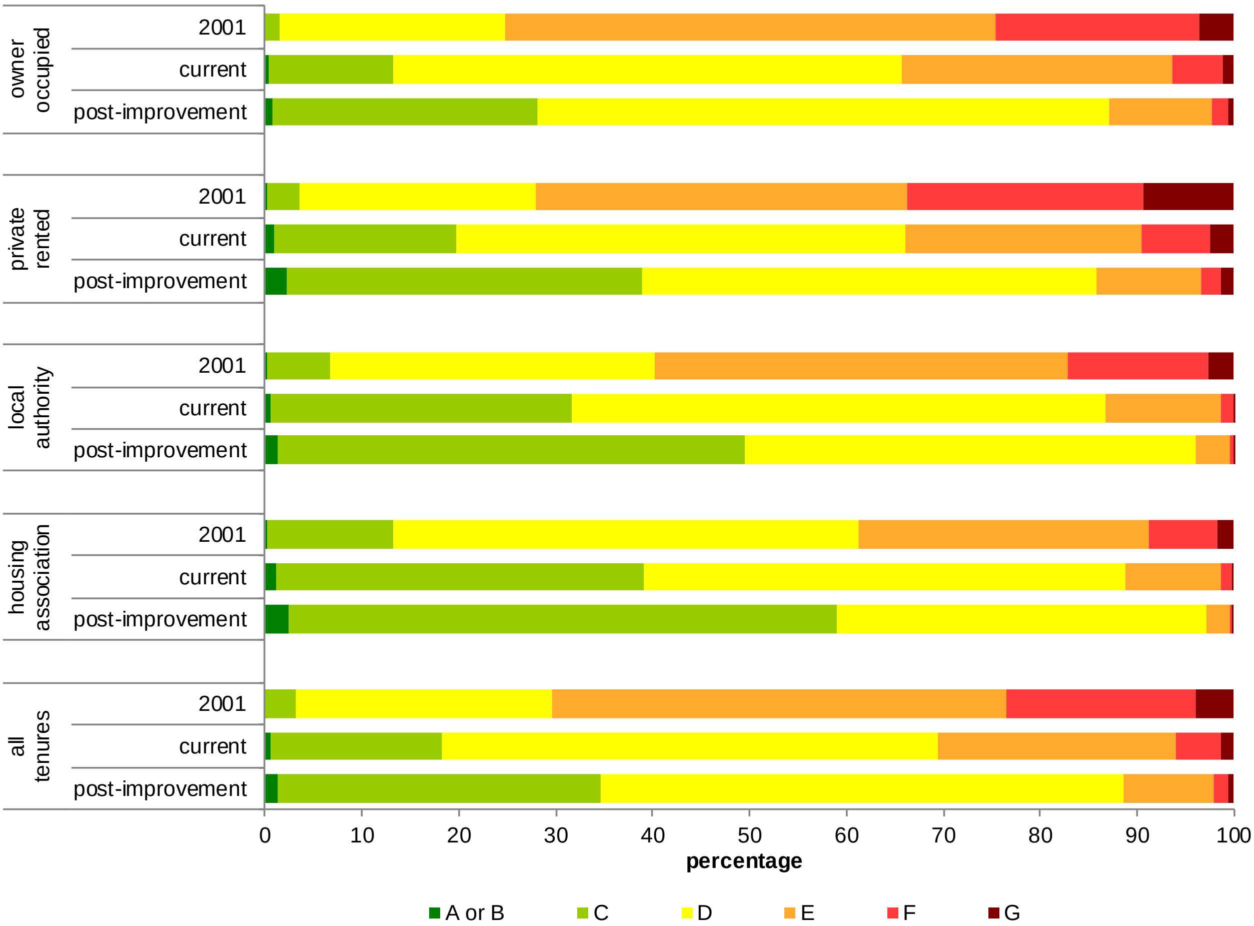
1.67. Substantial improvements in energy efficiency occurred from 2001 to 2012 with the proportion of dwellings in the top energy efficiency bands (A - C) rising from 3% in 2001 to 18% in 2012. Applying the full range of cost effective EPC measures would almost double the proportion of dwellings in these bands to 35%. In addition, the percentage of homes in the least efficient bands (E to G) would fall to 11%, representing a considerable improvement from the 2001 position (in which 70% of all homes were in the E to G band), Figure 1.10.

1.68. Should the full range of measures be applied, this would result in there being very few social sector homes in Bands E to G (3 - 4%). Furthermore, 59% of housing association dwellings and 50% of local authority dwellings would be in Bands A to C, compared with 39% of private rented dwellings and 28% of owner occupied dwellings, Annex Table 1.21. This is due to the different type and age profiles within tenures; the private sector has a higher proportion of both the oldest pre 1919 homes and semi-detached and detached houses,

[16] Replacing warm air system has been included in the post-improvement Energy Efficiency Rating/CO_2 emissions but, due to modelling complexity, installation of a biomass boiler has not. Given the relatively small number of dwellings that could benefit from a HETAS approved biomass boiler this will not have any significant effect on the overall indicators of post-improvement performance used in this section

categories which are typically associated with the lowest energy efficiency ratings (see Table 1.1).

Figure 1.10: Dwellings in each Energy Efficiency Rating Band by tenure, 2001 and current and post-improvement performance, 2012[17]



Base: all dwellings
Note: underlying data are presented in Annex Table 1.21
Sources:
2001: English House Condition Survey, dwelling sample;
2012: English Housing Survey, dwelling sample

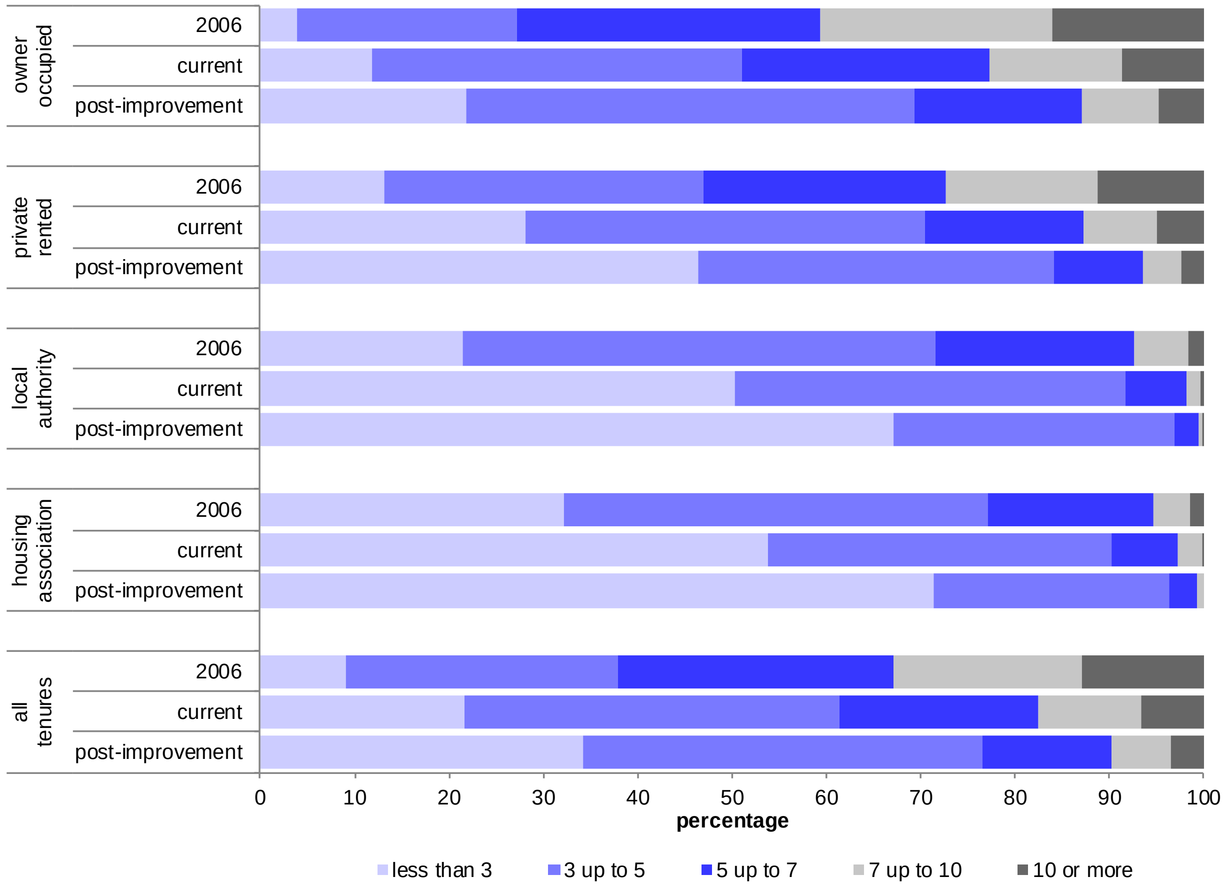
1.69. If all of the potential cost effective EPC recommended measures were installed, there would also be marked improvements in CO_2 emissions. For the whole stock, the proportion of dwellings notionally emitting less than 3 tonnes/year of CO_2 would increase from 22% to 34% while the proportion emitting 7 or more tonnes/year would fall from 18% to 10%, Figure 1.11.

1.70. A further comparison has been made with 2006 data to demonstrate progress made in improving the average energy efficiency of the stock. In 2006 the proportion of homes emitting less than 3 tonnes/year of CO_2 was less than half the proportion in 2012; the proportion emitting 7 or more tonnes/year decreased from 33% to 18%.

[17] Improvements are those EPC recommended energy efficiency measures given in Figure 1.6

1.71. The private sector would still contain virtually all homes emitting 7 or more tonnes (99%). Approximately 71% of housing association dwellings would emit less than 3 tonnes /year compared with just 22% of owner occupied homes, Annex Table 1.22.

Figure 1.11: Dwellings with given levels of carbon dioxide (CO2) emissions (tonnes/year) by tenure – 2006 baseline, current and post-improvement performance, 2012



Base: all dwellings
Note: underlying data are presented in Annex Table 1.22
Sources:
2006: English House Condition Survey, dwelling sample, SAP 2005 methodology;
2012: English Housing Survey, dwelling sample, SAP 2009 methodology

1.72. The average cost of applying all of these EPC improvements is estimated to be £1,094 per improved dwelling, for homes that could have at least one energy upgrade, amounting to a total cost of £18.2 billion across the stock as a whole. However, for 20% of dwellings the measures required would cost less than £380 to install. In contrast, the most expensive 20% of homes would cost in excess of £1,550 to improve. In general, the most expensive dwellings to improve were owner occupied homes (£1,140) and detached houses (£1,330). Interestingly, the oldest dwellings (pre 1919) did not have significantly different average costs to more recently built homes, likely because they have had some improvement works already, Annex Table 1.23.

Chapter 2
Hard to treat properties

This chapter focuses on those dwellings that had the worst energy performance (energy efficiency rating bands F and G) in 2012 and how the profile of these has changed over time. It then examines the feasibility of undertaking energy improvements to these homes and how this compares to more energy efficient homes. The chapter also investigates the difficulties in undertaking energy improvements in so-called ‘hard to treat’ homes, presenting some case studies to illustrate key and common issues.

Additional findings relating to energy inefficient dwellings can be found in web tables DA7101 to DA7104.

Homes with the worst energy efficiency

Types of dwellings

2.1 In 2012, around 1.4 million dwellings (6%) had the poorest energy efficiency ratings (SAP bands F and G), Annex Table 2.1. The majority of the worst energy efficient homes were owner occupied (68%). However, the private rented sector was over represented among these homes, comprising 28% of energy inefficient homes, but only 18% of the total housing stock. By contrast, only 4% of these homes were in the social sector. Around 10% of these homes were vacant at the time of the survey, Table 2.1.

2.2 Detached dwellings (28%), bungalows (13%) and converted flats (9%) were also over represented among the worst energy efficient homes whilst purpose built flats were under represented (6%), Table 2.1.

2.3 Over half of the worst energy efficient homes were built before 1919 (52%). Homes in rural areas were over represented, comprising 41% of energy inefficient homes compared with 17% of the total stock. This is largely because rural areas have a higher proportion of older homes and a lower proportion of purpose built flats, Table 2.1.

Table 2.1: Profile of homes with the worst energy efficiency compared with the profile of the rest of the housing stock, 1996 and 2012

all dwellings

	1996		2012	
	SAP bands F and G	all dwellings	SAP bands F and G	all dwellings
			percentage of dwellings	
tenure				
owner occupied	70.1	68.5	68.0	65.1
private rented sector	13.8	9.8	28.3	18.1
social sector	16.1	21.7	3.7	16.8
type of vacancy				
occupied	94.7	96.1	89.7	95.6
vacant	5.3	3.9	10.3	4.4
dwelling type				
small terraced house	12.9	13	7.6	9.5
medium/large terraced house	12.9	15.8	13.9	18.2
semi detached	29.1	26.3	22.3	25.8
detached	20.2	15.4	28.5	17.3
bungalow	16.1	10.2	13.1	8.9
all houses	91.2	80.8	85.4	79.7
converted flat	3.9	4.3	8.7	4.1
purpose built flat	4.9	14.9	5.9	16.2
all flats	8.8	19.2	14.6	20.3
dwelling age				
pre 1919	33.9	23.4	51.9	19.7
1919 to 1944	25.2	19.2	20.8	16.6
1945 to 1964	20.1	20.9	12.1	20.1
1965 to 1980	18.5	23.3	11.5	21.0
post 1980	2.3	13.3	3.8	22.6
area				
city and other urban centres	17.3	20.9	19.7	20.6
suburban residential areas	52.5	59.5	39.0	62.3
rural areas	30.2	19.6	41.3	17.2
all dwellings	**100.0**	**100.0**	**100.0**	**100.0**
sample size	*3,533*	*13,711*	*650*	*12,763*

Note: underlying data are presented in Annex Table 2.1
Source: English Housing Survey, dwelling sample

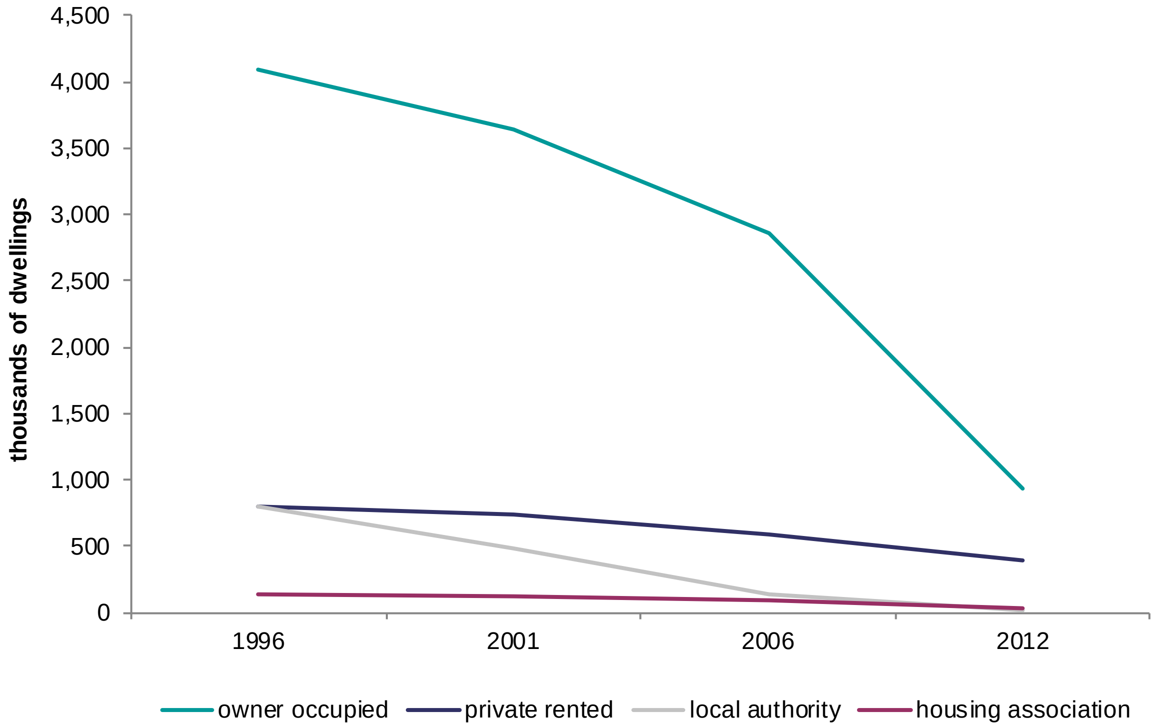
2.5 In 1996, dwellings with the worst energy efficiency comprised 29% of the total housing stock, but this proportion had decreased to 6% by 2012. The profile of these dwellings changed over this period. The proportion in the private rented sector increased from 14% to 28% in 2012, while the proportion in the social sector decreased from 16% to 4%, Table 2.1.

2.6 This above finding demonstrates the greater progress made by the social sector in improving the energy efficiency of homes, for example, via the Decent Homes programme. In addition, it may reflect the on-going lack of incentives for some private landlords to install energy improvement measures. Landlords have to meet the costs of these measures, but do not directly accrue some key benefits, for example, reduced heating bills. Also, as rents may not reflect the differences in the thermal efficiency of a property, there may be little incentive for landlords to invest in these measures.

2.7 Overall, houses comprised a lower proportion of the poorest energy efficient homes in 2012 (85%) than in 1996 (91%) although the proportion of detached homes increased from 20% to 28%. Homes built after 1919 accounted for a smaller proportion of these homes in 1996 (34% compared with 52% in 2012), which reflects the difficulties (costs and feasibility) in installing energy efficiency measures in these oldest dwellings, Table 2.1.

2.8 The number of dwellings with the worst energy efficiency ratings decreased from 5.8 million to 1.4 million from 1996 to 2012, Annex Table 2.2. Those in the owner occupied sector fell from 4.1 million in 1996 to 938,000 in 2012.The smallest decrease occurred within the housing association sector, although these homes accounted for the smallest proportion and number of homes with the poorest energy efficiency in 1996. The number of homes with the poorest energy efficiency fell steadily within the local authority sector between 1996 and 2006, aligning levels to those found among housing association homes by 2012. This is likely due to planned maintenance programmes in this sector and to the improvements made under the Decent Homes programme, Figure 2.1.

Figure 2.1: Dwellings with the worst energy efficiency by tenure, 1996-2012



Base: all dwellings
Note: underlying data are presented in Annex Table 2.2
Sources:
1996-2006: English House Condition Survey, dwelling sample;
2012: English Housing Survey, dwelling sample

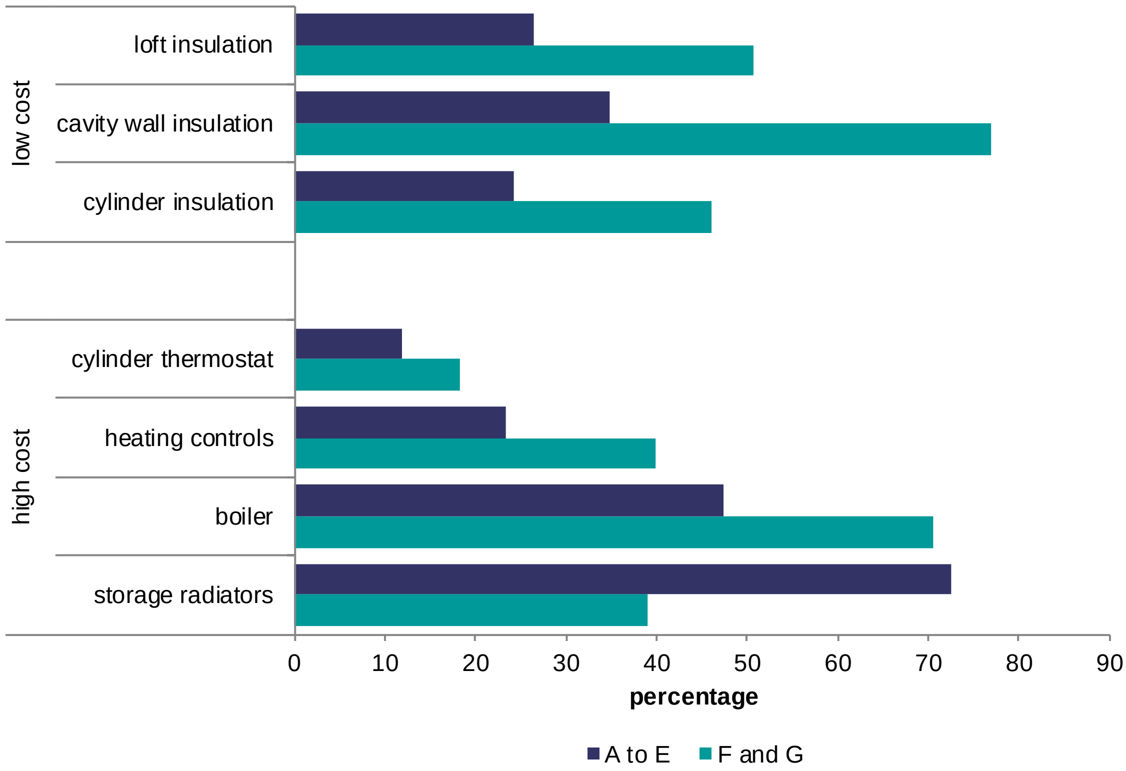
Feasibility of installing energy measures

2.9 The current insulation and heating characteristics of homes impact on the type and feasibility of energy improvements that can be made. Not surprisingly, many of the dwellings with F and G SAP band ratings were found to lack effective insulation. A quarter of these dwellings (25%) had uninsulated cavity walls and two-thirds (66%) were non cavity walled dwellings with no additional internal or external insulation. Of those dwellings with a loft, 13% had no loft insulation. These dwellings were also more likely to have no double glazing, 19% compared with 5% in more energy efficient dwellings (with A-E SAP band ratings), Annex Table 2.3.

2.10 Dwellings with the worst energy efficiency ratings were more likely to have fixed room heaters (25%) and storage heaters (12%) than more energy efficient homes (1% and 6% respectively). Consequently, they were far less likely to have central heating than more energy efficient homes (63% compared to 92% respectively). Dwellings with poor energy efficiency were more likely to use electricity for the main heating (33%) and less likely to use mains gas (46%), Annex Table 2.3.

2.11 The overall potential to improve the energy efficiency of these homes using low and high cost EPC measures, irrespective of the ease of installation, is shown in Figure 2.2. Around half of these homes would benefit from loft insulation (51%), and hot water cylinder insulation (46%) whilst 77% would benefit from having cavity wall insulation. The most common high cost measure that could be applied was an upgrade to either a gas or oil condensing boiler (71%), Figure 2.2.

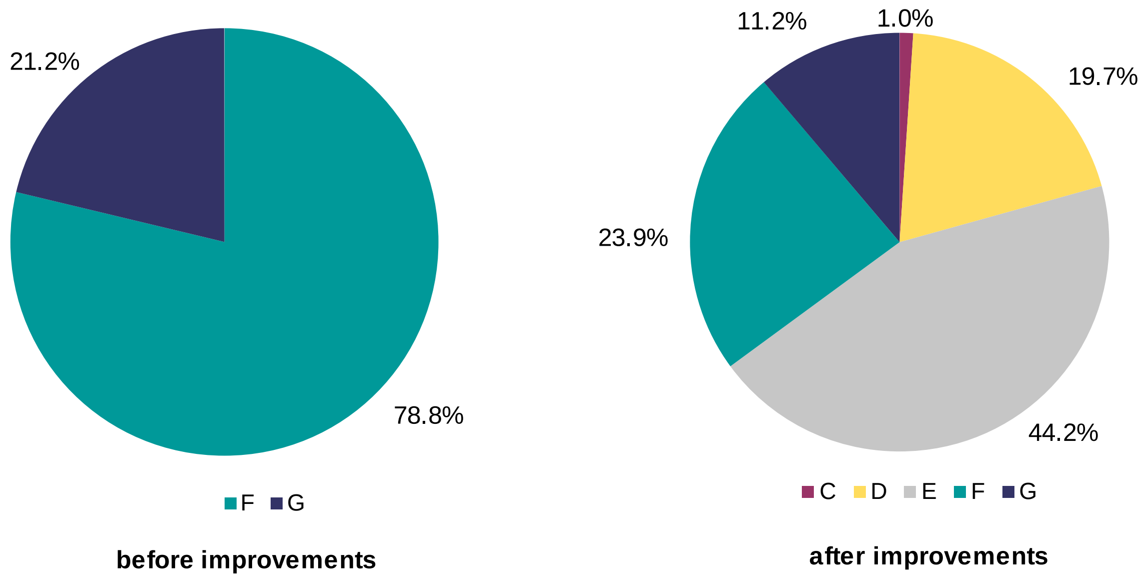
Figure 2.2: Potential energy performance upgrades by SAP rating bands for all dwellings, 2012



Base: number of dwellings where this improvement might be possible irrespective of the ease of installation, e.g. for cavity wall insulation the base is the number of dwellings with cavity walls
Note: underlying data are presented in Annex Table 2.4
Source: English Housing Survey, dwelling sample

2.12 Of the 1.4 million dwellings in SAP bands F and G, around 992,000 would improve by at least one SAP band if both low and high cost energy improvement measures were applied, Annex Table 2.5. Approximately 21% of these dwellings would move up to band C or D, 44% of these dwellings would move up to band E and 35% would remain in bands F and G (although the proportion in Band G would reduce considerably), Figure 2.3.

Figure 2.3: SAP rating before and after energy improvement measures have been applied, 2012



Base: all energy inefficient dwellings where improvements might be possible irrespective of the ease of installation, e.g. for cavity wall insulation the base is the number of dwellings with cavity walls
Note: underlying data are presented in Annex Table 2.5
Source: English Housing Survey, dwelling sample

2.13 Of those 484,000 dwellings that remained in SAP band F and G, the vast majority (79%) were non-cavity walled dwellings with no additional external or internal insulation, Annex Table 2.6. Potentially, these properties could benefit from solid wall insulation, discussed later in this chapter.

2.14 Table 2.2 demonstrates how the installation of energy improvement measures would improve the average SAP rating, CO_2 emissions and energy costs for energy inefficient dwellings, and how these compare with the post-improvement performance of other dwellings. The average SAP ratings for the poorest energy inefficient dwellings would increase by 14 points whilst the average energy cost would reduce by around £400 to £1,410 per year. Nonetheless, this average fuel cost would still be considerably greater than the current average for more energy efficient dwellings.

Table 2.2: Potential improvements in energy efficiency (SAP) ratings, CO^2 emissions and fuel costs by energy efficient and inefficient dwellings, 2012

all dwellings

	mean energy efficiency (SAP09) rating		mean notional total CO_2 emissions (tonnes/yr)		mean notional total energy cost (£/yr)		
	current	post-improvement	current	post-improvement	current	post-improvement	*sample size*
current SAP band							
SAP band A to E	60.5	65.8	4.8	4.0	861.2	746.7	*12,113*
SAP band F and G	27.8	41.7	10.5	7.6	1,811.8	1,409.7	*650*
all dwellings	**58.5**	**64.4**	**5.1**	**4.2**	**919.0**	**787.0**	***12,763***

Source: English Housing Survey, dwelling sample

Homes with hard to treat walls and lofts

2.15 This analysis categorises the housing stock according to the ease with which cavity wall, solid wall and loft insulation could be fitted if necessary. The dwelling characteristics of those which were hard to treat were then assessed to identify the house types that are most difficult to improve. It should be noted, however, that this section is not intended to form any definitive guidance on how these homes should or should not be treated, as this can only be undertaken on a case by case basis.

Original wall construction

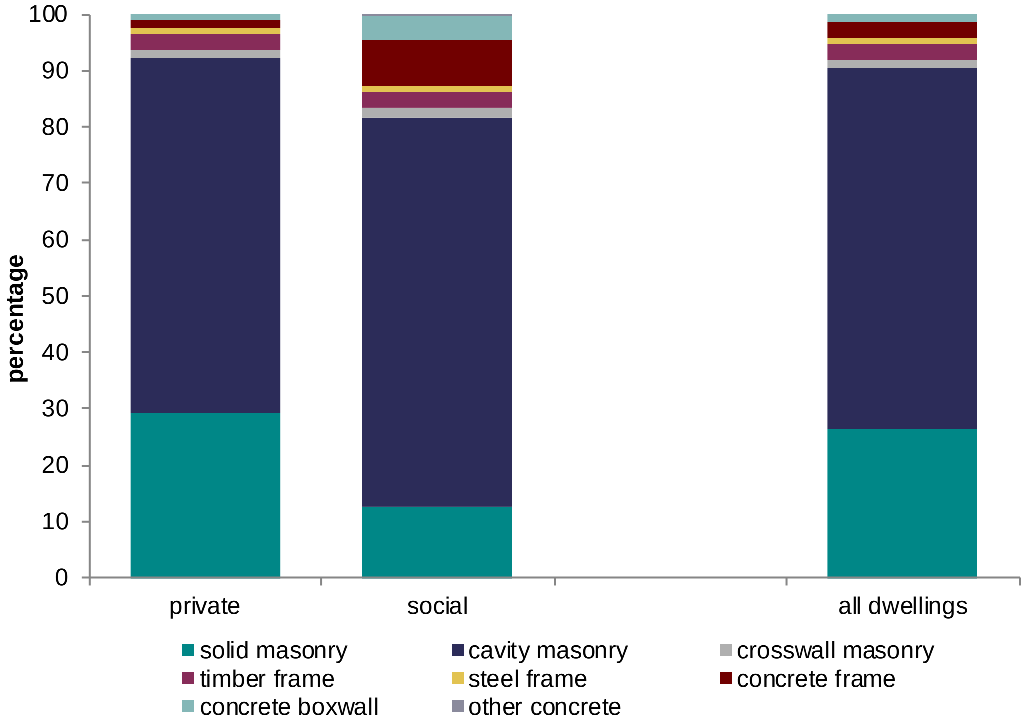
2.16 Before looking more closely at aspects of solid and cavity walled homes that could impede improvements to their energy efficiency, this section examines the types of wall construction found in the English housing stock. These are recorded for the original construction of the dwelling, before considering extensions and improvements which may change the predominant construction type. Further details regarding the different construction methods over time can be found in Chapter 1 of the 2011 EHS Stock Report.

2.17 Wall construction has always been dominated by masonry (brick, block, stone and flint), although cavity masonry has replaced solid masonry as the dominant construction type for load-bearing walls since 1945 and was used in 82% of all homes built after 1990. Around 2% of existing dwellings built before 1919 were built with a traditional timber frame. Timber frame building declined until modern factory-built systems were developed in the 1970s. This method accounted for 9% of all homes built after 1990, Annex Table 2.7.

2.18 From 1945 to 1980, concrete frame and concrete boxwall methods were used in around 7% to 8% of homes, but concrete boxwall construction was rare in homes built after this period, Annex Table 2.7.

2.19 Owing to the higher proportion of older homes, it is not surprising that a greater proportion of homes of solid wall construction were found in the private sector (29%) compared with social sector homes (13%). Whilst the proportion of timber framed dwellings was similar between the two sectors (3%), the social sector contained a higher proportion of homes of concrete construction (13% compared with 3%) due to the greater proportion of purpose built flats, Figure 2.4.

Figure 2.4: Construction type by tenure, 2012



Base: all dwellings
Note: underlying data are presented in Annex Table 2.7
Source: English Housing Survey, dwelling sample

2.20 City and urban areas and rural areas also contained a higher proportion of older homes, so solid wall construction was more prevalent here (49% and 29% respectively) compared with homes located in suburban and residential areas (19%). Owing to the greater proportion of purpose built flats in city and urban locations, homes of concrete construction were more prevalent (10%), Annex Table 2.7.

Cavity wall insulation

2.21 In this section homes with predominantly cavity walls are classified as standard or hard to treat according to the criteria in Box 1. This classification and analysis differs from the approach used in the 2010 and 2011 EHS Stock Profile Reports. The 2012 methodology aims, as far as possible, to provide a count of hard to treat cavity walls consistent with the energy company obligation definition, although the EHS is unable to fully replicate this[1].

Box 1: Hard to treat cavity walls

The categories for the ease of filling uninsulated cavity walls are:

Standard fillable: no compelling physical barrier to installation exists. These are typically bungalows or 2 storey houses with standard masonry cavity walls and masonry pointing or rendered finishes.

Hard to treat cavity walls: These are homes with cavity walls that could in theory be filled, but which exhibit one of the following difficulties:

1. They are in a building with 3 or more storeys, where each storey has cavity walls. The need for scaffolding to install insulation in these higher buildings would contribute to the complication and cost of improving these homes.
2. The gap found in the cavity wall is found to be narrower than in standard walls. Although an attempt could be made to insulate these homes by injecting foam, the limited cavity space may lead to an uneven spread of the insulating material, resulting in substandard thermal properties.
3. The dwelling is of predominantly prefabricated concrete, metal or timber frame construction. Although more recent examples of these homes will have had insulation applied during construction, these are generally unsuitable for retrospective treatment. In the case of timber frame construction, the industry recommendation is not to inject insulation as this can hamper ventilation between the frame and the external wall that may lead to rot in the timber frame.
4. The cavity wall has an outer leaf finished predominantly with tiles or cladding.

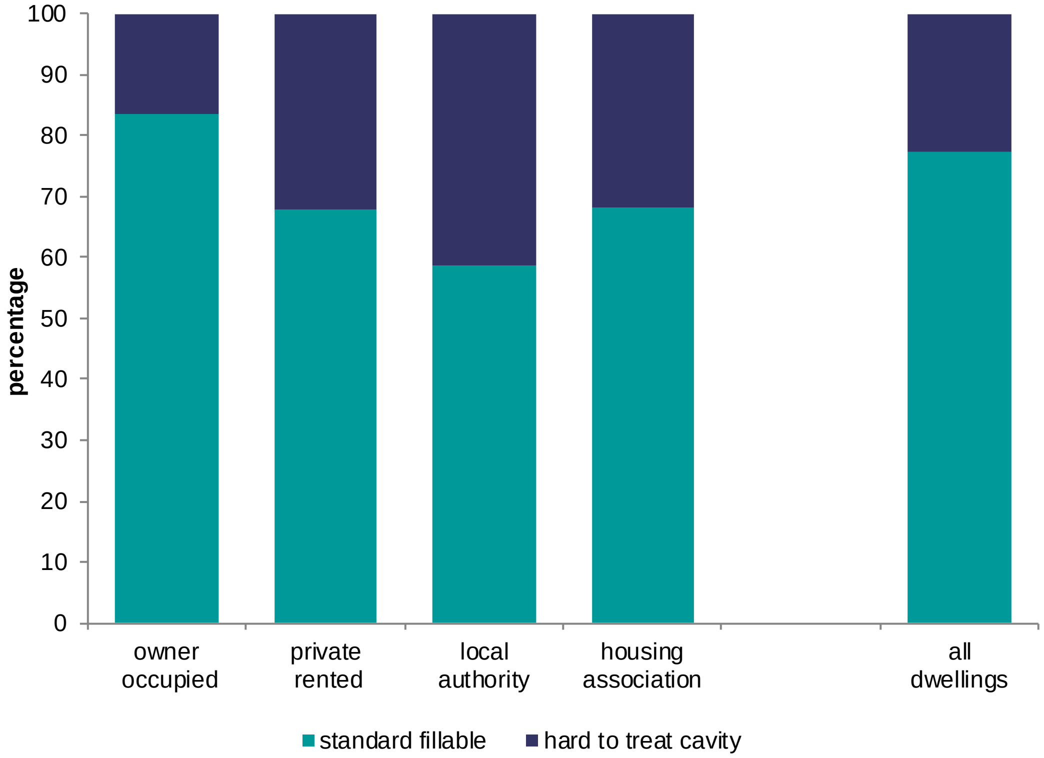
2.22 Of the 5.3 million dwellings[2] that could potentially benefit from the installation of cavity wall insulation, 77% were assessed to fall into the standard fillable category whilst the remaining 23% (1.2 million) of homes were classified as hard to treat. Amongst the tenures, owner occupied homes were the least

[1] For the ECO definition see https://www.ofgem.gov.uk/ofgem-   publications/84197/ecosupplementaryguidanceonhard-treatcavitywallinsulation.pdf

[2] For this analysis, the number of dwellings that could potentially benefit from cavity wall insulation will not match the number identified for the EPC improvements identified in chapter 1 of this report. This analysis excludes those post 1990 cavity walled dwellings where there is no evidence of insulation (as it assumes homes of this age are likely to have this installed).

likely to be hard to treat with only 16% of uninsulated cavity wall homes being problematic, compared with 41% of local authority homes and 32% of private rented and housing association dwellings, Figure 2.5.

Table 2.5: Barriers to installing cavity wall insulation by tenure, 2012



Base: all dwellings with theoretical potential to install cavity wall insulation
Note: underlying data are presented in Annex Table 2.8
Source: English Housing Survey, dwelling sample

2.23 Some explanation of the higher proportion of hard to treat cavity walls in the rented tenures comes from the types of dwelling that typically fall into this category. Due to the height of blocks of flats, it is not surprising that 59% of purpose built and 42% of converted flats, with uninsulated cavity walls, were classified as hard to treat, compared with 11% of semi-detached and only 6% of detached homes. The latter houses were considerably more likely to be owner occupied, whilst flats were most frequently found in the rented sector (see EHS 2012 Profile of English Housing report, chapter 1), Annex Table 2.8.

2.24 Dwellings built before 1919 and from 1965-1980 had a higher proportion of hard to treat cavity walls (31% and 30% respectively). The older age band includes a high proportion of houses with 3 or more storeys, whilst homes built between 1965 and 1980 were both more likely to be flats and to be of concrete frame construction than those in other age bands. The high percentage of flats classed as hard to treat largely explains the high proportion of urban dwellings with hard to treat cavity walls, 46% compared with 19% in suburban and 14% in rural areas, Annex Table 2.8.

Solid wall insulation

2.25 This section examines the ease with which solid walls may have external insulation applied. In a similar way to cavity walls, the applicable group has been split into non-problematic and hard to treat, with applicable dwellings here including those classed as having hard to treat cavities so that the whole stock can be assessed for some form of wall insulation. The hard to treat category is further categorised by specific issues that may increase the cost and difficulty of applying solid wall insulation, Box 2. Further details on how solid wall insulation is undertaken and associated cost estimates are provided in Box 3[3]

Box 2: Hard to treat solid walls

Non-problematic: homes with non-cavity walls or those with cavity walls previously identified as hard to treat which do not include the barriers listed below.

Hard to treat by increasing level of difficulty:

> **Masonry-walled dwellings with attached conservatories or other features:** fixing the insulation round any projections like conservatories, porches or bays requires additional work and therefore additional expense.
>
> **Dwellings with a predominant rendered finish:** this may add to the costs of the work as the render may need to be removed, repaired or treated before the insulation can be installed.
>
> **Dwellings with a predominant non-masonry wall finish:** improving dwellings with wall finishes such as stone cladding, tile, timber or metal panels would either add to the cost of the work or even preclude external solid wall insulation where the wall structure itself is stone or timber.
>
> **Flats:** These can be problematic for 2 reasons. Firstly, there are likely to be issues related to dealing with multiple leaseholders (getting their agreement and financial contribution to the work). Also, the height of the module for high-rise flats would present significant complications in applying external solid wall insulation.

There are other barriers such as planning restrictions that apply in conservation areas or listed building status that will affect the real potential for installing solid wall insulation but EHS does not collect data on these.

[3] See http://www.energysavingtrust.org.uk/Insulation/Solid-wall-insulation

2.26 Some 8.0 million homes, including those with hard to treat cavity walls, could potentially benefit from the installation of some form of solid wall insulation, but 6.8 million (85%) of these are categorised as hard to treat. For 24% of homes additional work would be needed to apply insulation around external features, whilst 32% had rendered rather than plain masonry wall finishes. An additional 3% would be difficult to treat due to cladding or stone finishes, Annex Table 2.9.

2.27 The proportion of hard to treat homes for solid wall insulation was relatively close for all tenures (82-92%), in contrast to the degree of variation seen between tenure for hard to treat cavity walls, Annex Table 2.9.

2.28 However, there was a great deal more divergence regarding the nature of barriers to potential insulation improvements. Flats comprised the main barrier to insulation among rented dwellings (44-65%), but only 12% for owner occupied homes. Owner occupied homes had the highest proportions of dwellings with external features (31%) and those with rendered walls (40%), suggesting that a large number of these homes could benefit from solid wall insulation, albeit at a higher average cost, Annex Table 2.9.

2.29 Terraced houses with solid or hard to treat cavity walls were more likely to be non-problematic than other house types, 25-27% compared with 15% of detached houses and 12% of semi-detached houses. This is mainly due to the lower proportion of terraced homes with predominantly rendered walls. Pre-1919 and post-1990 homes had higher proportions of both non-problematic homes (21% and 25% respectively) and homes with external features (31% and 33% respectively) than other age bands. Hard to treat solid walls due to existing rendered finishes were far more likely to be found in the 1919-44 dwelling age group (57%), Annex Table 2.9.

2.30 In addition to these barriers, there are further restrictions for which the EHS does not collect data. These include planning restrictions that apply in conservation areas and listed building status. Overall, there are around 374,000 listed buildings in England[4], some of which are dwellings. An additional estimated 1.1 million dwellings are located in conservation areas[5].

[4] See http://www.english-heritage.org.uk/caring/listing/listed-buildings/
[5] See http://www.eci.ox.ac.uk/research/energy/downloads/40house/background_doc_K.pdf

Box 3: Installing solid wall insulation
The energy improvements delivered by solid wall insulation vary considerably depending on the precise construction and thickness of the original wall (e.g. single leaf brick, 9-inch brick, stone or concrete).

External solid wall insulation is applied by fixing insulating boards to the outside of the building and covering them with a weatherproof render and sometimes false stone or brick cladding. Internal insulation can be added in a similar way using insulated plasterboard and a standard plaster finish or by constructing a timber frame inside the existing wall and filling this with mineral wool insulation, with a plasterboard and plaster finish. This work involves the added cost associated with moving power points, radiators, kitchen and bathroom fittings etc. as well as making good or adjusting floor coverings and decorations. Also, the affected rooms will be slightly smaller than before – a key consideration in some small terraced houses and converted flats.

Estimates for the cost of insulating a typical solid walled dwelling range from £9,000 to £25,000 for external insulation, and from £4,500 to £15,000 for internal insulation. These costs can be mitigated by combining the work with other necessary improvements such as renewing damaged plaster or render.

Loft insulation

2.31 The presence and type of loft will affect the ease of fitting insulation in the roof space, with hard to treat categories described in Box 4. The figures and analysis in this section cover 8.5 million dwellings: the 5.6 million identified in chapter 1 of this report where there was potential to upgrade the insulation under the EPC methodology, plus an additional 2.9 million homes where the existence of a flat roof or a fully converted loft space could preclude further work on improving the energy efficiency of the roof. The analysis does not include those dwellings that have no roof above i.e. flats that do not have any rooms on the top floor of a building.

Box 4: Ease of installing or topping up loft insulation

Non problematic: installation would be straightforward with no barriers.

Hard to treat by increasing level of difficulty/feasibility:

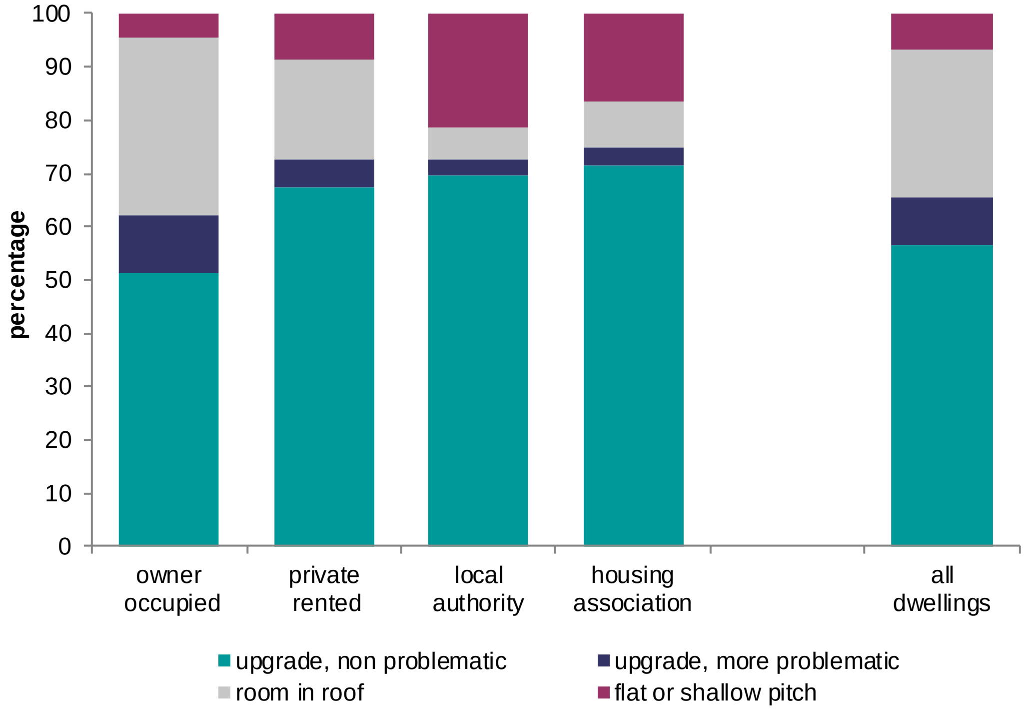
More problematic: loft is fully boarded across the joists which would lead to extra work and expense.

Room in roof: insulation would need to be added between the rafters which would involve very extensive work and considerable expense.

Flat or shallow pitched roof: not feasible to install loft insulation as there is no access into the loft or no loft space.

2.32 Some 56% of these 8.5 million homes should be non problematic to upgrade, leaving 44% harder to treat. The loft was fully boarded in 9% of homes, a permanent room in a loft was present in 28% of homes and a flat or shallow pitched roof was evident in 7% of homes, Figure 2.6. The latter two categories may not be considered potentially upgradeable because the level of insulation is usually unknown. These homes may already have had sufficient insulation installed during construction, but this analysis highlights the numbers of such dwellings that would be difficult to improve to a high level of thermal insulation.

Figure 2.6: Barriers to installing loft insulation by tenure, 2012



Base: all dwellings with theoretical potential to improve loft insulation and those that may have insufficient loft insulation
Note: underlying data are presented in Annex Table 2.10
Source: English Housing Survey, dwelling sample

2.33 Unlike the installation of cavity wall insulation, owner occupied homes were the most likely to have had hard to treat (49%) lofts, compared with rented homes (29% and 33%). Whilst only 5% of owner occupied homes were not feasible to insulate due to the presence of a flat roof (compared with 9-21% of rented homes), a larger proportion of these homes had a room or rooms in the loft 33%) compared with rented homes.

2.34 Rooms in the roof, normally resulting from loft conversions, were a much more common barrier in private rented homes (19%) compared with just 6-8% of the social sector, Annex Table 2.10.

Case studies – energy inefficient homes

2.35 This chapter has examined the characteristics of dwellings in bands F and G and considered some of the barriers that may prevent their improvement. Below are three case studies which take stereotypes of dwellings with poor energy efficiency ratings and summarise potential improvements, barriers to further improvement, and the estimated effect these would have on the SAP rating, CO_2 emissions and fuel costs.

Case study 1, Semi–detached in need of energy improvements – non problematic to treat

Source: BRE photo library

2.36 This 1930s semi-detached home has benefitted from the installation of double glazing but currently has uninsulated cavity walls and only 50mm of loft insulation. The property has mains gas and is centrally heated by a standard non-condensing boiler. Hot water is provided by the central heating, but the storage cylinder is also uninsulated. It currently has a SAP rating of 45, in SAP band E and annual CO_2 emissions of 5.8 tonnes, whilst the annual fuel costs are £1,034.

2.37 A number of low cost energy improvement measures could be applied to this dwelling, including an upgrade to the loft insulation to 270mm, applying an 80mm insulating jacket to the hot water cylinder, and the installation of cavity wall insulation, although the bay windows and tile-hung wall finish at the front of the dwelling would increase the costs of this measure. In addition, the higher cost measure of an upgrade to a condensing boiler would increase the dwelling's SAP rating to 67 putting it near the top of SAP band D. The annual CO_2 emissions would fall to 3.1 tonnes and the annual fuel costs to £625. With the work costing approximately £1,700 the payback period would be around 4 years.

Case study 2, Bungalow in need of energy improvements – problematic to treat

Source: BRE photo library

2.38 This rural detached bungalow built between 1944 and 1965 does not have a mains gas supply and the main heating is through electric heaters, supplemented by a solid fuel fire, whilst hot water is provided by an immersion heater in an uninsulated cylinder. It has double glazing but has uninsulated cavity walls. To extend the living and bedroom space at the dwelling, the owner has undertaken a large loft conversion which had 150mm of insulation installed between the rafters, but would be difficult and costly to further improve. It currently has a band F energy efficiency rating of 29, with annual CO_2 emissions of 10.3 tonnes and fuel costs of £1,097.

2.39 As the insulation in the loft space is now difficult to access, improvements to insulation are limited. Cavity wall insulation can be applied, though the large windows at the front of the dwelling will limit its effectiveness, whilst the hot water cylinder can also be insulated. The lack of a mains gas supply means that there are fewer options for a cost effective improvement to the heating, although the electric heaters can be replaced with relatively efficient modern storage heaters. Making these changes would cost around £1,500 and would improve the SAP rating to 53, in band D, with the CO_2 emissions decreasing to 5.8 tonnes per year. The annual fuel costs would fall to £820 giving a payback period of between 5 and 6 years.

Case study 3, 19th century purpose built flat – problematic to treat

Source: BRE photo library

2.40 This 3rd floor period flat is situated in a 6 storey city centre block built in the later 19th century. The walls are solid masonry with decorative brickwork to the front, and the windows are single glazed. It is heated using old storage heaters with an immersion heater supplying hot water to an insulated storage cylinder. The SAP rating is currently 54, which is high for a dwelling of this age, but fairly typical for a mid-floor flat with low heat losses through exposed surfaces. The flat has annual CO_2 emissions of 3.8 tonnes and fuel costs of £522 per year.

2.41 Some energy efficiency improvements can be undertaken, but not to the same extent as the previous examples. The storage heaters can be upgraded and a thick jacket fitted to the hot water cylinder. These upgrades would bring about a modest rise in the SAP rating to 63, taking it from band E to band D. The annual CO_2 emissions would be reduced to 3.1 tonnes and the fuel costs to £453, giving a 7 year payback period on upgrade costs of almost £500. Although further improvements would in theory be possible they would be expensive, and the lack of mains gas in the block prevents the installation of a more efficient boiler system. External solid wall insulation may be an option but would be more complicated and expensive due to the bay windows and brickwork detail, whilst planning permission would also be difficult to obtain for a dwelling of this age and type. Insulated plasterboard could possibly be applied internally but would negatively impact on the already small space available and period decoration.

Appendix A
Logistic regression

Methodology

3.1. Logistic regression has been used to assess which key factors (independent variables) are statistically related to households/landlords having carried out energy.

3.2. As all of the independent variables are categorical variables, the regression analysis provides an insight into which types of households/landlords are more or less likely to have undertaken any energy improvement to their home during this period. When using categorical variables in regression analysis one of the groups needs to be specified as the baseline group. The odds ratio, EXP (β) of the baseline group, is set as 1(labelled as 'reference category' in the tables). The odds ratios of the other groups are then calculated relative to the baseline group.

3.3. For this analysis, where the odds ratio is greater than 1, this group is less likely to have had an energy improvement measure compared with the baseline group. Alternatively, where the odds ratio is less than 1 this group is more likely to have had an energy improvement measure compared with the baseline group, see Table A1.

3.4. The independent variables below are presented in order of their 'predictiveness' (based on the R squared value of the model) with the most important factors in explaining a household's likelihood of carrying out an energy improvement measure listed first. This mirrors the order of the textual information provided in this chapter.

3.5. The logistic regression used standardised weighted data, (by weighting the weights by the overall mean weight) so that any relationships found would be not biased to the over-sampled groups or the very large weighted data sample size.

3.6. Although logistic regression can be used to explore associations between variables, it does not necessarily imply causation and results should be treated as indicative rather than conclusive.

Table A1: Logistic regression model for households who have carried out an energy efficiency improvement in the last 12 months, 2012-13

all households

Independent variables	Odds ratios	Significance
accomodation type		
detached house or bungalow	*Reference category*	
semi-detached	1.09	0.07
terrace/end of terrace	1.24	0.00 *
purpose built flat/maisonette	2.29	0.00 *
flat conversion/rooms	2.30	0.00 *
tenure		
housing association	*Reference category*	
owner occupier	0.61	0.00 *
private renter	1.17	0.04 *
local authority	0.91	0.33
household composition		
couple with dependent child(ren)	*Reference category*	
couple, no dependent child(ren) under 60	1.08	0.15
couple, no dependent child(ren) aged 60 or over	1.08	0.19
lone parent with dependent child(ren)	1.10	0.21
other multi-person household	1.19	0.02 *
one person under 60	1.77	0.00 *
one person aged 60 or over	1.40	0.00 *
income band		
highest 20%	*Reference category*	
lowest 20%	1.60	0.00 *
quintile 2	1.26	0.00 *
quintile 3	1.14	0.02 *
quintile 4	1.03	0.54
age of HRP		
35-44	*Reference category*	
16-24	1.66	0.00 *
25-34	1.24	0.00 *
45-54	0.89	0.04 *
55-64	0.90	0.08
65+	1.12	0.04 *
employment status of hrp		
full time employment	*Reference category*	
part time	0.96	0.53
retired	1.16	0.00 *
unemployed	1.18	0.10
full time education	2.04	0.00 *
other inactive	1.35	0.00 *
sample size	*13,652*	

Note: 'other' types of accommodation were excluded from the analysis (42 cases)
Significance: * the result is significant at (or below) the .05 level
Source: English Housing Survey, full household sample

Table A2: Logistic regression model for owner occupiers who have carried out an energy efficiency improvement in the last 12 months, 2012-13

owner occupier households

Independent variables	Odds ratios	Significance
household composition		
couple with dependent child(ren)	*Reference category*	
couple, no dependent child(ren) under 60	1.00	0.99
couple, no dependent child(ren) aged 60 or over	1.23	0.00 *
lone parent with dependent children	0.90	0.40
other multi-person household	1.09	0.38
one person under 60	1.42	0.00 *
one person aged 60 or over	1.50	0.00 *
accomodation type		
detached house or bungalow	*Reference category*	
semi-detached	1.07	0.19
terrace/end of terrace	1.11	0.07
purpose built flat/maisonette	1.89	0.00 *
flat conversion/rooms	2.07	0.00 *
age of HRP		
35-44	*Reference category*	
16-24	0.71	0.20
25-34	0.96	0.60
45-54	0.94	0.37
55-64	1.01	0.84
65+	1.27	0.00 *
employment status of hrp		
full time employment	*Reference category*	
part time	1.04	0.66
retired	1.32	0.00 *
unemployed	1.07	0.71
full time education	0.67	0.59
other inactive	1.13	0.36
income band		
highest 20%	*Reference category*	
lowest 20%	1.49	0.00 *
quintile 2	1.13	0.08
quintile 3	1.05	0.49
quintile 4	0.98	0.71
sample size	*13652*	

Note: 'other' types of accommodation were excluded from the analysis e.g. boats or caravans (35 cases)
Significance: * the result is significant at (or below) the .05 level
Source: English Housing Survey, full household sample

Table A3: Logistic regression model for private renters who have carried out an energy efficiency improvement in the last 12 months, 2012-13

private renter households

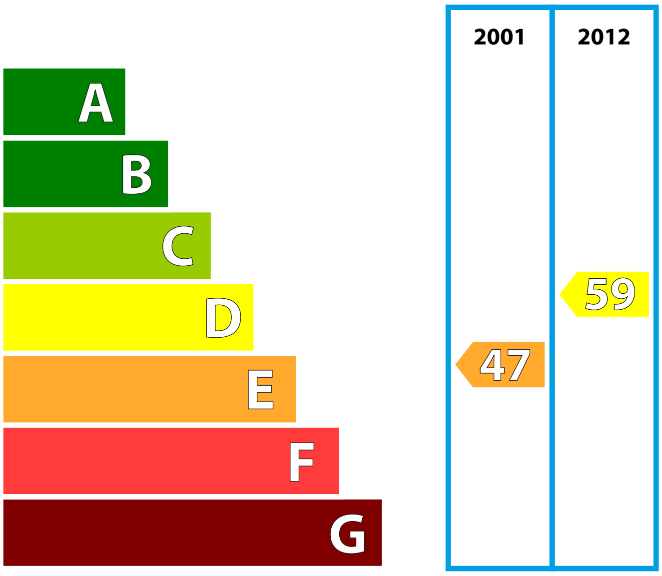
Independent variables	Odds ratios	Significance
household composition		
couple with dependent child(ren)	*Reference category*	
couple, no dependent child(ren) under 60	1.77	0.00 *
couple, no dependent child(ren) aged 60 or over	0.76	0.24
lone parent with dependent child(ren)	0.85	0.30
other multi-person household	1.32	0.06
one person under 60	2.04	0.00 *
one person aged 60 or over	1.11	0.62
accomodation type		
detached house or bungalow	*Reference category*	
semi-detached	0.85	0.35
terrace/end of terrace	1.13	0.47
purpose built flat/maisonette	1.91	0.00 *
flat conversion/rooms	1.70	0.01 *
employment status of hrp		
full time employment	*Reference category*	
part time	0.69	0.01 *
retired	0.82	0.26
unemployed	0.78	0.21
full time education	1.26	0.31
other inactive	0.73	0.04 *
age of HRP		
35-44	*Reference category*	
16-24	1.56	0.01 *
25-34	1.19	0.15
45-54	1.08	0.62
55-64	0.95	0.78
65+	0.82	0.27
income band		
highest 20%	*Reference category*	
lowest 20%	0.96	0.79
quintile 2	0.85	0.31
quintile 3	0.84	0.27
quintile 4	1.08	0.67
sample size	*13,652*	

Note: 'other' types of accommodation were excluded from the analysis e.g. boats or caravans (5 cases)
Significance: * the result is significant at (or below) the .05 level
Source: English Housing Survey, full household sample

Appendix B
Infographics

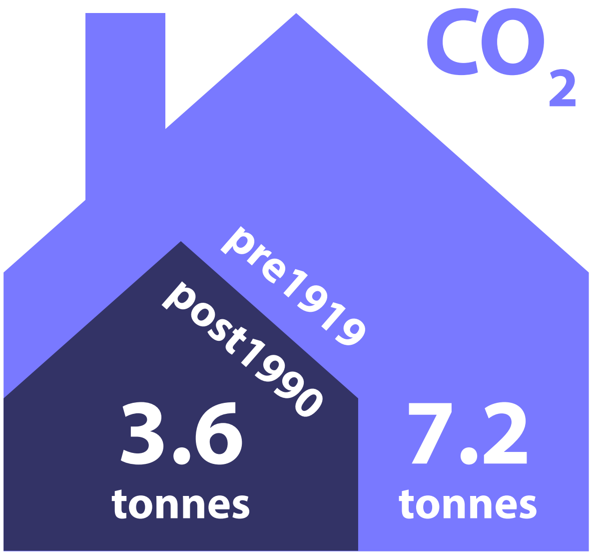
Energy Efficiency of English Housing

Energy efficiency for all dwellings has increased between 2001 and 2012

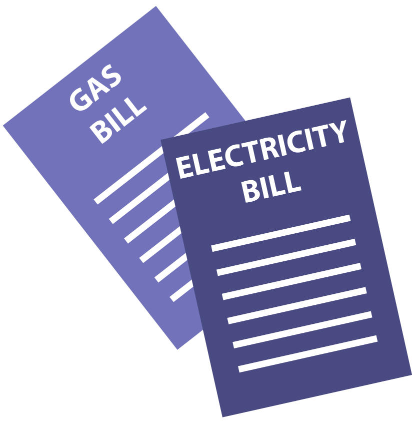


Average SAP* rating

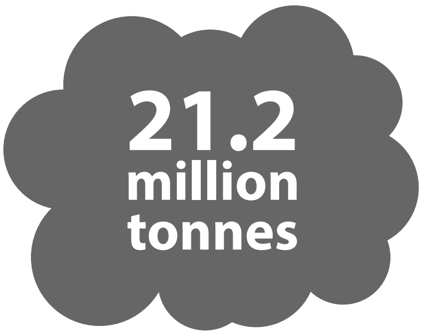
Newer homes had lower average CO_2 emissions



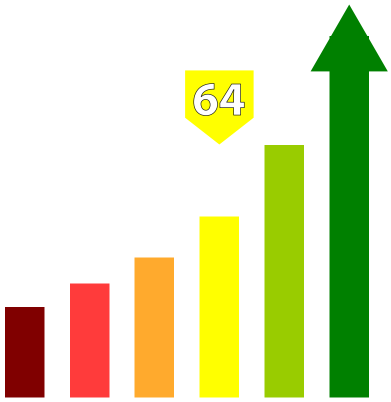
73% of the housing stock could have benefitted from energy improvement measures. This could result in:



A potential 14% reduction in average fuel bills for all households



Average CO_2 emissions falling by almost 1 tonne/year per dwelling across the whole stock - a total saving of 21.2 million tonnes/year of CO_2 emissions (18% of total current emissions)



Increase the average SAP rating from 59 to 64

*SAP is the Government's Standard Assessment Procedure for Energy Rating of Dwellings, where properties are scored between 1 and 100 based on energy costs associated with space heating, water heating, ventilation and lighting. A score of below 30 is considered very energy inefficient, while a score of 70 or more is considered very energy efficient.

Please see the main report for more information: https://www.gov.uk/government/collections/english-housing-survey

Glossary

Area type:

- **city or other urban centre:** includes
    - *city centre*: the area around the core of a large city.
    - *other urban* centre: the area around towns and small cities, and also older urban.
    - areas which have been swallowed up by a metropolis.

- **suburban residential:** the outer area of a town or city; characterised by large planned housing estates.

- **rural:** includes:
    - *rural residential*: a suburban area of a village, often meeting the housing needs of people who work in nearby towns and cities.
    - village centre: the traditional village or the old heart of a village which has been suburbanised.
    - rural: an area which is predominantly rural e.g. mainly agricultural land with isolated dwellings or small hamlets.

Carbon dioxide (CO_2) emissions: The total carbon dioxide emissions from space heating, water heating, ventilation and lighting, less the emissions saved by energy generation as derived from the Standard Assessment Procedure (SAP; defined below) calculations and assumptions. These are measured in tonnes/year and are not adjusted for floor area, but represent emissions from the whole dwelling. The highest and lowest emitting performers have also been grouped with cut-off points set at 3 tonnes per year for the low emitters and 10 tonnes per year for the highest. CO_2 emissions for each dwelling are based on a standard occupancy and a standard heating regime.

Construction type: The construction method refers to the main structural components supporting the roof and floors, and possibly walls. These components generally comprise either some frame structure or some part of the external walls. The most common construction method is Boxwall, consisting of a rigid ‘box’ formed by all of the external walls and perhaps some internal walls. All ‘traditional’ buildings are of this construction.

The next most common method of construction is Crosswall, whereby two opposite walls (of the four), usually the party or end walls, are loadbearing, while the others consist of lightweight non-loadbearing panels normally incorporating large windows. Under the frame method of construction, the load of the roof, floors and walls is borne on a skeleton of metal, concrete or timber.

The most common construction material is masonry (brick, block, stone, flint etc.) solid or with a cavity. Concrete materials include all types of concrete prepared on

site or precast concrete used in panel systems or post and panel systems.

Double glazing: This covers factory made sealed window units only. It does not include windows with secondary glazing or external doors with double or secondary glazing (other than double glazed patio doors, which are surveyed as representing two windows).

Dwelling: A unit of accommodation which may comprise one or more household spaces (a household space is the accommodation used or available for use by an individual household). A dwelling may be classified as shared or unshared. A dwelling is shared if:

- the household spaces it contains are 'part of a converted or shared house', or
- not all of the rooms (including kitchen, bathroom and toilet, if any) are behind a door that only that household can use, and
- there is at least one other such household space at the same address with which it can be combined to form the shared dwelling.

Dwellings that do not meet these conditions are unshared dwellings.
The EHS definition of dwelling is consistent with the Census 2011.

Dwelling age: The date of construction of the oldest part of the building.

Dwelling type: Dwellings are classified, on the basis of the surveyor's inspection, into the following categories:

- **small terraced house:** a house with a total floor area of less than $70m^2$ forming part of a block where at least one house is attached to two or more other houses.
- **medium/large terraced house:** a house with a total floor area of $70m^2$ or more forming part of a block where at least one house is attached to two or more other houses.
- **end terraced house:** a house attached to one other house only in a block where at least one house is attached to two or more other houses.
- **mid-terraced house:** a house attached to two other houses in a block.
- **semi-detached house:** a house that is attached to just one other in a block of two.
- **detached house:** a house where none of the habitable structure is joined to another building (other than garages, outhouses etc.).
- **bungalow:** a house with all of the habitable accommodation on one floor. This excludes chalet bungalows and bungalows with habitable loft conversions, which are treated as houses.

- **converted flat:** a flat resulting from the conversion of a house or former non-residential building. Includes buildings converted into a flat plus commercial premises (such as corner shops).

- **purpose built flat, low rise:** a flat in a purpose built block less than six storeys high. Includes cases where there is only one flat with independent access in a building which is also used for non-domestic purposes.

- **purpose built flat, high rise:** a flat in a purpose built block of at least six storeys high.

Employment status: Respondents self-report their situation and can give more than one answer.

- **working full time/part time**: full-time work is defined as 30 or more hours per week. Part time work is fewer than 30 hours per week. Where more than one answer is given, 'working' takes priority over other categories (with the exception that all those over State Pension Age (SPA) who regard themselves as retired are classified as such, regardless of what other answers they give).

- **unemployed**: this category covers people who were registered unemployed or not registered unemployed but seeking work.

- **retired**: this category includes all those over the state pension age who reported being retired as well as some other activity. For men the SPA is 65 and for women it is 60 if they were born before 6th April 1950. For women born on or after the 6th April 1950, the state pension age has increased incrementally since April 2010[1].

- **full-time education**: education undertaken in pursuit of a course, where an average of more than 12 hours per week is spent during term time.

- **other inactive**: all others; they include people who were permanently sick or disabled, those looking after the family or home and any other activity.

Energy cost: The total energy cost from space heating, water heating, ventilation and lighting, less the costs saved by energy generation as derived from SAP calculations and assumptions. This is measured in £/year using constant prices based on average fuel prices for 2009 (which input into the 2009 SAP) and do *not* reflect subsequent changes in fuel prices. Energy costs for each dwelling are based on a standard occupancy and a standard heating regime.

Energy Performance Certificate (EPC): The EPC provides a range of indicators based on current performance, whether the property would benefit in terms of improved performance from a range of low cost and higher cost measures, and the likely performance arising from the application of those measures. The EPC

[1] For further information see: www.gov.uk/browse/working/state-pension

assessment is based on a simplified form of the energy efficiency SAP known as reduced data SAP.

The EHS currently provides the following EPC based indicators, calculated using the survey's own approach to SAP (see the Technical Advice Note on Energy Efficiency and Energy Improvements for further information):

- **current** performance**:**
  - *energy efficiency* rating (EER) and bands
  - *environmental impact rating* (EIR) and bands
  - *primary* energy *use* (kWh/m^2/year)
  - *energy* cost (£/year), but unlike the EPC these are based on 2009 constant prices
  - *CO_2* (carbon dioxide) emissions (tonnes/year)

- **improvement** measures**:** as part of the EPC, certain improvement measures are suggested, which would increase the energy efficiency of the dwelling. These include improvements to both heating and insulation measures:-

a) *higher cost measures* (more than £500):

upgrade to **central heating controls**, for boiler driven systems, typically to a stage where a room thermostat, a central programmer and thermostatic radiator valves (TRV's) have been installed (although the range of upgraded controls can vary depending on the heating system);

upgrading to a **class A condensing boiler** using the same fuel (mains gas, LPG or fuel oil), where a non-communal boiler is in place (this improvement measure is most appropriate when the existing central heating boiler needs repair or replacement);

upgrading existing storage radiators (or other electric heating) to more **modern, fan-assisted storage heaters**;

installation of a **hot water cylinder thermostat** where a storage cylinder is in use but no thermostat exists;

replacement **warm-air unit** with a fan-assisted flue, where the original warm-air heating unit is pre-1998;

installation of a manual feed **biomass boiler** or **wood pellet stove** where an independent, non-biomass solid fuel system exists. This measure was assessed to identify the number of dwellings that would benefit from this measure but was not included in the post improvement energy efficiency rating or carbon dioxide emissions (reported in section 4) due a combination of the small amount of dwellings that would benefit and modelling complexity.

b) *lower cost measures* (less than £500):

installation or upgrade of **loft insulation** which is less than 250mm, where the dwelling is not a mid- or ground-floor flat and where the loft does not constitute a full conversion to a habitable room;

installation of **cavity wall insulation**, where the wall is of cavity construction;

installation or upgrade of **hot water cylinder insulation** to a level matching a 160mm jacket. Recommended where the current level is less than 25mm of spray foam or less than a 100mm jacket.

The survey is not able to include the following improvements: draft proofing and low energy lighting. Other more expensive measures that are not included are: solar water heating; double or secondary glazing; solid wall insulation; complete change of heating system to class A condensing boiler (including fuel switching); solar photovoltaics (PV) panels.

- **Cost of energy efficiency improvement measures**: the cumulative cost of implementing the measures that have been recommended for each dwelling is calculated by applying standard costs on a per unit area basis for loft and cavity wall insulation and a single unit cost for other measures.

Energy efficiency rating: A dwelling's energy costs per m^2 of floor area for standard occupancy of a dwelling and a standard heating regime and is calculated from the survey using a simplified form of the SAP. The energy costs take into account the costs of space and water heating, ventilation and lighting, less cost savings from energy generation technologies. They do not take into account variation in geographical location. The rating is expressed on a scale of 1-100 where a dwelling with a rating of 1 has poor energy efficiency (high costs) and a dwelling with a rating of 100 represents zero net energy cost per year.

The detailed methodology for calculating SAP to monitor the energy efficiency of dwellings was updated in 2009 to reflect developments in the energy efficiency technologies and knowledge of dwelling energy performance. This means that a SAP rating using the 2005 method is not directly comparable to one calculated under the 2009 methodology, and it would be incorrect to do so. All SAP statistics used in reporting from 2010 are based on the SAP 2009 methodology and this includes time series data from 1996 to the current reporting period (i.e. the SAP 2009 methodology has been retrospectively applied to 1996 and subsequent survey data to provide consistent results in the 2010 and following reports).

Energy efficiency rating (EER) bands: The energy efficiency rating is also presented in an A-G banding system for an Energy Performance Certificate, where Band A rating represents low energy costs (i.e. the most efficient band) and Band G rating represents high energy costs (the least efficient band). The break points in SAP used for the EER Bands are:

- Band A (92–100)
- Band B (81–91)
- Band C (69–80)

- Band D (55–68)
- Band E (39–54)
- Band F (21–38)
- Band G (1–20)

Ethnic minority HRP: where the respondent defines their ethnicity as something other than white.

Gross annual income: The annual income of the household reference person and (any) partner. This includes income from private sources (regular employment, self-employment, government schemes, occupational pensions, private pensions and other private income), state benefits/allowances and tax credits, as collected on the EHS survey (this includes housing benefit/Local Housing Allowance but excludes council tax benefit and Support for Mortgage Interest) and interest from savings. It is a gross measure i.e. income before Income Tax or National Insurance deductions.

Heating system

a) **main space heating type:**
   - o **central heating system**: most commonly a system with a gas fired boiler and radiators which distribute heat throughout the dwelling (but also included in this definition are warm air systems, electric ceiling/underfloor and communal heating). It is generally considered to be a cost effective and relatively efficient method of heating a dwelling.
   - o **storage heaters**: predominately used in dwellings that have an off-peak electricity tariff. Storage heaters use off-peak electricity to store heat in clay bricks or a ceramic material, this heat is then released throughout the day. However, storage heating can prove expensive if too much on peak electricity is used during the day.
   - o **room heaters**: this category includes all other types of heater such as fixed gas, fixed electric or portable electric heaters, this type of heating is generally considered to be the least cost effective of the main systems and produces more carbon dioxide emissions per kWh.

b) **heating fuel:**
   - o **gas**: mains gas is relatively inexpensive and produces lower emissions per unit of energy than most other commonly used fuels. Liquefied Petroleum Gas and bottled gas are still associated with slightly higher costs and emissions.
   - o **electricity**: standard rate electricity has the highest costs and CO_2 emissions associated with main fuels, but is used in dwellings without a viable alternative or a back-up to mains gas. An off-peak tariff such as Economy 7, is cheaper than bottled gas but with the same emissions as standard electricity.

   - o **oil**: in terms **of** both costs and emissions, oil lies between main gas and electricity.

- **solid fuel**: these are similar costs to oil with the exception of processed wood which can be **more** expensive than off-peak electricity. Fuels included are coal and anthracite, with CO_2 emissions above those of gas and oil; wood, which has the lowest emissions of the main fuels; and smokeless fuel, whose emissions are close to those of electricity. By law, areas (usually towns or cities) are designated as smoke control areas where solid fuels emitting smoke are illegal.

c) **water heating system:**
   - **combined**: provides heat to supply hot water for the dwelling.
   - **separate**: dwellings which have electrical space heating systems often use electric immersion heaters to heat water. Other dwellings may be fitted within instantaneous water heaters, such as electric showers.

d) **boiler type:**
   - **standard**: provides hot water or warm air for space heating with the former also providing hot water via a separate storage cylinder.
   - **back**: located behind a room heater and feeds hot water to a separate storage cylinder. They are generally less efficient than other boiler types.
   - **combination**: provides hot water or warm air for space heating and can provide hot water on demand negating the need for a storage cylinder, therefore requiring less room.
   - **condensing**: standard and combination boilers can also be condensing. A condensing boiler uses a larger, or dual, heat exchanger to obtain more heat from burning fuel than an ordinary boiler, and is generally the most efficient boiler type.

e) **secondary heating system:**
   - **fixed room heaters**: the majority of secondary systems fall into this category, which includes various types of mains gas fires, solid fuel fires and stoves, and direct acting electric panels and radiators which are wired into the mains electricity.
   - **storage radiators**: individual storage heaters which are subsidiary to the main heating system are included here.
   - **portable heaters**: where the only secondary heating is through a portable electric or paraffin heater. This includes cases where the SAP methodology has concluded that the main fixed heating is insufficient to heat the dwelling to a satisfactory level, so a portable secondary system is imputed to allow an energy efficiency rating to be calculated.

Household: One person living alone, or a group of people (not necessarily related) living at the same address who share cooking facilities and a living room or sitting room or dining area. The EHS definition of household is consistent with the Census 2011.

Household reference person (HRP): The person in whose name the dwelling is owned or rented or who is otherwise responsible for the accommodation. In the case of joint owners and tenants, the person with the highest income is taken as the HRP. Where incomes are equal, the older is taken as the HRP. This procedure increases the likelihood that the HRP better characterises the household's social and economic position. The EHS definition of HRP is not consistent with the Census 2011, in which the HRP is chosen on basis of their economic activity. Where economic activity is the same, the older is taken as HRP, or if they are the same age, HRP is the first listed on the questionnaire.

Household type: The main classification of household type uses the following categories:

- married/cohabiting couple with dependent child(ren) – may also include non-dependent child(ren).
- married/cohabiting couple under 60 with no dependent children or with non-dependent child(ren) only.
- married/cohabiting couple age 60 or over with no dependent children or with non-dependent child(ren) only.
- lone parent family (one parent with dependent child(ren) – may also include non-dependent child(ren)).
- other multi-person household (includes flat sharers, lone parents with non-dependent children only and households containing more than one couple or lone parent family).
- one person aged under 60.
- one person aged 60 or over.

The married/cohabiting couple and lone parent household types (the first four categories above) may include one-person family units in addition to the couple/lone parent family.

Insulation:

- **wall insulation:**
  - **cavity *walls*:** where a dwelling has external walls of predominantly cavity construction, it is defined as having cavity wall insulation if at least 50% of the cavity walls are filled with insulation. This could have been fitted during construction or retrospectively injected between the masonry leaves of the cavity wall.
  - ***non*-cavity walls:** where a dwelling has not been defined as cavity walled, analysis is carried out on information regarding additional insulation applied either externally (e.g. insulated board attached to the external face with a render finish) or internally (e.g. insulated plasterboard fitted to the external walls inside each room, with a plaster finish). This is often referred to as solid wall insulation, but for reporting purposes any dwelling with non-cavity walls (e.g. timber, metal or concrete frames) are included in this analysis.
- **loft insulation:** the presence and depth of loft insulation is collected for all houses and top-floor flats. Insulation could be found between joists above the ceiling of the top floor of the dwelling or between the roof timbers where the loft

has been converted to a habitable space. Where insulation could not be observed, information is taken from the householder or from imputed estimates based on the age and type of the dwelling.

Renewable energy: Data is collected on the presence of three types of renewable technology:

- **solar thermal panels:** these are usually roof mounted and use direct sunlight to heat water, providing an additional source of domestic hot water to the internal boiler or other water heater. The most common types are evacuated tube and glazed flat plate collectors.

- **photovoltaic panels:** a photovoltaic cell is a device that converts light into electric current, contributing to the domestic electricity supply. A large photovoltaic system could provide a surplus of energy, allowing a household to export electricity to the national grid.

- **wind turbines:** a domestic small-scale wind turbine harnesses the power of the wind and uses it to generate electricity.

SAP: The energy cost rating as determined by Government's Standard Assessment Procedure (SAP) and is used to monitor the energy efficiency of dwellings. It is an index based on calculated annual space and water heating costs for a standard heating regime and is expressed on a scale of 1 (highly inefficient) to 100 (highly efficient with 100 representing zero energy cost).

The method for calculating SAP was comprehensively updated in 2005, with a further update in 2009-10. This new SAP09 methodology has been used in all EHS reports since 2010-11.

Size: The total usable internal floor area of the dwelling as measured by the surveyor, rounded to the nearest square metre. It includes integral garages and integral balconies but excludes stores accessed from the outside only, the area under partition walls and the stairwell area.

Storeys: The number of storeys *above* ground i.e. it does not include any basements.

Tenure: Four categories are used for most reporting purposes, and for some analyses these four tenure categories are collapsed into two groups:

- **private sector**: includes:
    - *owner occupied*: includes all households in accommodation which they either own outright, are buying with a mortgage or are buying as part of a shared ownership scheme.
    - *private rented*: includes all households living in privately owned property which they do not own. Includes households living rent free, or in tied dwellings and tenants of housing associations that are not registered.

- **social sector**: includes:
    - *local authority*: *includes* Arms Length Management Organisations (ALMOs) and Housing Action Trusts.

- *housing association*: mostly Registered Social Landlords (RSLs), Local Housing Companies, co-operatives and charitable trusts.

A significant number of Housing Association tenants wrongly report that they are Local Authority tenants. The most common reason for this is that their home used to be owned by the Local Authority, and although ownership was transferred to a Housing Association, the tenant still reports that their landlord is the Local Authority. There are also some Local Authority tenants who wrongly report that they are Housing Association tenants. Data from the EHS for 2008-09 onwards incorporate a correction for the great majority of such cases in order to provide a reasonably accurate split of the social rented category.

Vacant dwellings: The assessment of whether or not a dwelling is vacant is made at the time of the interviewer's visit. Clarification of vacancy is sought from neighbours. Surveyors are required to gain access to vacant dwellings and undertake full inspections.

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