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

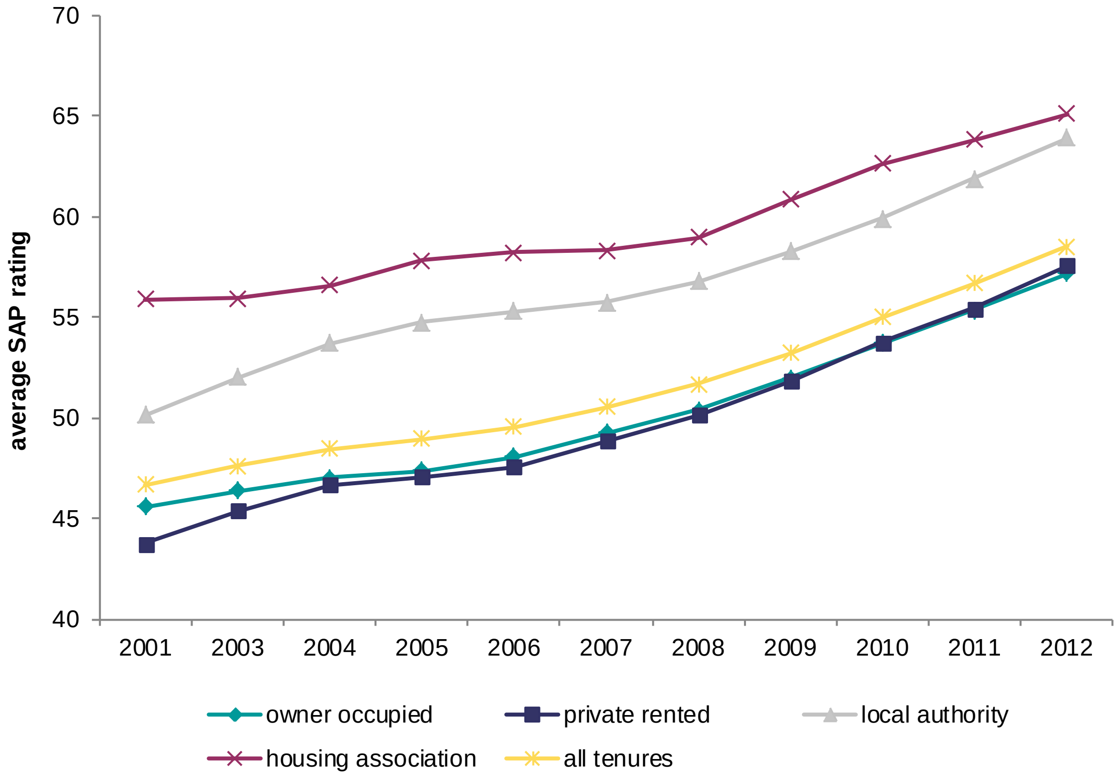
	private sector		social sector		all dwellings		
	mean SAP	mean CO_2 (tonnes per dwelling)	mean SAP	mean CO_2 (tonnes per dwelling)	mean SAP	mean CO_2 (tonnes per dwelling)	sample size
heating system							
central heating	58.1	5.5	65.0	3.0	59.2	5.1	11,482
storage heater	57.9	5.9	62.2	4.5	59.0	5.6	972
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

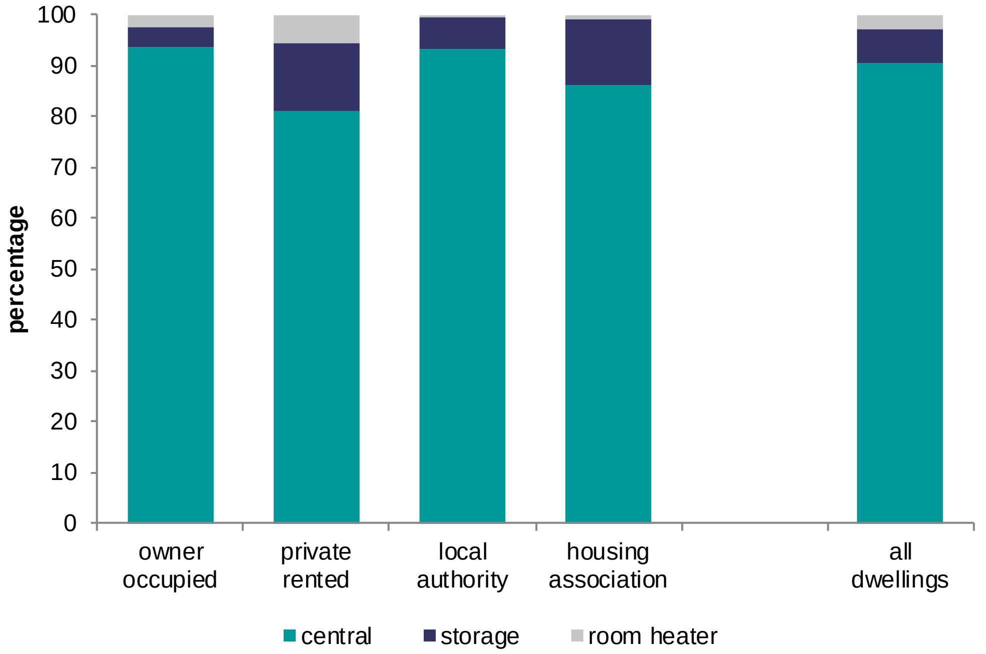
Heating systems

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

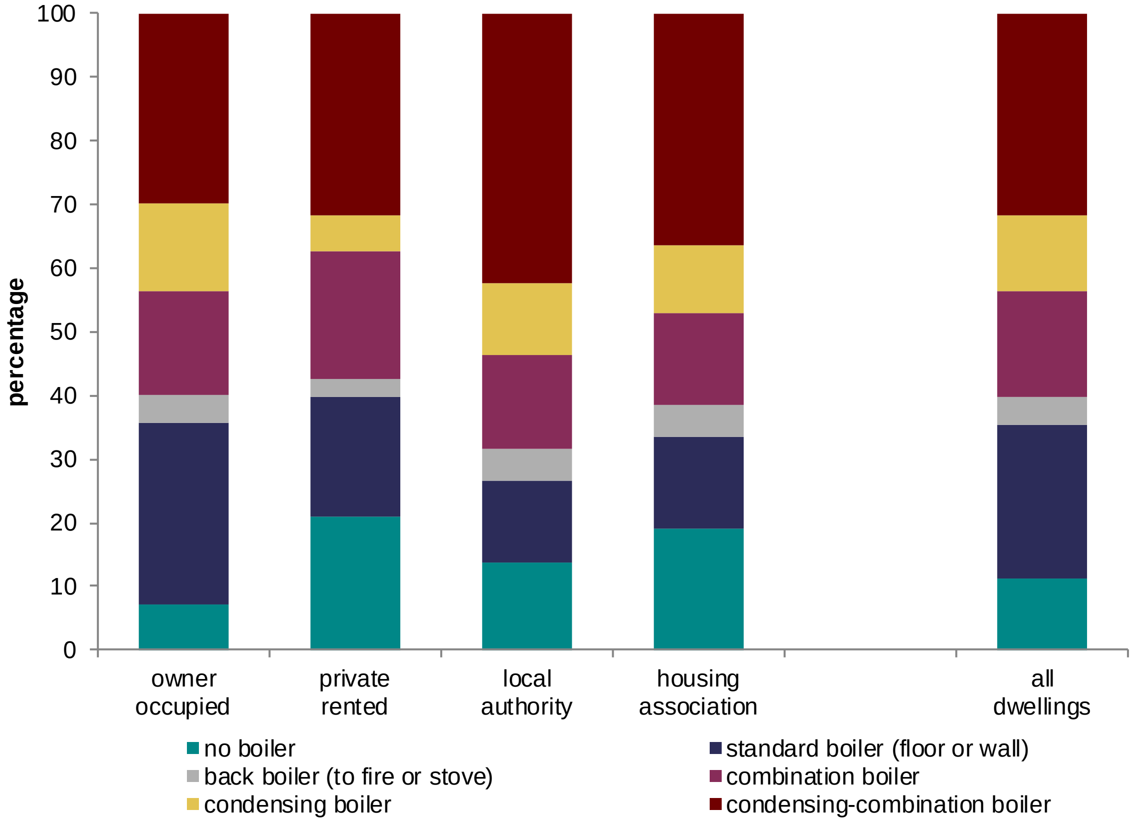
1.10. The vast majority of houses (95%) had central heating, compared with around three-quarters of flats (73%). Around a quarter (22%) of flats were heated using storage heaters, Annex Table 1.2.

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.

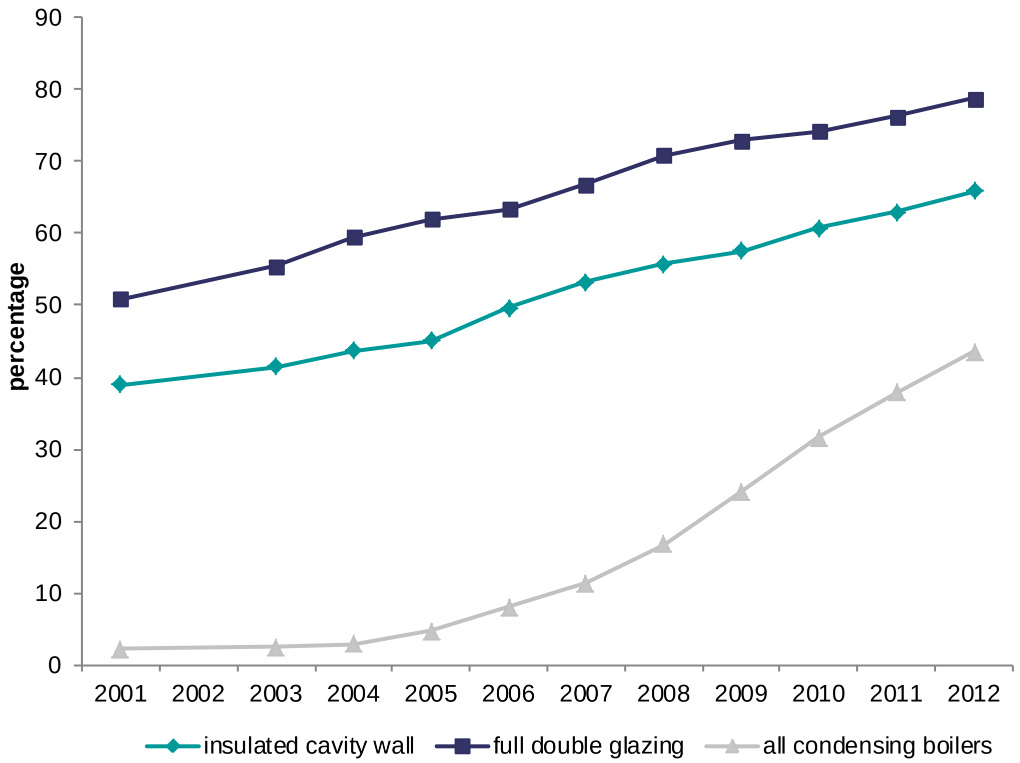
This may be due to private sector landlords having less incentive to install cavity wall insulation.[7]

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.

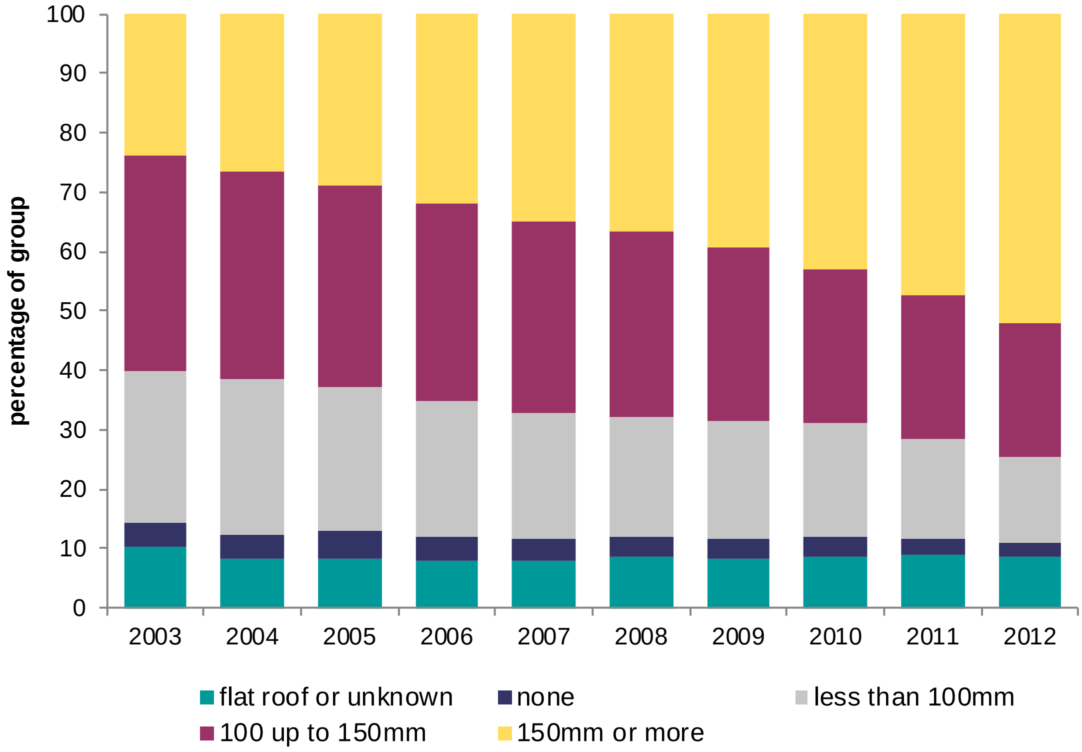
1.19. There was a marked improvement in the proportion of homes with the thickest levels of insulation (150mm or more) from 24% in 2003[8] to 52% in 2012. Over the same period, there was a relatively consistent proportion of homes with no insulation, although the number of these dwellings was lower in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

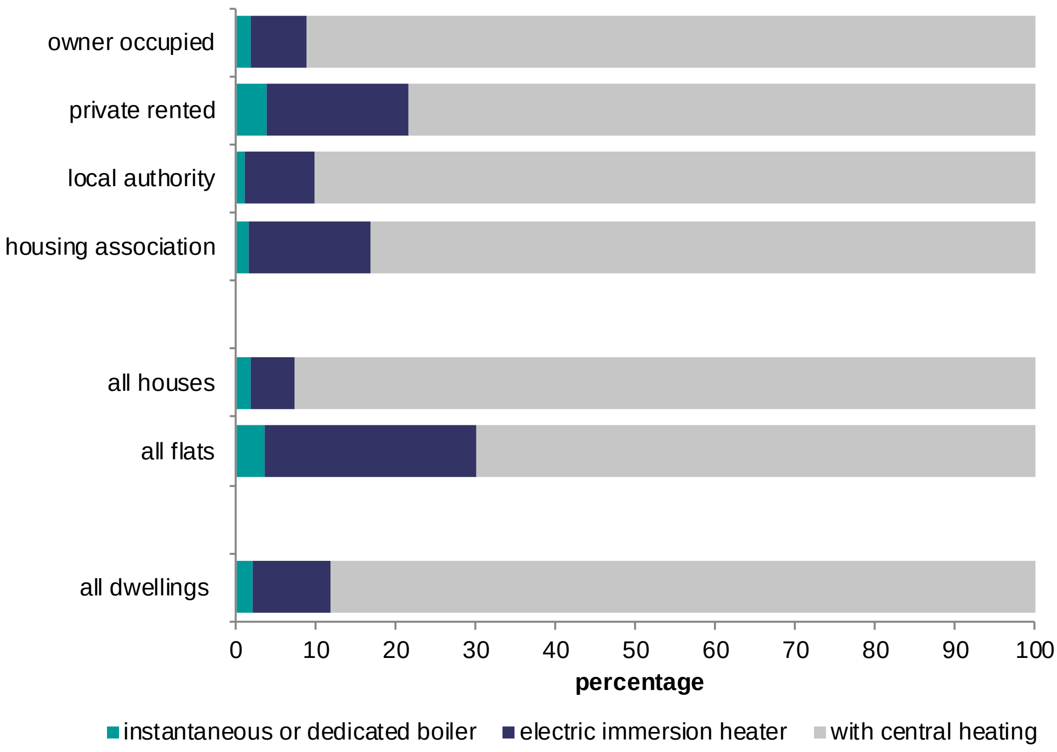
Note: some dwellings included both measures
Base: dwellings with a renewable energy measure
Source: English Housing Survey, dwelling sample

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.

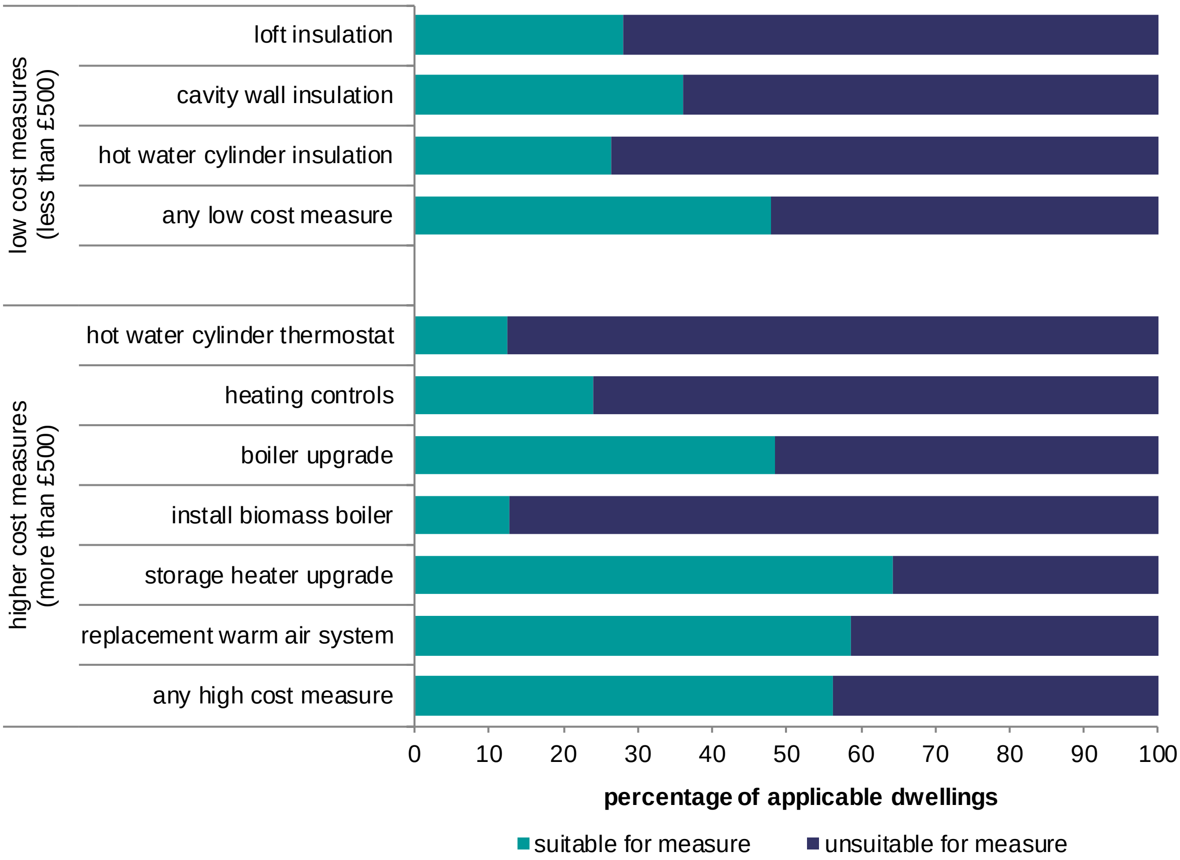
Potential for energy improvements

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.

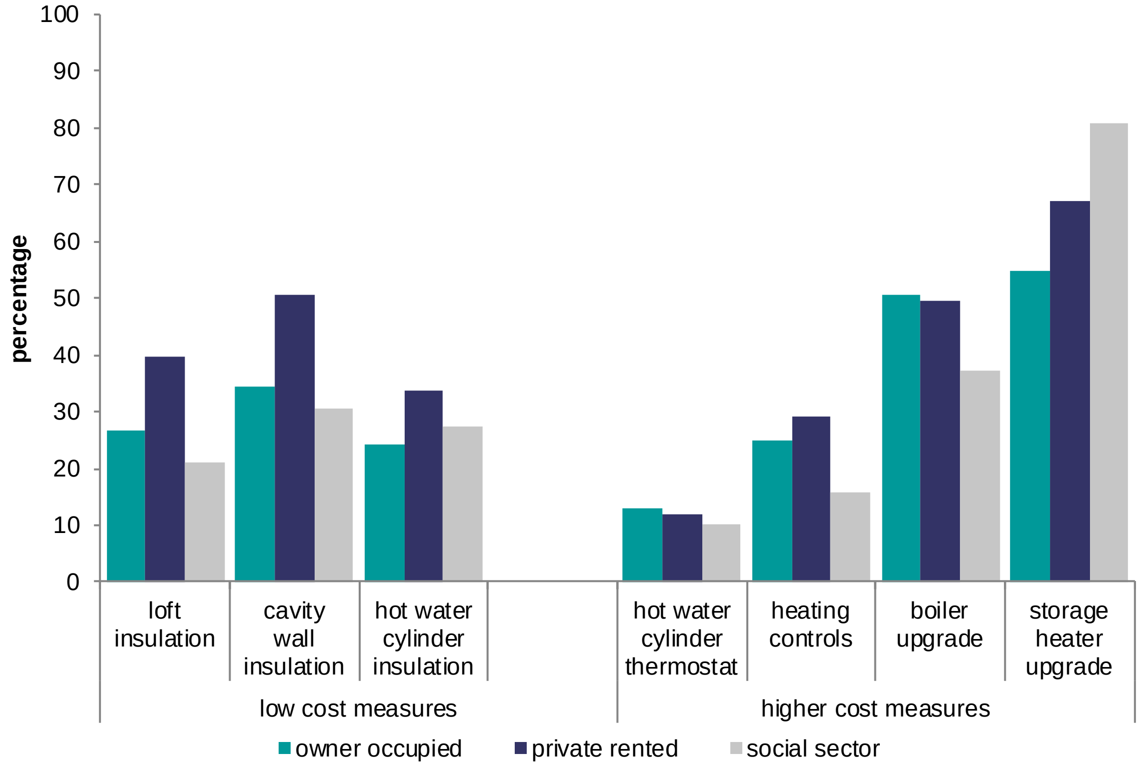
1.33. There were 2.2 million dwellings with storage radiators or other non-central electric heating systems and 64% of these could be replaced with more modern slim-line storage heaters, which generally cost less to run[13], Annex Table 1.12.

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

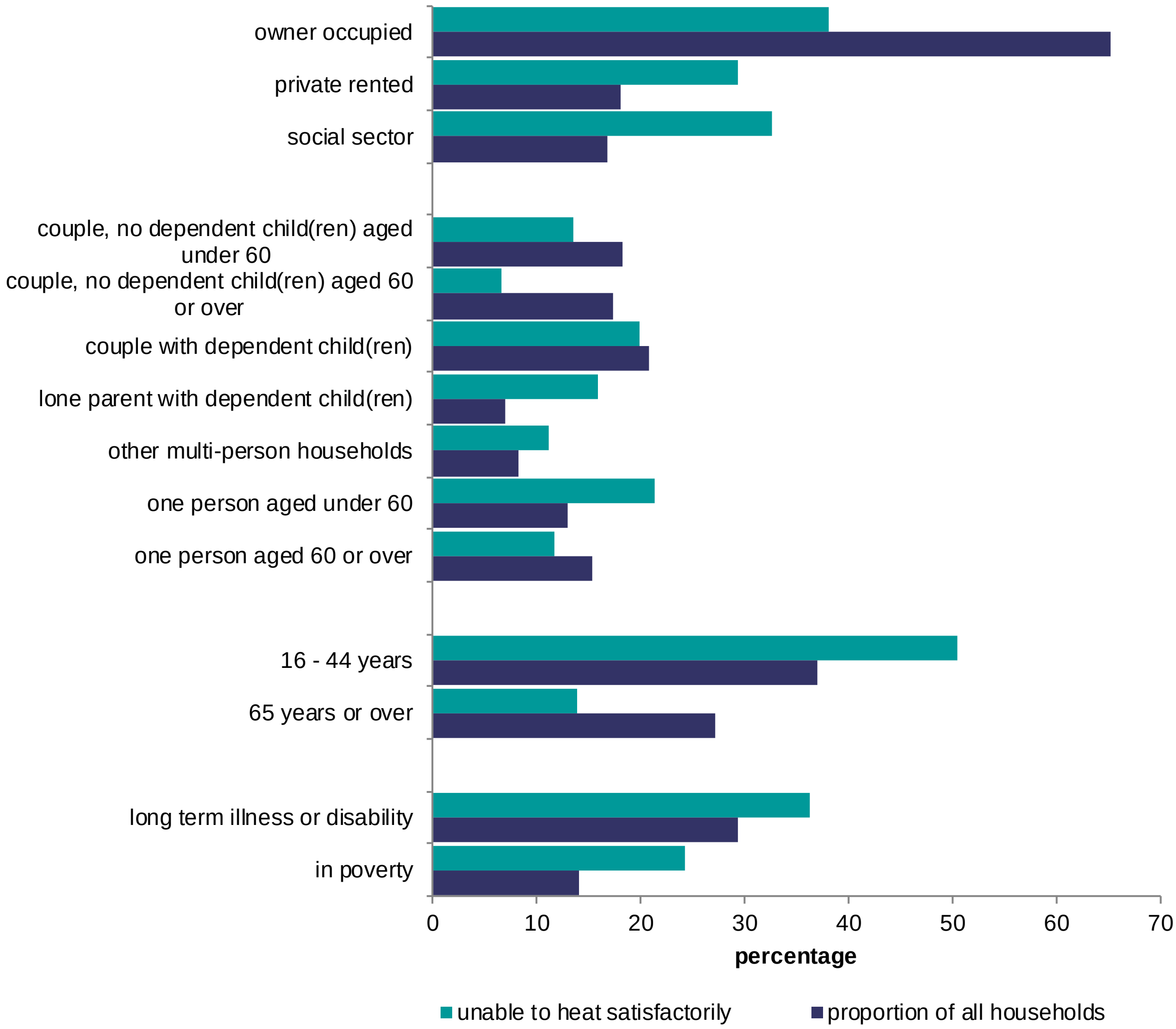
1.58. From the information collected for the 2012-13 EHS interview survey, 2.4 million households (11%) that stated that they were unable to keep their living room comfortably warm during cold winter weather. Some 29% of private renters and 33% of those living in the social sector stated that there were 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.

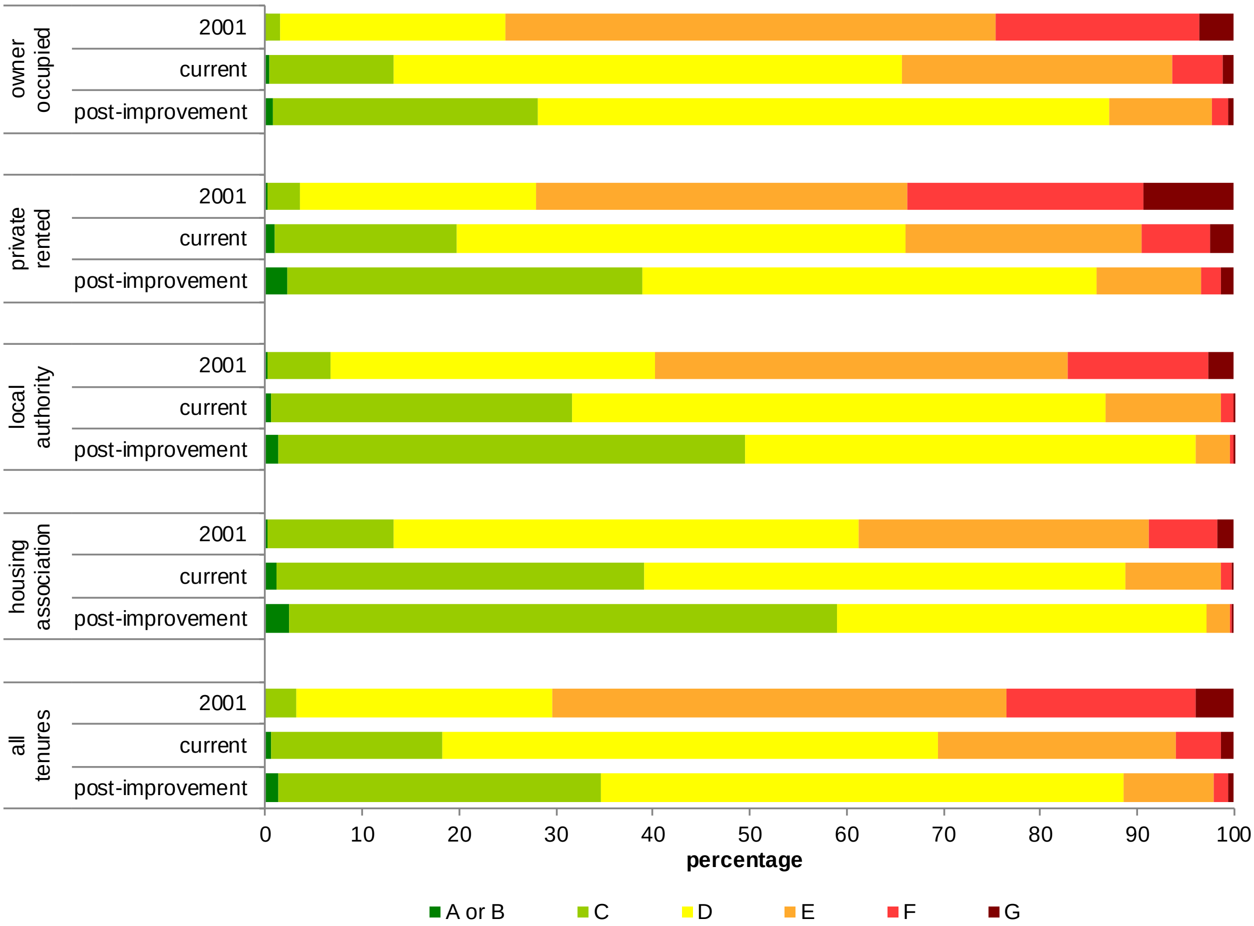
1.67. Substantial improvements in energy efficiency occurred from 2001 to 2012 with the proportion of dwellings in the top energy efficiency bands (A - C) rising from 3% in 2001 to 18% in 2012. Applying the full range of cost effective EPC measures would almost double the proportion of dwellings in these 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

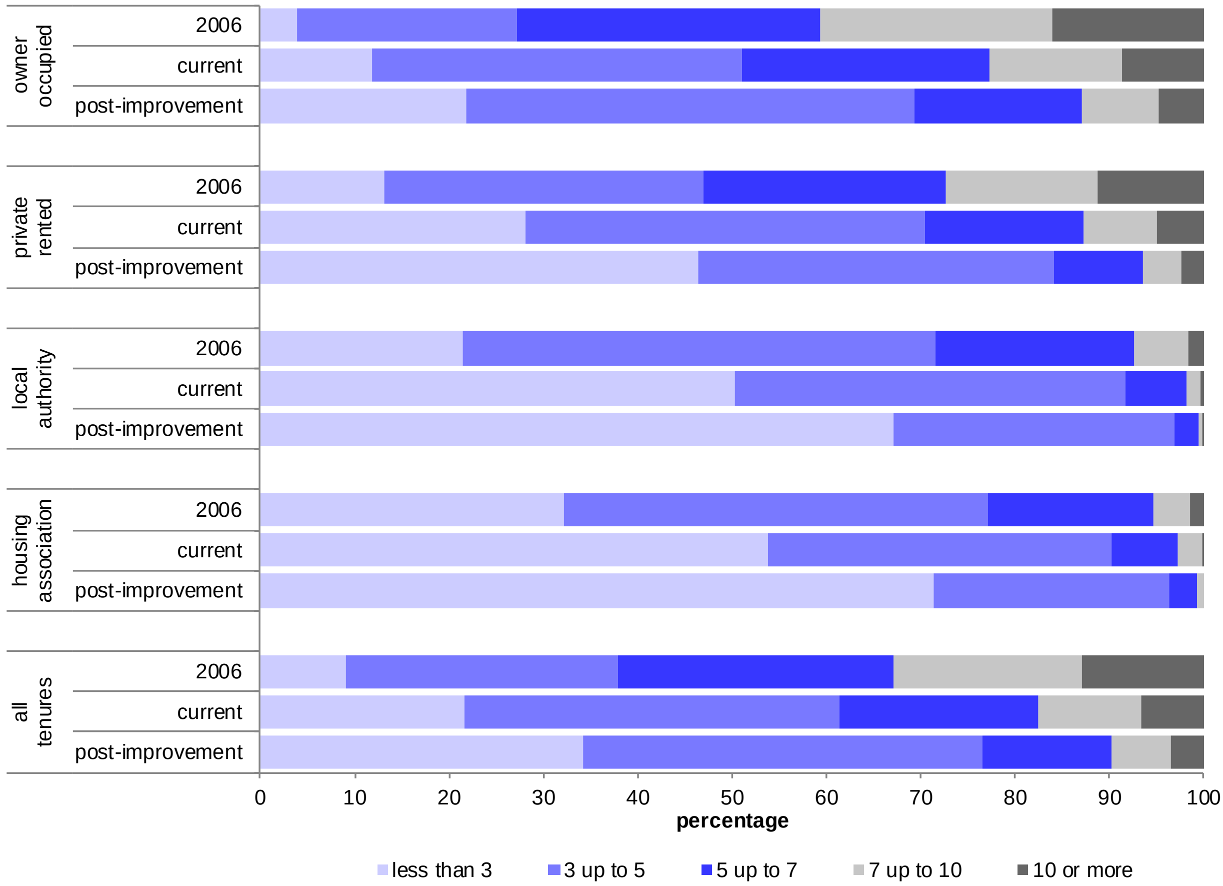
1.69. If all of the potential cost effective EPC recommended measures were installed, there would also be marked improvements in CO_2 emissions. For the whole stock, the proportion of dwellings notionally emitting less than 3 tonnes/year of CO_2 would increase from 22% to 34% while the proportion emitting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