Communities
and Local Government

Review of Sustainability of Existing Buidings

The Energy Efficiency of Dwellings – Initial Analysis

Review of Sustainability of Existing Buidings

The Energy Efficiency of Dwellings – Initial Analysis

November 2006
Department for Communities and Local Government

On 5th May 2006 the responsibilities of the Office of the Deputy Prime Minister (ODPM) transferred to the Department for Communities and Local Government (DCLG)

Department for Communities and Local Government
Eland House
Bressenden Place
London
SW1E 5DU
Telephone: 020 7944 4400
Website: www.communities.gov.uk

If you require this publication in an alternative format please email alternativeformats@communities.gsi.gov.uk

DCLG Publications
PO Box 236
Wetherby
West Yorkshire
LS23 7NB
Tel: 08701 226 236
Fax: 08701 226 237
Textphone: 08701 207 405
Email: communities@twoten.com
or online via the DCLG website: www.communities.gov.uk

November 2006

Product Code: 06BD04239

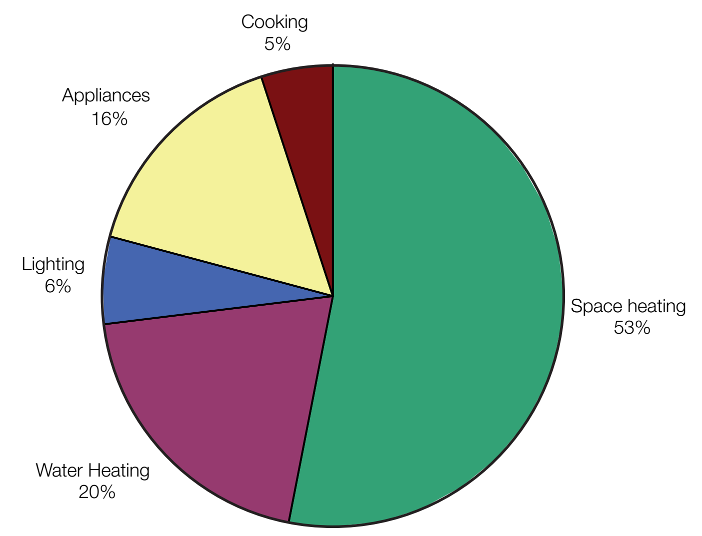
Current energy performance of the existing stock

152 million tonnes of carbon (MtC) were produced by the UK in 2004. Emissions from the domestic building stock were responsible for 41.7 MtC in 2004 – 27% of total UK carbon emissions[1]. Annual carbon emissions are 5.3% lower than in 1990. To meet government targets domestic emissions have to fall to 17 MtC[2] p.a. by 2050, if the domestic sector were to reduce in line with overall carbon emissions targets.

Providing **space and water heating** is responsible for 73% of domestic emissions[3]. Over 80% of heating systems in UK are fuelled by gas. Gas-fuelled energy is also one of the biggest sources of emissions. However, natural gas produces less carbon dioxide for the amount of energy it provides than coal, oil or electricity. Over the long term, energy demand has grown fastest from appliances, with energy for heating remaining largely stable, although recent changes are much smaller.

The Stern Review suggests that, as a result of predicted climate change, fewer people will die from the cold in winters but this will be offset by an increase in heat related deaths in the summers. This is likely to be reflected in a reduced demand for heating but an increase in energy consumption for cooling homes. This, in turn, could result in reduced demand for gas for central heating but offset by an increase in electricity consumption as energy intensive air conditioning systems are installed. We have already seen, this last summer, a demand for relatively low cost, high energy, portable air conditioning units being satisfied by DIY outlets.

Domestic carbon emission – 2005



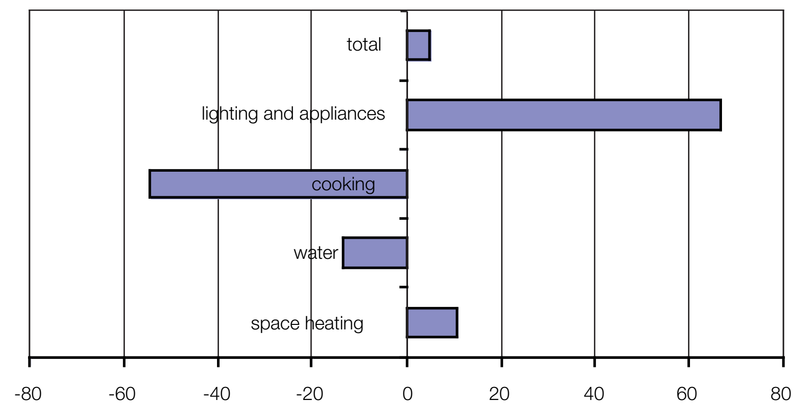
Source: DEFRA

[1] UK Climate Change Programme 2006, Defra

[2] Note: 1 metric tonne = 1000 kg; 1 mega-tonne (Mt) = 1 million metric tonnes

[3] UK Climate Change Programme 2006, Defra

% change in domestic energy demand, 1971 to 2001



Source: EHCS

Insulation is an effective way of improving the energy performance of buildings, reducing heat loss from walls, lofts, floors and windows.

This illustration shows the proportions of total domestic heat loss from walls, roofs, floors, doors and windows

Energy performance of buildings is measured using the Standard Assessment Procedure (SAP)[4], which measures the fuel efficiency of the heating systems and thermal efficiency of the building fabric i.e. how well it retains heat.

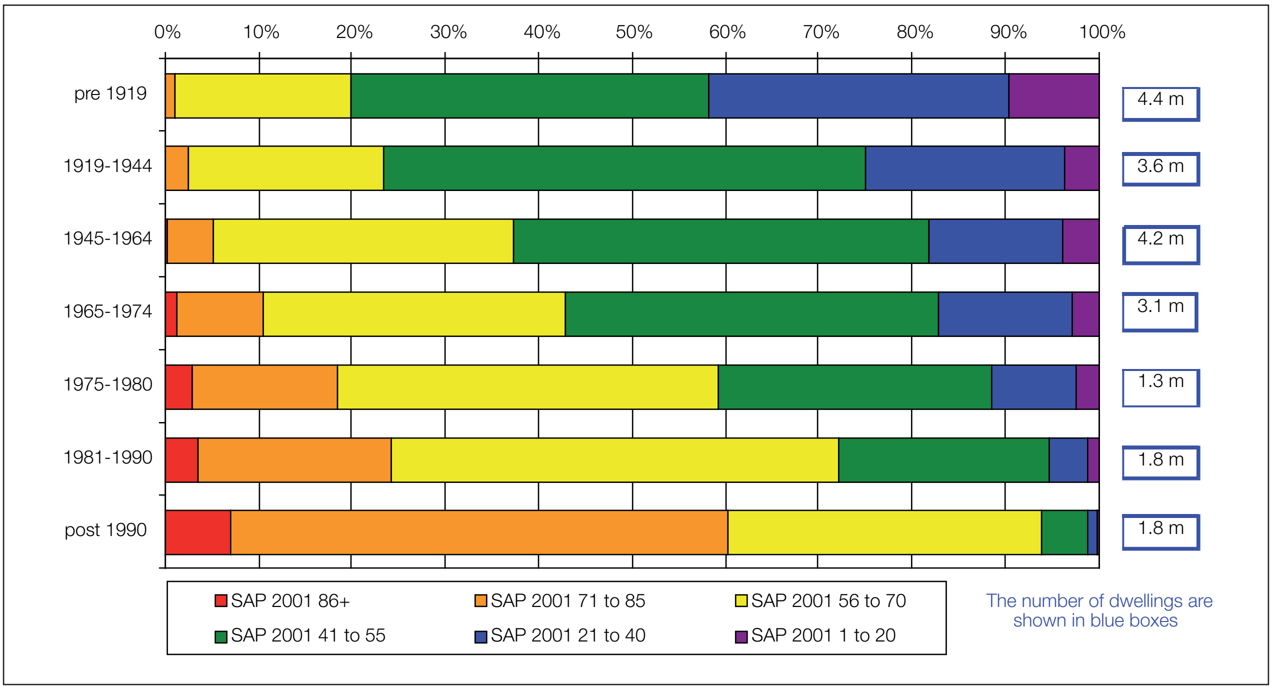
With Government's commitment to increase housing supply, around two-thirds of homes standing in 2050 are likely to have been built before 2005. New build represents only approximately 1% of the total stock each year. Building Regulations have raised energy efficiency standards of new homes significantly in recent years – current (April 2006) standards are 40% higher than for properties built in 2002; 70% more than in 1990. So most of the existing stock, and a significant proportion of those that will still exist in 2050, were constructed to lower, often much lower, standards than new build today. The existing stock, therefore, accounts for the great majority of carbon emissions from dwellings, both in terms of their lower energy efficiency and their numbers.

Energy efficiency varies widely across the stock. The energy efficiency of many older homes will have been improved over the original condition as a result of householder improvements such as installing new boilers, draught-proofing and insulation. But, overall, there remains a close correlation between the age of a property and its energy efficiency, as demonstrated in the chart below.

4 The EHCS analysis presented in this paper is based on SAP2001, which is measured on a scale of 1 (least efficient) -120 (most efficient)

The **factors that have the greatest correlation with energy performance** of the existing stock are age and dwelling type/size. Modern properties are much more energy efficient and smaller properties suffer less heat loss. Apart from these more or less immutable factors, the quality and amount of insulation and efficiency of heating systems also affect energy performance. Other factors that are taken into account in the SAP calculations include building shape, orientation, window sizes and distribution.

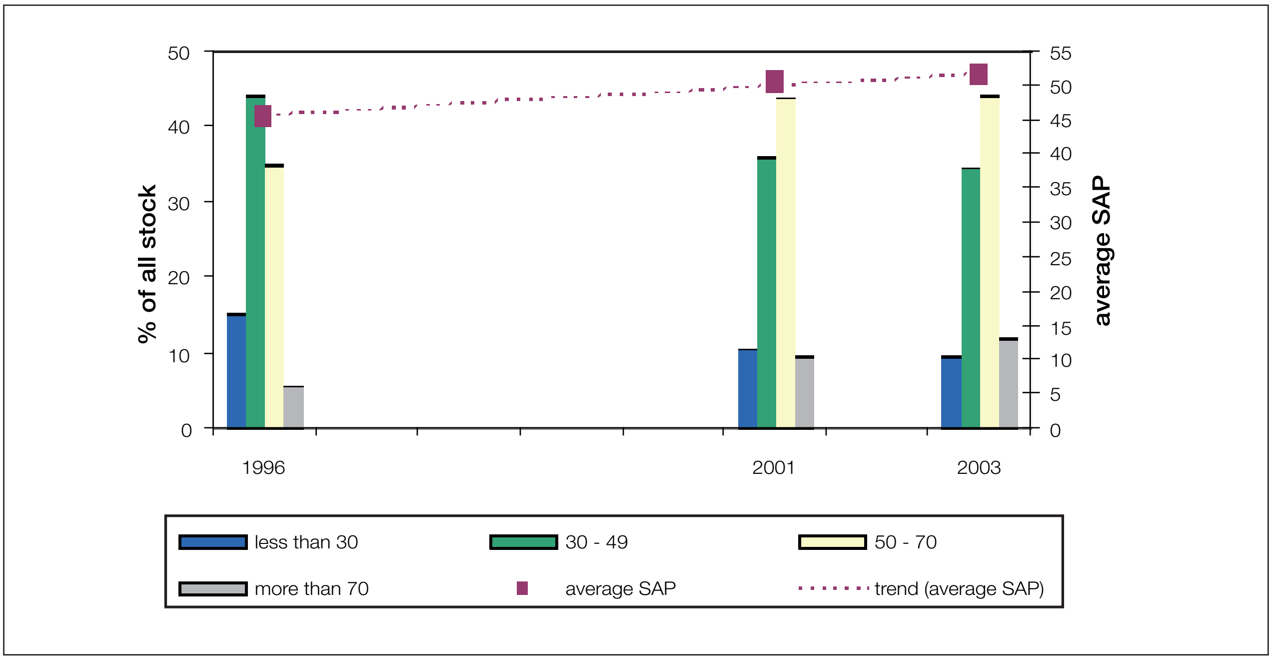
Profile of Energy Performance in Existing Dwelling Stock, 2004



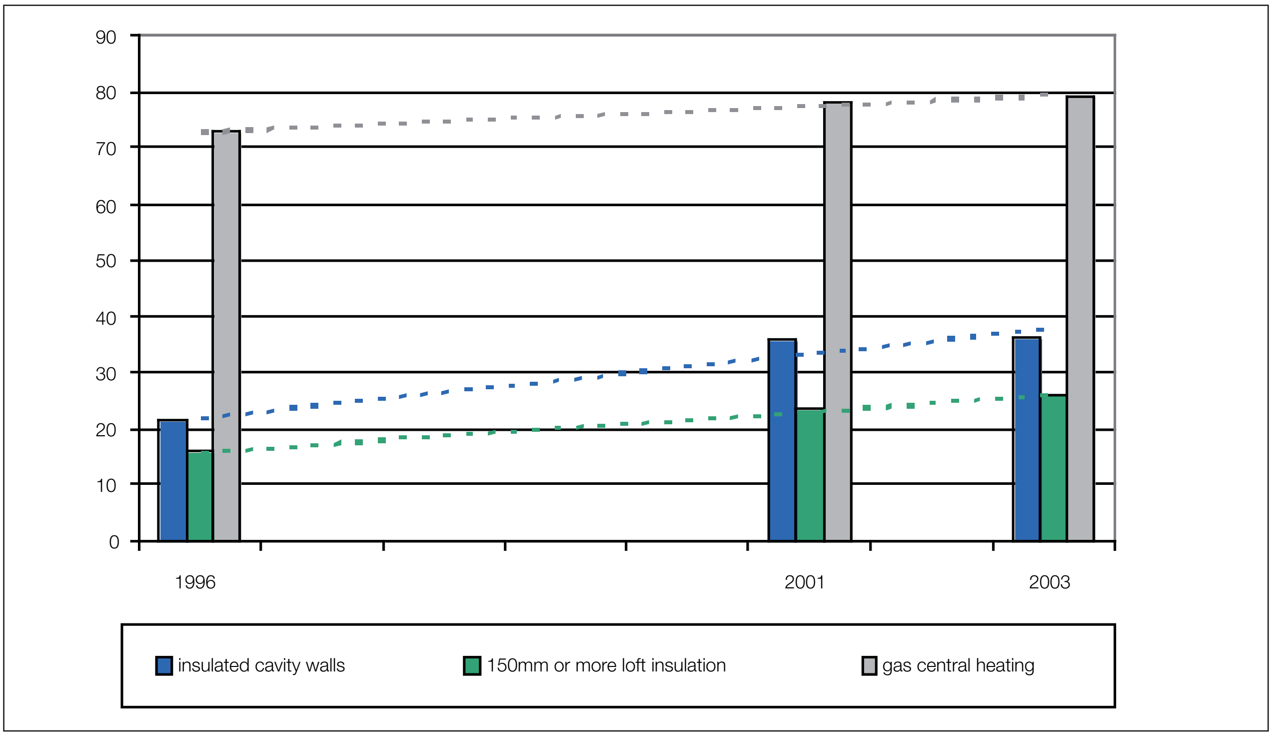
Based on English House Condition Survey (EHCS) 2004, DCLG

This chart clearly demonstrates a step change in the energy efficiency of post-1990 stock since when Part L of the Building Regulations has progressively raised the energy efficiency standards for new homes. Improvements in the energy performance of new build, combined with household improvements have led to an increase in the average energy efficiency of the stock. Two thirds of all properties have SAP values between 41 and 70. There is a clear trend that older properties have much lower energy performance with over 40 per cent of properties built before 1919 with SAP less than 41. By contrast 60 per cent of properties built since 1990 have SAP ratings above 70.

Distribution of average SAP, 1996-2003



Trends in Insulation and Heating, 1996-2003 (% of all stock)



Excluding the effect of more efficient new build, improvements made to the existing stock have been indicated by comparing the energy performance of the stock between 2001 and 2004 (EHCS). 7% more properties built between 1945 and 1964 now have SAP 2001 ratings above 55. 6% more properties built between 1981 and 1990 now have SAP 2001 ratings above 70. The number of cavity walls and lofts insulated has also increased over time, which helps to explain the overall improvement in energy performance. Cavity wall insulation has increased from around 20% of the stock in 1996 to 36% in 2003. There were about 4 million more homes with loft insulation (over 150mm) in 2004 than in 2001.

How much of this improvement to the existing stock might be due to energy efficiency is difficult to establish from the EHCS data, which is inconclusive due to changes in the samples between surveys. Evidence from independent cumulative installation data indicates that the number of insulated cavity walls may have been overstated in 2001, and that there was an estimated increase in insulated cavities of 2-3% between 2001 and 2003[5]. A large proportion of this is likely to have been delivered through the first wave of Energy Efficiency Commitment (EEC) activity, which is reported to have fitted nearly 800,000 homes with cavity wall insulation between 2002 and 2005.

Technical measures & cost-effectiveness of improving existing stock

There are a number of existing technologies that can help reduce carbon emissions from the existing domestic stock. As the majority of carbon emissions are generated by space and water heating, an effective way to tackle emissions without changing behaviour or the carbon content of the mainstream energy supply is to improve the thermal efficiency of the building, so that less energy is needed to heat the property.

Improving efficiency involves a combination of improving insulation and using the most efficient heating systems. More commonly applied potential measures are listed below, with typical costs and potential savings that can be made. The costs presented in the table below (Box 1) are the full costs that the household faces by installing the measure, inclusive of fitting though not accounting for any grants or subsidies that they may be able to get.

The measures in Box 1 are ranked in order of their cost effectiveness. This is measured by the length of financial payback – how many years it takes for the benefits in terms of energy bill savings to equal the cost of installation. In the savings figures, no account is taken for behavioural response such as comfort taking. Cost effectiveness here is related purely to the energy efficiency element of the measure. For example, the double glazing payback does not account for the benefits that the measure has in terms of noise reduction, reduced maintenance or improved security.

Cavity wall insulation currently offers the largest potential carbon saving per dwelling and across the whole stock within a 3-year payback period. Other cost effective measures generally offer lower carbon savings.

Other measures, such as micro Combined Heat and Power (CHP), solid wall insulation and ground source heat pumps, have the potential to achieve relatively large potential carbon savings. However, a high up-front installation cost means that these have longer payback periods and, therefore, are not particularly cost-effective for households without additional support or incentives.

The potential fuel bill savings and carbon savings of each measure varies slightly across dwelling types, mostly by size. The variation occurs because the installation costs vary little by property size, yet larger properties require more energy to heat the building, so potential savings from efficiencies are relatively larger. Cavity wall insulation therefore offers relatively more potential carbon savings in detached properties.

[5] *2003 Thermal Insulation Update Report,* BRE (2006)

Not all measures can be applied across the whole stock. For example, many properties already have cavity wall and loft insulation. In other properties these measures are not possible e.g. where there is no loft or the property has solid walls, or experiences prolonged periods of driving rain with an increased risk of water penetration across the cavity.

Box 1: Domestic Efficiency Measures – estimated costs & savings

Measures	Average cost (£)	Cost saved (£/yr)	Carbon saved (kgC/yr)	Pay- back (yrs)	Potential homes ('000) †	Potential total carbon saving (MtC/yr)
Hot water cylinder insulation	14	29	53	**0.5**	1,137	**0.1**
Cavity wall insulation	342	133	242	**2.6**	8,500	**2.1**
Loft insulation (full and top-up)	284	104	190	**2.7**	6,186	**1.2**
Improved heating controls	147	43	77	**3.4**	2,102	**0.2**
Draught proofing	100	23	43	**4.3**	9,793	**0.4**
Micro CHP	1,571	230	508	**6.8**	12,000[4]	**6.1**
Solid wall insulation	3150	380	694	**7.5**	7,479	**5.2**
A-rated boiler	1,500[1]	168	177	**8.9**	17,128	**3.0**
Micro wind	2,363	224	263	**10.5**	-[2]	**–**
Ground source heat pump [3]	4,725	368	990	**12.8**	17,000	**16.8**
Photovoltaic (PV) electricity	9,844	212	249	**46.4**	9,892	**2.5**
Solar water heating	2,625	48	88	**54.7**	19,330	**1.7**
Windows (Single to Double Glazing)	4,000[1]	41	26	**97.6**	10,746	**1.7**

Source: The First Draft Illustrative Mix of Measures for EEC 2008-11 (Defra), 2006 and †Buildings Research Establishment (BRE), 2005

Note: There is significant variation in costs, for some measures, particularly where professional installation is required. Potential savings are based on a typical 3-bed semi-detached property. The figures for micro-generation in particular are subject to a high degree of variability and uncertainty and should therefore be treated as indicative only. The savings shown are gross and take no account for comfort taking (estimated to be up to 30% of potential savings).

1 Estimate based on currently available price comparisons

2 Planning permission is currently required for this technology

[3] This is an emerging technology and is not yet widely commercially available to households. In addition, the estimated potential total carbon savings from installing ground source heat pumps is based purely on the number of houses with gardens (EHCS), but it is unclear for how many properties this technology may be feasible and is likely to be an overestimate. There are likely to be massive variations in installation cost as it is strongly affected by the geological and environmental conditions of the site.

[4] J Harrison, EA Technology. This estimate is based on an emerging technology, which has not yet been fully explored for feasibility and potential in the UK.

Micro-generation and other low carbon technologies have potential to make a significant impact on carbon emissions by reducing the level of carbon in the gas and electricity supply. Local electricity generation also reduces the significant transmission losses associated with supplying power through the National Grid. Emerging technologies include:

- Heat generation: solar water heating, ground source heat pumps, air source heat pumps, biomass stoves and boilers (e.g. wood and energy crops e.g. willow)

- Electricity generation: Solar photovoltaic (PV) systems, micro-wind turbines, micro-hydro systems (in hilly areas or river valleys)

- Combined Heat and Power: MicroCHP (provides heat and electricity together; many technologies can be used including gas, Stirling engines, internal and external combustion engines, and fuel cells).

These technologies are currently much more expensive and, again, cannot be applied in all properties. For example, there may be physical difficulties in dense urban areas installing ground source heat pumps; the lack of a suitable roof (in flats) or appropriate roof aspect may reduce the effectiveness of solar heating and PVs. Micro-CHP can potentially be applied across the majority of the stock where the house is on mains gas.

Some of the measures, such as A-rated Boilers and Double Glazing may be more attractive options than suggested here. This analysis is based on the assumption that these measures are installed early. In practice these measures are often introduced for other reasons. The great majority of boiler replacements occur when the old boiler breaks down and cannot be economically repaired. In such cases, the installation of a high efficiency (A or B rated) condensing boiler is required in all but specific exceptional cases so the householder's choice is essentially limited to the model – there is no additional cost that results from choosing a more efficient boiler other than the marginal price differences between an A or a B rated condensing boiler. Double glazing will usually be installed for reasons of reduced maintenance, reduced noise, or increased security rather than to reduce heating costs – often for a combination of all these benefits.

EEC subsidies mean that, in practice, most householders pay less than the full prices for some of the measures shown in Box 1, and those measures are generally free to those in the "priority group" on qualifying benefits.

The energy efficiency of domestic appliances is outside the scope of the Existing Buildings Review but we compare them here for illustration. The savings are relatively small.

Insulating cavity walls costs about £342 and saves 242kgC/yr[6]. For the same total marginal cost (ie the additional cost of the more efficient products over the less efficient ones) a more expensive top energy efficient washing machine, tumble drier, dishwasher, electric hob and oven could be purchased, compared with standard appliances[7]. Collectively these would only achieve one quarter of the carbon and fuel bill savings offered by cavity wall insulation.

Which dwelling types have the potential for biggest carbon savings?

Using SAP ratings, a measure of overall energy performance, we can assess the potential carbon savings of improvements across the stock. This demonstrates carbon savings, in principle, and does not take into account what can feasibly be done to improve each dwelling type. The table below shows the carbon emissions expected from the 2004 dwelling stock if all properties were improved by 10 points on the SAP 2001 scale. All calculations are based on gas heating systems.

Box 2: Illustration of the effect of improving all existing dwellings by 10 SAP 2001 points

SAP 2001 rating	Count ('000s)	Current 2004 Emissions (MtC)	Increase by 10 points Emissions (MtC)	Average saving per dwelling (tC)	Total saving (MtC)
86+	283	0.2	0.1	0.1	0.0
71 to 85	2,268	1.8	1.5	0.1	0.3
56 to 70	6,082	6.5	5.4	0.2	1.0
41 to 55	7,593	10.6	9.0	0.2	1.7
21 to 40	3,438	6.9	5.8	0.3	0.5
1 to 20	873	2.6	2.1	0.6	0.5
Total	**20,536**	**28.6**	**24.1**	**0.2**	**4.5**

Based on EHCS, 2004

The average of the 2004 stock was SAP 52. If all properties were improved by 10 SAP 2001 points, 4.5 MtC would be saved per annum. The relationship between SAP and carbon emissions means that at the lower end of the SAP scale (where energy performance is worst), improvements bring about a relatively larger carbon saving than at higher SAP levels. The greater carbon savings are therefore, on average, achieved by raising the energy performance of the lowest performing dwellings.

[6] *The First Draft Illustrative Mix of Measures for EEC 2008-11 (Defra)*

[7] *Figures taken from Buildings Research Establishment (BRE), 2005*

If all properties with SAP 2001 below 56 were raised by 10 points, 3.3 MtC could be saved per annum. For illustration, a 1930s semi-detached property with cavity wall insulation, loft insulation, double glazing and a modern heating system could achieve a SAP rating of 70.

Insulating cavity walls in a typical property will raise the SAP rating by about 10 points. Alternatively, similar improvements could be made by fitting a new boiler with improved controls and insulated cylinders/pipes (depending on the efficiency standard of the boiler it replaced).

Improving the stock has *diminishing marginal returns,* in terms of the incremental carbon saving by adding each additional measure. Once the cheapest (and usually easiest) measures have been fitted (e.g. CWI and loft insulation), to make further improvements to the energy performance of the property becomes relatively more expensive. Retrofitting a property to the highest energy performance standards usually requires some form of low carbon energy source i.e. micro-generation. For properties that are hardest to treat (typically those with solid walls, no mains gas and no loft), retrofitting to an average energy performance standard is currently much more costly as it would generally require either solid wall insulation or micro-generation.

Characteristics of the Dwelling Stock, by Energy Performance

Twenty percent of 2004 stock has a SAP 2001 rating of 40 or less. As explained previously, age is a very significant factor and size also has an effect. On average, the least efficient stock has a higher property value, is more likely to be occupied by households on higher incomes and to be larger, private, detached properties.

Private sector housing represents about 80% of the total stock. However, social stock is on average more energy efficient. This can be explained in part by improvements made to the social stock, which is demonstrated in the EHCS; when comparing similar dwelling types, the social sector properties perform better on average than private. A larger part of the average performance is explained by the type of dwellings in the social stock relative to private. The social sector has relatively more modern and smaller properties e.g. purpose built flats, which are on average more energy efficient.

Box 3: Summary of least energy efficient 20% of existing dwelling stock, compared with all dwellings

	Stock SAP 2001<=40	All stock
Built before 1945	63%	39%
Built before 1900	28%	13%
Average size	96m^2	85m^2
No wall cavities	52%	30%
Loft insulation < 10cm	45%	35%
Heating system > 12 yrs old	54%	40%
Gas heating	57%	84%
No double glazing	27%	16%
Social stock	11%	19%
Lowest 20% incomes	24%	20%

Based on EHCS, 2004

The hard to treat stock is generally properties that have any of the following features: solid walls, off the mains gas network, no loft space, high-rise blocks, or for other technical reasons cannot be fitted with standard efficiency measures. Approximately 9.2 million dwellings (43%) in England have at least one of these features[8]. 84% of this group is in the private sector. Solid wall properties and those off the mains gas network makes up the majority of the hard to treat stock; about 800,000 dwellings have both characteristics[9]. Less than 1% of the stock has three hard to treat characteristics (no mains gas system, solid walls and no loft space).

There are no distinguishing socio-economic characteristics of households in hard to treat homes, as recorded in the English House Condition Survey, relative to the whole domestic stock. Nonetheless, as size and age are important drivers in energy performance (and hard to treat properties tend to be older and larger) it is likely that these properties have a relatively higher value in the market, and also tend to be privately owned.

There are a number of efficiency measures that can be retrofitted to the least efficient stock. Improvements could be made to loft insulation, where loft space exists and is un-insulated, which represents approximately 3.1 million dwellings with solid walls. In some properties off the mains gas network, there is potential to fit loft insulation in approximately 250,000 dwellings or cavity wall insulation in 380,000 dwellings.[10]

Properties suffering from a combination of features, such as solid walls and no loft, or high-rise and mid-floor flats, have very little potential for retrofitting using the simplest

8 EHCS 2004

9 *A study of hard to treat homes using the English House Condition Survey,* BRE 2006

10 *A study of hard to treat homes using the English House Condition Survey,* BRE 2006

and cheapest insulation measures. These would require more expensive and difficult measures, such as replacing old and non-gas heating systems, insulating solid walls, installing double glazing or installing micro-generation systems.

The table below illustrates 3 "Case Studies" of properties found in England and illustrates the variety of measures that can be applied to them and the variability in impact on fuel bills and carbon of making these improvements.

Large Hard To Treat

e.g. a large 1910s mid-terraced house. This is likely to be occupied by older families or couples

Potential measures	Capital cost (£)[11]	Bills (£)	Carbon (t/yr)
***Loft insulation (top up)	120	19	0.1
**Boiler and heating control upgrade for radiators	200	130	0.3
*Solid wall insulation	1,500	190	0.4
*Double glazing	2,800	48	0.1
Total	**9,345**	**387**	**0.9**

	Current	Savings	Potential
Bills (£)	1,310	387	923
Carbon (t/yr)	1.8	0.9	0.9

New heating systems can be expensive but can produce significant savings. Solid wall insulation is expensive and messy but does save a lot of energy so should be considered when renovating. Combining all these measures halves the carbon emissions from this property.

[11] Energy Saving Trust installation costs

Average English Home

e.g. a small 1970s semi-detached house. A typical young family might live here. Over 90% of these are owner occupied.

Potential measures	Capital cost (£)	Bills (£)	Carbon (t/yr)
***Hot water tank insulation	10	12	0.0
***Loft insulation (from none)	210	100	0.3
***Cavity wall insulation	300	89	0.2
†Micro-CHP	1,571	230	0.5
Total	**2,091**	**431**	**1.0**

	Current	Savings	Potential
Bills (£)	921	431	490
Carbon (t/yr)	1.5	1.0	0.5

Since this property has cavity walls, insulating these is a quick and cost effective solution to save money and energy. All properties should have insulated lofts and hot water tanks. These are very cheap and easy to do and there are significant savings to be made. A more expensive option is a micro combined heat and power system that produces both heat and electricity for the property.

Small Modern Construction

e.g. a post 1990 purpose built flat. These are likely to be occupied by wealthy small households or rented from an RSL.

Potential measures	Capital cost (£)	Bills (£)	Carbon (t/yr)
**Boiler and controls upgrade for radiators	200	22	0.1
†Solar Water Heating	2,625	48	0.1
Total	**2,825**	**70**	**0.2**

	Current	Savings	Potential
Bills (£)	391	70	321
Carbon (t/yr)	0.3	0.2	0.1

A modern property is likely to have good insulation and heating systems. However money can still be saved by minimising the time heating systems are left on. Solar water heating supplements existing water heating using energy from the sun.

*** Low cost effective measures
** Medium cost effective measures
* Measures to consider when making other improvements
† Emerging technologies[12]

Figures based on EST's household online checker unless stated otherwise

[12] Data from *The First Draft Illustrative Mix of Measures for EEC 2008-11 (Defra)*

Potential paths to achieving 60% carbon emission reduction by 2050

There is no presumption that Government would seek to achieve the same percentage reductions across all sectors of the economy. However if we were to seek to reduce carbon emissions from households in line with the overall carbon emissions target for the UK, then the net reduction required would be 25.5 MtC.

There are a number of existing and announced policies impacting on the building fabric and affecting domestic energy efficiency:

- the **Energy Efficiency Commitment (EEC)** is the existing flagship instrument to improve energy efficiency in the household sector and works by imposing a statutory obligation on energy suppliers to promote energy efficiency measures directed at householders. EEC has been very successful with the first phase (2002-2005) delivering 0.4MtC a year by 2010, stimulating about £600m investment in energy efficiency, and delivering net benefits to householders in excess of £3billion (for every £1 spent by suppliers householders benefited by about £9). The net resource benefit for saving each tonne of carbon saved is around £300. EEC2 (2005-2008) is in progress and should deliver over 0.6MtC a year by 2010, and the Government has already announced its intention that EEC3 (2008-11) will be 50-100% more ambitious than EEC2. The Energy Review announced that a household obligation on suppliers would continue in some form until at least 2020 with an average level of annual savings at least equal to EEC3;

- **Decent Homes:** improving the condition of an existing home to one that is warm, weatherproof and with reasonably modern facilities. The Government's aim is to make all council and housing association housing decent by 2010. It is not intended specifically to improve energy efficiency but, by including a thermal comfort criterion, it is expected to have a significant effect on the energy performance of those homes. Local authorities typically work very closely with EEC suppliers when tackling their housing stock, so most of the carbon savings from the Decent Homes programme are attributed to EEC, and to a lesser extent to Building Regulations. But some additional activity does take place that is not accounted for elsewhere, and savings from this are conservatively estimated at 0.02 MtC a year;

- **Warm Front:** Government's main grant-funded programme for tackling fuel poverty, launched in June 2000. The scheme fits packages of measures including insulation and heating systems. Grants are offered up to £2,700 for families and the disabled and a grant of up to £4,000 where the work approved is installation of an oil fired central heating system. Carbon emission reductions under Warm Front and other fuel poverty programmes are expected to be 0.4MtC a year by 2010;

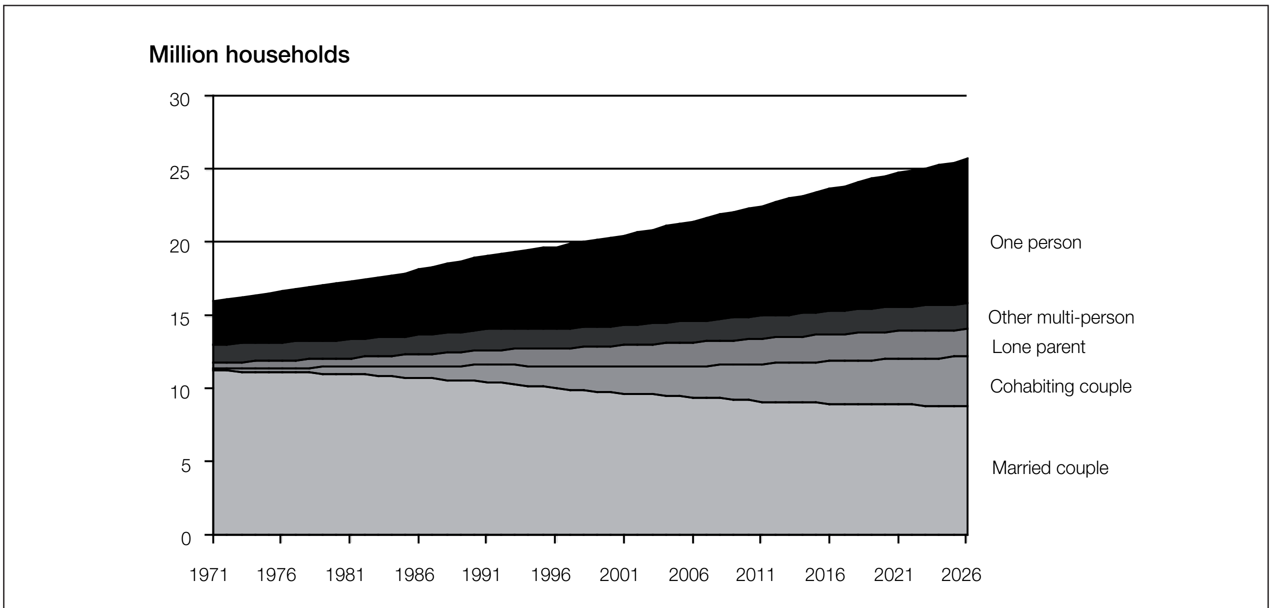
- **Energy Performance Certificates (EPCs)** will be required on sale or rent of buildings. They will give potential buyers/tenants information on the current performance of a house and its cost-effective potential, setting out the cost-effective measures relevant to the property;

- The **Code for Sustainable Homes:** similar to a predecessor demonstration standard, 'Ecohomes'. The Code will rate the sustainability of new housing. The energy and water elements of the Code are not tradable, so reaching higher code levels will require improved performance in these areas (and should make this a more stretching standard than Ecohomes);

- **Building Regulations:** If building work is being carried out on existing buildings, the building regulations are likely to apply. This covers work from building an extension to replacing windows or the boiler. Part L of the building regulations sets standards related to the conservation of fuel and power.

A key challenge is that carbon reduction targets are set against a backdrop of rising trends in energy consumption. This likely to be driven by increased appliance use as incomes rise and work and leisure patterns change (e.g. home working), demographic factors e.g. population and household growth and housing supply expansion and, more generally, rising trends in other sectors, particularly transport.

Number of households 1971 to 2026, England



Source: DCLG household estimates and projections.

Using the estimated carbon savings presented in Box 1, if the top 5 measures offering the fastest pay back to households are adopted (basic insulation and better heating controls) and more efficient boilers are fitted in all homes, which will happen over time, it may be possible to achieve a total carbon emissions saving of 7 MtC. Compared to the net reduction needed of 25.5 MtC, this leaves a significant shortfall of 18.5 MtC.

Under current existing stock conditions and with currently known technologies, this means that to achieve a 60% reduction would require the application of microgeneration technologies. The Building Research Establishment (BRE) have estimated that, taking housing growth into account, it is possible to get close to the 60% target, but that it would require a significant take-up in these emerging technologies e.g. photovoltaic electricity and solar heating. In their model this was illustrated by a scenario that reached the 60% target, using heat pumps in 50% of dwellings that have central heating by 2050 and biomass boilers in the other 50%, and a range of simpler efficiency measures for the remainder.

Currently, this sort of take-up is not feasible where technologies are not widely commercially available to households and are very expensive, relative to fuel savings that can be made. Retrofitting the existing stock, even with basic energy efficiency improvements will also take time to fully penetrate the market. For example, estimates based on past rates of take-up, without significant new policies, indicate that cavity wall insulation (CWI) will reach 100% of the existing stock by 2025[13]. It is expected that EEC and particularly the third phase of EEC will speed up the penetration of CWI, by potentially fitting a further 3 million homes between 2008 and 2011.

By stimulating demand and development it should be possible to bring costs down. Estimates based on experience of low and zero carbon technologies, indicate that costs could be reduced *significantly* for each doubling of installed capacity[14]. Industry analysts have predicted that if there were 12m installed Micro-Combined Heat and Power (CHP) units the additional cost might fall from around £2,000 (marginal cost based on a current typical market price) to £400.

Demand for Energy Efficiency and Household Behaviour

Household demand for energy efficiency is likely to be affected by several factors, including: fuel prices (relative to incomes) and their media coverage, cost of efficiency measures, technology available, good information about how to improve and the impact on energy bills, level of thermal comfort achieved, and attitudes to the environment and climate change.

There are challenges. Generally only a small minority (around 5%) of home owners consider the heating of their home to be ineffective and therefore in need of improvement[15]. Only at low SAP levels (below 40) is their any significant increase in homeowners thinking they would benefit from heating improvements (well below the average SAP for the sector of around 50). The vast majority therefore are likely to see no need for improvement in terms of their own thermal comfort.

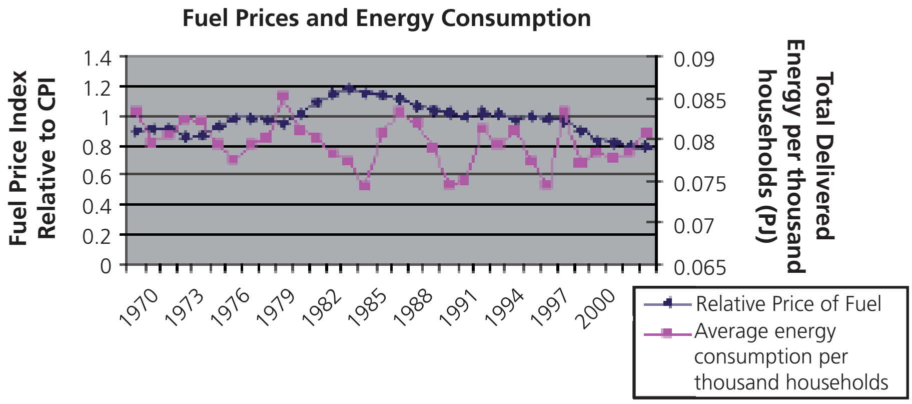
Households do not pay for the wider costs (*the externality*) of carbon emissions on society and future generations when they consume energy, except in so far as energy prices reflect the wider costs of carbon due to current interventions such as EU Emissions Trading Scheme and Climate Change Levy.

13 *Reducing carbon emissions from the UK housing stock,* BRE, 2005

14 Based on research conducted by M. Hinnells, the International Energy Agency and the Government Performance and Innovation Unit, and Code for Sustainable Homes cost review, EP/Housing Corp.

15 EHCS, 2003

Fuel Prices and Energy Consumption



From DTI data. Assuming no further increases in the current number of households, a lag period for consumers to adapt their behaviour, and present allocations of fuel sources

Fuel prices are variable, despite a rise in the 1980s, fuel prices (relative to other consumer prices) have remained similar to 1970. Over time, households have not changed their level of energy consumption very much in response to changes in prices[16].

The proportion of household expenditure has fallen across income groups, from 13% to 5.6% in the lowest income groups between 1970 and 2004, and from 4.6% to 1.9% in the highest income groups over the same period[17]. Moreover, encouraging efficiency in the private sector is made more difficult by the fact that most households do not notice lower thermal comfort except in properties that have very low energy performance.

Conclusions

The analysis so far shows that a substantial reduction in carbon emissions can be made by introducing cost effective technology, that can make substantial savings for consumers on their fuel bills.

However, there are still barriers to take up including information and upfront costs which many of our developing policies are designed to address. In the longer term, we need to look at new, emerging technologies and a wider range of measures in order to meet the 2050 timetable.

In taking this work forward, we will be working across Government to look at further measures to promote greater energy efficiency and more sustainable buildings. Our existing programmes, in particular the Energy Efficiency Commitment, will continue to provide support for householders to introduce improvements and we will be looking at ways of encourage the market to provide innovative and more cost effective solutions where the existing technologies are too costly or otherwise unattractive to householders. Our conclusions will feed in to the forthcoming Energy White Paper.

16 Price elasticity of demand has been estimated at -0.22 and low positive income elasticity of 0.34 (Hunt *et al.* 2003)

17 Family Expenditure Survey, ONS.