English Housing Survey

Technical Advice Note

Efficiency and energy improvements: 2011-12 Update

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Introduction

1. The English Housing Survey (EHS) collects a large amount of detailed information relating to building construction, heating and insulation. This provides a detailed profile of the energy performance and carbon emissions of the existing housing stock and how far these could be improved using different types of measures. This note sets out how the individual components that contribute to overall efficiency are defined and modelled; the methods and assumptions used to calculate SAP (energy efficiency) ratings and carbon dioxide emissions; and how an assessment is made of what measures could be installed to improve energy efficiency and reduce carbon emissions and what the impact of installing these possible improvements would be.

Individual aspects of energy efficiency

Heating systems

2. The EHS records up to two forms of space heating system and all water heating systems present in each dwelling. Where two types of space heating system are present, the EHS designates the one that covers the largest proportion of the dwelling as the primary heating system and collects detailed information on its overall type, the fuel used, boiler details (where relevant) and heating controls. The primary space heating type is classified as follows:

- ***central heating system:*** this is most commonly a system with a gas fired boiler and radiators, distributing heat throughout the dwelling. Also included in this definition are warm air systems, communal heating and electric ceiling/under floor heating, (included in ‘other systems’ in the 2011 dataset). Central heating is generally considered to be a cost effective and relatively efficient method of heating a dwelling, although the cost effectiveness and level of carbon dioxide (CO_2) emissions will be closely linked to the type of fuel.
- **storage heaters:** these are 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. These are more cost effective than fixed or portable room heaters, but storage heating can prove expensive if too much on peak electricity is used during the day.
- **room heaters:** this category includes all other types of heater such as 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 CO2 emissions per kWh.

3. Where the heating system has a boiler, the EHS also collects basic information on its generic type:

- **standard:** these provide hot water or warm air for space heating; with the former also providing hot water via a separate storage cylinder.
- **back:** these older models are located behind room heaters and feed 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, thus negating the need for a storage cylinder and 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. Recent changes to Building Regulations have seen an increase in condensing boilers as they have become mandatory for all replacements.

4. The EHS also collects information about the make and model of the boiler and its age so that an accurate estimate of its overall fuel efficiency can be derived. For storage heater systems, their efficiency is calculated based on their age and the type of controls present.

5. Where more than one space heating system or appliance has been recorded and the primary system identified as above, the additional appliance is coded as the secondary system and, along with the secondary fuel, used in the SAP calculation and other analysis.

6. Where more than one space heating system is present, all existing water heating systems are recorded with the most efficient being selected for analysis. The categories of water heating systems used in the report are:

- ***with central heating:*** the water is primarily heated by the same system as the primary space heating, usually a standard boiler with a separate storage cylinder or a combination boiler heating water on demand.
- ***dedicated water boiler:*** a separate boiler to the space heating system, possibly using a different fuel, provides the hot water.
- ***immersion heater:*** hot water is provided by a single or dual electric immersion heater in the storage cylinder. These are less energy efficient than central or separate boilers, but are often found as a 'top-up' system for other systems.
- ***instantaneous water heater:*** the least energy efficient water heating appliances heat small amounts of water on demand in a similar way to a kettle and distribute the hot water to one or more points.

Wall types and wall insulation

7. The construction of the external walls and whether they contain any additional insulation is an important determinant of heat loss. The EHS collects detailed information on the overall construction type, age of the building, added wall insulation and what proportion of the external walls consists of different types, which is used to determine whether the dwelling is classed as having cavity walls and whether the walls (cavity or other) have any added insulation. A cavity wall is one constructed of two brick or block walls separated by a cavity that is at least 50mm wide. They are generally found in houses dating from about 1930 onwards, although some older examples exist. Many dwellings (especially older private sector homes) have a mix of wall types because they have had one or more extensions added at different times. Dwellings are only classed as ‘cavity wall’ where at least 50% of the total external wall area is cavity brickwork. This means that a small house built with solid 9” brick walls in 1900 which had a cavity brickwork extension that was larger than the original building added in 1960 would be classed as having ‘cavity walls’.

8. Dwellings with cavity walls can have none, part or all of the cavity wall area insulated. The insulation can be built into the original wall construction or installed later and can reduce fuel costs by up to 15%.

9. In addition to cases which have been identified as cavity insulated and cavity uninsulated, the 2010 and 2011 Homes Reports used a third category for post-1990 dwellings with predominantly cavity walls but no evidence of cavity wall insulation. It is likely that these dwellings had insulation installed when built, but this can not necessarily be assumed since the 1990 and 1994 Building Regulations both specify an external wall U-value which could be achieved through other mechanisms as an alternative to cavity fill. Further, in the 1994 Building Regulations the ‘Target U-value’ method was introduced as an alternative method of showing compliance. The requirement would be met if the calculated average U-value of the dwelling did not exceed the Target U-value, corrected for the proposed method of heating. This allowed a greater flexibility in selecting the insulation levels of individual elements in the building envelope. For example, 1994 Building Regulations specify an external wall U-value of 0.45 $W/m^2/K$. Using the Target U-value approach in the 1994 Building Regulations meant that the external wall U-values could be greater than 0.45 $W/m^2/K$ but to compensate the U-values of the other external elements had to reduce below the specified U-values, or as the Target U-value approach was based upon a central heating system of 72%, installation of a more efficient heating system meant that the specified insulation levels in the Building Regulations could be relaxed[1].

10. Where dwellings do not have cavity walls, external or internal wall insulation can be installed to improve energy efficiency where the thermal properties of the external walls are poor. Where a surveyor has

[1] For examples of the Target U-value methodology see Appendix F of the 1994 Building Regulations Part L1 A - http://www.planningportal.gov.uk/uploads/br/BR_PDF_ADL_1995.pdf

recorded that external wall insulation had been applied to at least 50% of a non-cavity walled dwelling, it was classed as having a solid wall with external insulation. Similarly, a non-cavity walled dwelling identified as having at least 50% of the measured rooms by area with internal insulation applied to the outside walls was classed as ‘predominantly internally insulated’.

Loft insulation

11. Adequate loft insulation can make significant savings to both heating costs and CO_2 emissions, making this a cost effective method of insulation. It involves fitting insulating foam or fibre between the joists or rafters in a loft, which prevents the rising heated air from escaping through the roof.

12. The EHS physical survey involves an inspection of the loft where the surveyor notes whether insulation is present and measures its thickness. The collection of loft insulation data was changed after the 2001 English House Condition Survey (EHCS), so analysis of data from 2003 onwards can not be directly compared to previous data (see the EHCS 2003 technical report for details). In cases where surveyors are unable to access lofts or where the dwelling is a house or top-floor flat with a flat or shallow pitched roof, the amount of insulation in the dwelling was classed as unknown in the 2011 Homes Report. However for the purpose of calculating a SAP rating, an amount was assigned using the mean value for dwellings of that age, tenure and broad geographical area. These classifications were used because earlier regression analysis indicated that these factors were the main determinants of the amount of loft insulation present.

Low energy lighting and conservatories

13. New analysis in the 2011 Homes Report examines headline figures for homes which predominantly use low energy lighting and those with conservatories. The report uses the interior section to calculate the proportion of surveyed rooms with low energy lights at the time of survey, whist data relating to the size, glazing type and heating of conservatories is also taken from the raw physical survey data.

Renewable measures

14. Since 2009, EHS surveyors have recorded the presence of solar photovoltaic panels and domestic wind turbines for electricity generation, whilst the presence of solar hot water panels has been collected since 2001. The 2011 Homes Report included analysis of any observed renewable energy technologies.

SAP ratings and carbon dioxide emissions

SAP ratings

15. The Standard Assessment Procedure (SAP) is the Government's recommended system for home energy ratings. SAP ratings allow comparisons of energy efficiency between different dwellings to be made. The SAP rating is expressed on a logarithmic scale, which normally runs from 1 (very inefficient) to 100, where 100 represents zero energy cost. The rating can be greater than 100 for dwellings that are net exporters of energy; however these are extremely rare in the existing dwelling stock. In extremely inefficient cases the formula that defines the rating can result in negative values.

16. The Building Regulations require a SAP assessment to be carried out for all new dwellings and conversions. Local authorities, housing associations, and other landlords also use SAP ratings to estimate the energy efficiency of existing housing. The version of SAP used in the survey is currently SAP 2009, which was effective from March 2010 in England and Wales. This version is used in the current EHS dataset (employed retrospectively to provide a consistent measure from 1996 to the most recent survey year), whilst EHS reports dating from 2006 to 2009 used the previous (SAP 2005) version of SAP. Full details of how this differs from the current SAP 2009 can be found on page 5 of the SAP 2009 methodology document: http://www.bre.co.uk/filelibrary/SAP/2009/SAP-2009_9-90.pdf.

17. The SAP ratings give a measure of the annual unit energy cost of space and water heating for the dwelling under a set heating regime which assumes specific heating patterns and room temperatures. The fuel prices used are averaged over the previous three years across the different areas of the UK. The SAP rating takes into account a range of factors that contribute to energy efficiency, which include:

- thermal insulation of the building fabric;
- the shape and exposed surfaces of the dwelling;
- materials used for construction of the dwelling;
- efficiency and control of the heating system;
- the fuel used for space and water heating, ventilation and lighting;
- ventilation and solar gain characteristics of the dwelling;
- renewable energy technologies.

18. SAP is not affected by the individual characteristics of the household occupying the dwelling, nor by its geographical location. The calculation is based on a fixed heating pattern of 21°C in the main living area and 18°C elsewhere. It is also based on standard

occupancy assumptions with the household size correlating with the total floor area of the dwelling.

19. The Energy Efficiency Rating (EER) is derived by translating the SAP ratings into an A to G banding system where band A represents low energy costs and band G represents high energy costs. The cut-off points between bands are shown in Table 1.

Table 1: SAP rating and Energy Efficiency Rating (EER) bands

SAP rating	EER band
1 to 20	G
21 to 38	F
39 to 54	E
55 to 68	D
69 to 80	C
81 to 91	B
92 or more	A

20. The EHS uses a computerised version of the SAP methodology to calculate the SAP rating for each dwelling included in the physical survey sample. Most of the data required to calculate SAP are available from the survey, either directly from the questions asked or as a result of further modelling. Those data items that are not collected have very little impact on the final calculated rating. Where data items are missing these are dealt with using default information based on information from dwellings of the same age, built form, tenure, number of floors and size.

21. The effect of using the SAP 2009 methodology in the 2011 Homes report increased the average SAP rating by around 0.5 SAP points above the value given under the SAP 2005 method. In general, the range of SAP ratings achieved has narrowed slightly, with high and low SAP 2005 values being closer to the average under SAP 2009.

Carbon dioxide emissions

22. The carbon dioxide (CO_2) emissions are calculated using the same SAP document and method as for the SAP rating except that it uses CO_2 emissions factors for each fuel in place of unit prices to derive the CO_2 emissions rate per m^2 of floor area. The same logarithmic scale as used for SAP converts the CO_2 emissions rate into the Environmental Impact Rating (EIR), which also runs on a 1 – 100 scale where 1 represents very high emissions per m^2 and 100 is achieved at zero net emissions. The EIR can rise above 100 if the dwelling is a net exporter of energy.

Comparison with actual energy data

23. The SAP methodology that is used to calculate both energy efficiency and CO_2 emissions tends to provide higher estimates of energy requirements and associated emissions for heating, lighting and ventilating dwellings than estimates derived from actual household energy consumption. This is primarily because the assumed heating regime (achieving a temperature of 21°C in the living area of the dwelling and 18°C in the rest of the dwelling for a standard number of hours), and the assumed hot water and lighting requirements (depending on a level of occupancy determined by the floor area of the home rather than actual occupancy) are more likely to result in an overall over estimation than under estimation of actual energy consumption for most dwellings. However, such standardised assumptions are necessary in order to compare the energy performance of one part of the housing stock with another and over time.

Energy performance certificate improvement measures

24. Following the implementation of the European Energy Performance of Buildings Directive in 2007, all homes are required to have an Energy Performance Certificate (EPC). The EPC provides an overall assessment of the current energy performance of the property and makes recommendations regarding a range of lower and higher cost heating, insulation and lighting upgrades that would improve its energy performance. The EHS is able to provide a whole stock assessment of homes that could benefit from a subset of these measures.

25. Details of the upgrade measures recommended on an EPC are provided in Appendix T of the SAP 2009 specification, available at: http://www.bre.co.uk/filelibrary/SAP/2009/SAP-2009_9-90.pdf. These have been reduced to a set of measures that can be assessed using EHS data and are shown in Table 2.

Table 2: EPC measures assessed using EHS

EPC low cost measures (under £500)	**EPC higher cost measures (more than £500)**
Install cavity wall insulation where the wall is of cavity construction	Upgrade central heating controls - typically to a stage where a room thermostat, a central programmer and thermostatic radiator valves (TRV's) have been installed
Install or upgrade loft insulation where there is a loft that is not a full conversion to a habitable room and has 150mm or less of loft insulation	Upgrade to a class A condensing boiler using the same fuel (mains gas, LPG or fuel oil). This is not applied to communal heating systems.

Install or upgrade hot water cylinder insulation to a level matching a 160mm jacket. This is only recommended where the current level is less than 25mm of spray foam or a jacket that is less than 100mm thick.	Upgrade existing storage radiators (or other electric heating) to more modern, fan-assisted storage heaters
	Install a hot water cylinder thermostat where there is a cylinder without a thermostat
	Replace warm-air units that are over 20 years old with a fan-assisted flue
	Install a manual feed biomass boiler or wood pellet stove where the current system uses non-biomass solid fuel.

26. In the method used in the EHS, measures are only recommended for implementation if that measure alone would result in the SAP rating increasing by at least 0.95 SAP points. The suggested measures do not necessarily imply that current measures in place in the home are defective nor that the home is deficient in terms of any particular standard.

27. The EHS does not include all of the possible EPC measures. This is because some would only be recommended in a small number of dwellings or because the survey is unable to assess how effective they would be in improving the performance of individual dwellings. Table 3 lists the measures that are not included in the EHS analysis.

Table 3: EPC measures not covered in EHS modelling of improvement potential

EPC low cost measures (under £500)	**EPC higher cost measures**
Draught proofing single glazed windows	Solar water heating
Low energy lights	Double or secondary glazing
	Solid wall insulation
	Complete change of heating system to class A condensing boiler (including fuel switching)

	Solar photovoltaic (PV) panels

28. The EHS also estimates the notional costs of installing the recommended measures. The costs are applied in the following way for the respective energy efficiency measures:

- Price per unit: Heating controls (room thermostat, programmer), cylinder insulation, cylinder thermostat, boiler upgrade (separate prices for combination/non-combination boilers), biomass boiler upgrade, storage radiator upgrade, warm air heating upgrade;
- Price per habitable room: Heating controls (Thermostatic Radiator Valves);
- Price per m^2: cavity wall insulation, loft insulation.

Post improvement performance and costs

29. The EHS also estimates the SAP rating carbon dioxide emissions and fuel costs after any recommended improvements have been installed.

30. It is also important to emphasise that these are *notional* estimates based on standard assumptions about occupancy and consumption patterns. What improvements would be realised in practice will depend critically on actual occupancy and consumption patterns.

Barriers to improving insulation

31. A section in the 2011 Homes Report examined loft, cavity wall and solid wall insulation in dwellings with the lowest SAP ratings, and explored the practical and other barriers to actual installation that can occur, in order to provide a more realistic indication of the potential for carrying out these improvements. Categories classifying the ease of installation or specific barriers for each insulation type were created from EHS physical data on dwelling fabric and shape.

32. Categories for the ease of installing or topping up loft insulation were:

- ***non-problematic:*** these were identified as potentially upgradeable under the EPC improvement measure analysis and in these cases installation would be straightforward with no barriers.
- ***more problematic:*** these were identified as potentially upgradeable under the EPC improvement measure analysis but where the loft was fully boarded across the joists, which would lead to extra work and expense.
- ***room in roof:*** these cases may already have sufficient insulation installed when built or during the loft conversion, but if insulation

needed to be added between the rafters very extensive work and considerable expense would be involved.

- ***flat or shallow pitched roof:*** again, these cases may already have sufficient insulation installed when built but otherwise it is not feasible to install loft insulation as there is no access into the loft or no loft space.

33. Categories for the 'fillability' of uninsulated cavity walls were created using information on the area of external wall finish as surveyed and other factors such as the presence of external features such as conservatories and the dwelling type:

- ***standard fillable:*** with these cases, no compelling physical barrier to installation exists. These are typically houses with masonry cavity walls and masonry pointing or rendered finishes and no conservatory attached.
- ***non-standard, less problematic:*** these are homes with cavity walls that are fillable but include features such as conservatories (that may necessitate the use of scaffolding) or small areas of non-masonry wall finish (that will increase the costs).
- ***non-standard, more problematic:*** these cases present more serious barriers e.g. the majority of the wall finish is not masonry pointing or there is a mixture of wall structure types, necessitating more than one insulation solution. It also includes all flats, in which dealing with multiple leaseholders could provide a serious barrier, and houses with four or more storeys. This is an issue in all tenures as a large number of former social sector flats are now privately owned due to right to buy.
- ***unfillable:*** these include timber or steel framed dwellings that have masonry cavity walling. They also include all homes where none of the wall finish is masonry pointing or render.

34. Categories for the ease of installing external solid wall insulation were created using information on the area of external wall finish as surveyed and other factors such as the presence of external features such as conservatories, porches and bays and the dwelling type:

- ***non-problematic:*** no serious barriers.
- ***masonry-walled dwellings with attached conservatories or other features:*** these are otherwise non-problematic, but fixing the insulation round any projections like conservatories, porches or bays requires additional work and therefore additional expense.
- ***dwellings with a predominant rendered finish:*** although dwellings with a rendered finish can be treated with external solid wall insulation, 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:*** if the dwelling is a flat, then this treatment can be problematic for two reasons. Firstly, there are likely to be issues related to dealing with multiple leaseholders (getting their agreement and financial contribution to the work). Secondly, the height of the module for high-rise flats would present significant complications in applying external solid wall insulation.

Household awareness of energy performance certificates

35. Since October 2008 it has been a requirement for those selling or renting out dwellings to provide the new or potential occupants with an EPC. In the EHS interview survey for 2011-12, all those who had moved into their current home on or after October 2008 were asked whether they had seen an EPC relating to their new home. Respondents were given a show card illustrating what the EPC looks like so that they were clear about what was being asked. A new section in the 2011 Homes Report, using information collected in the household interview, explored the impact of the EPC on those households that saw it. The analysis looked only at those households that responded 'Yes' to the question as to whether they had moved after October 2008. There were some 291 cases with missing responses to this question as, in these cases, the household reference person (HRP) was not the respondent and this question was only asked of the HRP.

36. Further analysis was carried out to see if there was a difference in energy improvements carried out by those households that had seen an EPC compared with all households. The analysis calculated the number of households that had carried out one or more improvements using information collected in the EHS interview survey, listing the most common jobs carried out.

37. Additional analysis was carried out to examine which types of dwellings were improved and how these matched against those dwellings that actually needed improvements.