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Sustainable homes – the financial and environmental benefits

Science Report SC040050/SR

Environment Agency

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Professor Mike Depledge   Head of Science

Executive summary

People need homes. But with pressure on natural resources and the uncertainty of climate change, it is important that homes are built in ways that provide benefits for both residents and the environment.

The pace of UK house building is set to increase. Under its sustainable communities agenda, the Government is seeking to substantially increase the level of housing in the South East (particularly the Thames Gateway and dormitory areas around London).

Now is the time to make a significant shift to homes that use resources more efficiently. This would improve the quality of the built environment, create better places for people to live, and improve and protect the environment.

The environmental case for more sustainable homes is clear:

- Our demand for energy is increasing. Houses account for 30 per cent of the UK's total energy use, 27 per cent of UK carbon dioxide emissions and around 24 per cent of greenhouse gas emissions.
- We each consume about 150 litres of water every day. There is a shortage of water in many parts of the UK.
- Households produce about 6 per cent of the UK's total waste annually. The expected number of new homes in the next 20 years would increase municipal waste by almost a third, but we are already running out of space for existing levels.
- About half of household waste is reusable, but only 17 per cent is recycled or composted.

There are also sound economic reasons for improving the environmental standards of new homes. Our study demonstrated that:

- A 25 per cent improvement in resource efficiency has a maximum extra capital cost of £800 per home.
- These improvements produce savings for residents through reduced utility bills of approximately £138 a year. The *total* benefits of resource efficiencies would be much greater than this if we could quantify the wider effects on the environment, health, etc.
- The extra cost of a home built to higher levels of resource efficiency is unlikely to mean more expensive homes, but even if extra costs were passed on to the house buyer, only up to £4 per month (£48 per year) would be added onto a typical £100,000 mortgage. Therefore, more efficient homes can be more affordable overall, particularly for those on low incomes who spend a higher proportion of their income on bills.
- Even higher resource efficiency savings could be achieved by providing incentives to householders, by designing developments to encourage changes in behaviour, and by investing in micro-infrastructure such as greywater systems, solar heating or anaerobic waste digesters. The costs of many forms of micro-infrastructure are falling rapidly and some may already be cost-beneficial.
- The cost of higher standards will fall with technological development and economies of scale, while utility bills may continue to rise. Failing to build more resource efficient housing foregoes significant benefits to households, society and the environment. Investments now would also avoid costly corrective measures later.

In this study, we used a baseline of a typical new home built to 2002 Building Regulations, to identify two possible standards:

Achievable – Improvements to the fabric of the house that could be implemented on a large scale now without significantly affecting existing lifestyles or behaviour. In approximate terms it relates to a 25 per cent improvement in resource (water, energy and waste) efficiency.

Aspirational – These standards are currently available in niche or experimental developments. They should become mainstream and economically feasible on a large scale within a few years but may require some behavioural change by residents. They generally involve some form of micro-infrastructure, either as part of the fabric of the house or the wider development. The way the development works as a whole is as important as the resource efficiency of individual houses.

Our calculations show that the costs of *achievable* standards are up to £800 per home. Most of this relates to improvements in energy efficiency, while water and waste savings can be achieved at no or very low cost. Metered homeowners could save £55 a year in water bills without changing their lifestyles and up to £83 per year in fuel bills, depending on house type. The quantifiable financial benefits of meeting *achievable* standards over 25 years are significantly greater than the likely costs. The payback period for *achievable* standards is less than the seven year average stay in a house.

The costs of *aspirational* standards are currently several thousand pounds per home. Such efficiency improvements could reduce average water and fuel bills by £88 and £108 a year respectively, or even more depending on changes in behaviour and investments in micro-infrastructure. Nevertheless, the payback period (from 14 years) for these types of resource efficiency savings is longer.

We were only able to fully quantify the effect of higher standards on utility bills and, to some extent, reduced transport costs. The *environmental* benefits of resource efficiencies are likely to be very significant. Health benefits would also follow from more sustainable housing and developments. If we could place monetary values on some of these benefits then the case for both *achievable* and *aspirational* standards would be even greater.

Measures available to implement higher standards include information and labelling, regulations and standards, financial incentives and economic instruments, and Government-led procurement.

As a result of our studies we recommend that the 25 per cent or so resource efficiency improvements associated with *achievable* standards should be incorporated into the current proposed amendments to the Building Regulations and that the Code for Sustainable Buildings should be set at standards above these. In addition, we recommend that the Government should make it clear that regulations will be tightened further over the next 10 to 15 years, such that our *aspirational* standards become the norm and housing developments as wider systems become more sustainable.

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1. Introduction

People need homes. But with pressure on natural resources and the uncertainty of climate change, it is important that homes are built in ways that provide benefits for both residents and the environment.

With the pace of UK house building set to increase, now is the time to make a significant shift to homes that use resources more efficiently. Such a move would improve the quality of the built environment, create better places for people to live, and improve and protect the environment.

However, building homes to higher than usual resource efficiency standards may entail additional costs. In our study we looked at the additional costs of incorporating measures to:

- improve water and energy efficiency;
- reduce domestic waste generation;
- improve the overall resource efficiency of new developments and their infrastructure.

We then looked at the benefits associated with these measures in terms of:

- reduced water and fuel bills;
- reduced fuel and water poverty;
- retained value;
- reduced transport costs;
- reduced macro-infrastructure requirements;
- health, societal and environmental benefits.

This report is organised as follows. In Section 2, we describe the policy background to resource efficiency standards of new homes. We then set out exactly what we mean by higher standards in Section 3, and discuss how these would differ from typical current building standards for new homes. In Section 4, we then identify the cost elements associated with achieving higher standards and in Section 5 we identify the benefits. In Section 6, we bring these together into a simplified cost-benefit framework and in Section 7 we identify and discuss the key issues related to the implementation of higher standards. Finally, in Section 8, we draw some conclusions and recommend possible areas where further research would yield most benefit.

2. Policy background

Under its sustainable communities agenda, the Government is seeking to substantially increase the level of housing in the South East (particularly the Thames Gateway and dormitory areas around London). This may lead to an extra 200,000 homes on top of the 930,000 already planned (in regional planning guidance) across the wider South East by 2016. On top of this, if the proposals of the Barker Review (2004) are implemented in full, between 70,000 and 120,000 additional houses per year may be built across the UK.

The environmental implications of increases in the housing stock are of concern to all of us. Our demand for energy is increasing. Houses account for 30 per cent of the UK's total energy use, 27 per cent of UK carbon dioxide (CO_2) emissions and around 24 per cent of greenhouse gas emissions. We each consume about 150 litres of water every day. There is a shortage of water in many parts of the UK, particularly in the South East, which has less rainfall per capita than the Yemen (World Resources Institute, 1999). Households produce about 6 per cent (25 million tonnes) of the UK's total waste annually. The expected number of new homes in the next 20 years would increase municipal waste by almost a third, but we are already running out of space for existing levels. About half of household waste is reusable, but at present only 17 per cent is recycled or composted.

In February 2003 the Deputy Prime Minister, John Prescott, launched the Government's Sustainable Communities Plan, which set out a vision for housing and community development over the next 30 years. In this and subsequent announcements the Government emphasised its commitment to sustainable forms of construction, requiring higher sustainability standards for housing and other buildings. At the Government's Better Building Summit in October 2003, a new Sustainable Buildings Task Group was established by the Government to ensure that higher sustainability standards would be achieved through a combination of regulation, incentives and voluntary agreements for the house-building and construction industries.

This commitment from Government, along with proposed changes in legislation and improvements in technology, provides the greatest opportunity for a generation for new housing and residential developments to make a significant contribution to improving quality of life for many thousands of people in the UK.

3. Setting the standards

A number of environmental and resource efficiency standards for housing already exist. Perhaps the best known is the Building Research Establishment's Environmental Assessment Method (BREEAM). The standard for residential buildings is known as an ecohomes rating (BRE, 2003b), in which impacts are assessed in a number of categories including energy and water use, transport, pollution, materials, land use and ecology, and health and well-being. Individual assessments are combined into an overall score and translated into one of four ratings: *pass*, *good*, *very good* or *excellent*.

Other assessment tools look more specifically at certain aspects of homes. These include the Standard Assessment Procedure (SAP), the Government's recommended ratings system for home energy efficiency. The SAP rating is based on energy costs for space and water heating only. A SAP rating is required for all newly built dwellings and those that are undergoing significant material alteration. Housing associations and councils that own stock are required to submit average SAP figures for homes in their regions, so that the Government can monitor the amount of energy used, and associated carbon emissions, from domestic dwellings in the UK. The current version is 'SAP2001', with a scale of 1 (very poor) to 120 (excellent). A typical SAP for an average house in England is about 45.

The National Home Energy Rating (NHER) is a more rigorous analysis than SAP and takes into account the local environment and the effect it has on the building's energy rating. The NHER calculates the costs of space and water heating as well as cooking, lights and appliances. There is also SPeAR (Sustainable Project Appraisal Routine), developed by ARUP (www.arup.com) as a design tool to help companies evaluate, demonstrate and improve on the sustainability of their products, projects or performance, as well as benchmarking schemes such as the European Green Building Forum.

Building Regulations can also be used as a proxy for the resource efficiency of homes. These regulations are tightened on a regular basis with the latest changes to Part L in 2002 based on carbon output.[1] The legal requirements set out under 'Approved Document L1: Conservation of fuel and power in dwellings' (ODPM, 2002) are as follows:

> *Reasonable provision shall be made for the conservation of fuel and power in dwellings by:*
> *a) Limiting heat loss:*
> *i) through the fabric of the building;*
> *ii) from hot water pipes and hot air ducts used for space heating;*
> *iii) from hot water vessels;*
> *b) Providing space heating and hot water systems which are energy efficient;*

[1] It is worth noting that the regulations for energy efficiency are not fully consistent with requirements for ventilation. Homes built to current standards may well overheat in summer, particularly as we move into a period of global warming. This has been experienced already in some of the units (particularly on the top floors) at BedZED. (The Beddington Zero Energy Development, or BedZED, is the UK's largest carbon neutral eco-village. See http://www.bioregional.com/programme_projects/ecohous_prog/bedzed/bedzed_hpg.htm). This could potentially see the UK's energy use profile becoming more like that of the USA, as people use air conditioning in summer.

c) Providing lighting systems with appropriate lamps and sufficient controls so that energy can be used efficiently;
d) Providing sufficient information with the heating and hot water services so that building occupiers can operate and maintain the services in such a manner as to use no more energy than is reasonable in the circumstances.

Consultation is currently under way on further tightening of Parts L (energy) and G (water and drainage, which does not currently cover water conservation) of the Building Regulations. We are pressing for changes that would lead to around 25% improvement in both energy and water efficiency levels in new homes.

Lastly, a new Code for Sustainable Buildings (CSB) was recently proposed by the Sustainable Buildings Task Group (SBTG, 2004) and is being developed by Government and industry. Demonstration projects are expected in 2005. This code recognises some of the limitations of other methods; for example, *very good* ecohome standards can be met by other themes without achieving any water efficiency measures. It is likely that minimum standards in certain key areas (including water efficiency) will be specified. The CSB will also need to be consistent with other proposed standards currently under review, such as the Energy Saving Trust's Government-funded programme 'Energy Efficiency Best Practice (EEBP) for Housing'. However, at present there are no specific details about the standards that will actually be contained in the code.

Until details of the CSB are confirmed, it is clear that there is no single agreed classification system that provides minimum standards in the range of key areas of household resource efficiency (water use, energy use and domestic waste generation). We therefore focus on the financial costs and benefits associated with two simple measures of the resource efficiency of homes compared to current standards for new buildings.

1. ***Achievable***. These are efficiency improvements to the fabric of the house that could be implemented on a large scale now given the current technological and statutory framework and without significantly affecting existing lifestyles or behaviour. In approximate terms, it relates to a 25 per cent improvement in resource (water, energy and waste) efficiency.

2. ***Aspirational***. These relate to standards that may not be immediately achievable (for technological, institutional or other reasons). However, they are available in niche or experimental developments and should become mainstream and economically feasible on a large scale within a few years but may require some behavioural change by residents. They generally involve some form of micro-infrastructure, either as part of the fabric of the house or within the wider development site. This therefore affects the way the development works as a 'system' rather than solely the resource efficiency performance of individual housing units.

Broadly, the first of these equates to the current ecohomes *very good* standard, while the second ranges from current ecohomes *excellent* through to *Z-squared*-type[2] savings

[2] These relate to 'zero waste, zero carbon' communities, the most famous example being BedZED in South London. For more details, see http://www.bioregional.com/programme_projects/opl_prog/zsquared/bz_zsquared.htm.

(WWF, 2003a). Further detail on exactly how our two measures relate to these and other standards is provided later in this report.

Table 3.1 sets out average levels of resource use associated with these two standards over and above our baseline. Since water use is largely personal (flushing toilet, washing, etc), this is measured in per capita terms. Energy use and waste generation do not vary greatly according to the number of people in the household, so these areas are measured in terms of households. Detail on how the figures in Table 3.1 were derived is provided in the following sections.

Table 3.1 Average levels of resource use associated with higher building standards

	Baseline[1]	**Achievable**	**Aspirational**
Water use (litres per head per day, l/h/d)	122	92	71–84
Energy use (tonnes of carbon per household per year, tC)	0.47	0.35	0.10–0.28
Domestic waste generation (% domestic waste recycled or composted)	12	25	33–100

[1]These are average figures and vary depending on the number of people in the household and other factors. For example, the first adult in a household uses about 140 litres of water a day (less for metered households but more if the house has a garden), a second adult uses 100 litres, and a child around 60 litres.

3.1. Water use

There are two important elements in addressing water efficiency in the home:
- pipework, fittings and appliances that effectively and reliably fulfil their intended role;
- behaviour of the occupants.

Theoretically, *achievable* efficiencies of up to 25 per cent can occur by examining the first of these elements only. The Government has acknowledged that this level of efficiency improvement is both possible and desirable. Meeting *aspirational* standards would require some behavioural changes (e.g. showering rather than bathing, more careful use of water, ensuring fittings are well maintained) as well as additional efficiency measures including either rainwater collection or a greywater system for garden use and toilet flushing. Depending on the level of behavioural response, this could reduce average per capita consumption by 30 per cent or more. There are a number of ways in which more water efficient behaviour could be encouraged. These include using innovative tariff structures for metered homes (e.g. seasonal or peak use charges), labelling of fixtures and appliances, and raising awareness through education and information provision. Table 3.2 sets out how metered water use in a current baseline new build might compare with that in a household with water efficient specification for a range of appliances and uses under our two scenarios.

Table 3.2 Water use under different scenarios

Water use component[1]	**Baseline**		**Achievable**		**Aspirational**	
	Volume per use (litres)	Per capita consumption (l/h/d)[1]	Volume per use (litres)	Per capita consumption (l/h/d)[1]	Volume per use (litres)	Per capita consumption (l/h/d)[1]
Toilet[2]	6	28	4	17	2	9
Shower	45	25	30	17	30	17
Bath	85	30	80	28	80	20–28
Taps (internal)	-	12	-	10	-	8–10
Washing machine	60	13	40	9	40	9
Dishwasher	20	8	15	6	15	6
Garden	-	6	-	5	-	2–5
Total[3]	**-**	**122**	**-**	**92**	**-**	**71–84**

[1]Assumed average household occupancy of 2.5.
[2]Dual/low-flush toilets can reduce water use to around 4 litres per flush. The further 50% reduction associated with the move to *aspirational* standards might come from a rainwater harvesting or greywater system.
[3]Excludes other non-specific uses, which collectively may approximate to an additional 20 l/h/d.

Source: Environment Agency (2003)

The *achievable* standards set out in Table 3.2 are comparable to those for ecohomes, where the maximum four credits for internal water efficiency can be obtained by achieving 25–30 per cent improvement on a standard new build. However, the ecohomes system focuses on reducing consumption per bed space by specifying water efficient appliances but does not take account of the *use* of these appliances in the way set out in Table 3.2, meaning the two are not directly comparable. It should also be noted that the water efficiency aspects of ecohomes (which we believe currently carry too low a weighting in the assessment process) are currently being reviewed to take account of latest technology and regulations. *Aspirational* standards are broadly similar to ecohomes *excellent* with some behavioural changes on the part of residents.

3.2 Energy use

The baseline for energy use in typical new households is provided by the latest revision (2002) to the Building Regulations, discussed earlier. These already achieve significant energy savings for a new home, for example around 50 per cent compared to 1990 Building Regulations (DTI, 2004). A typical 3-bedroomed semi-detached house built to 2002 Building Regulations with a gross floor area of 100 m^2 now produces around 0.47 tonnes of carbon (tC) emissions per year on average (EST, 2003). This compares to 1.8 tC for an average UK household.[3]

Moving to an *achievable* efficiency standard (roughly equivalent to the Energy Saving Trust's (EST) current *best practice*) would lead to a reduction of around 25 per cent in carbon emissions to 0.35 tC, broadly consistent with the proposed changes to Building Regulations. While this could be achieved without any form of micro-infrastructure, the Mayor of London has stated that *all* large-scale developments should have a minimum 10 per cent renewable energy component. *Aspirational* levels (ranging from EST's

[3] However, around one-third of new homes still fail to comply with the latest Building Regulations. Any improved standards therefore need to be accompanied by an adequate compliance and enforcement structure. In addition, although standards for energy performance are improving, domestic energy demand is still increasing and the environmental implications of this therefore continue to be a serious issue.

advanced to *Z-squared* standards) would result in a minimum 40 per cent or so reduction in emissions, to between 0.10 and 0.28 tC.

Within the fabric of the building, these savings could be met in a number of ways but would involve improvements across the three broad areas that we consider below: space and water heating, appliances and lighting. It should be remembered though that these savings could also be (at least) partly achieved by behavioural changes such as reducing the heating 'on' time and 'set' temperature.

3.2.1 Space and water heating

Reducing heating requirements would have by far the biggest impact on household energy consumption. Meeting *achievable* standards in this area would require a minimum 15 per cent improvement over the baseline in average U-values. These measure heat loss through the fabric of the building (roofs, walls, floors, windows and doors). They can be reduced through a range of additional measures including thicker insulation, draughtproofing or double-glazing.

Meeting *aspirational* standards would require at least a 40 per cent improvement in U-values and further measures to reduce heating use and heat loss such as:

- solar water heating;
- energy efficient design to reduce heat loss and utilise solar gain, perhaps to the point where conventional central heating systems can be eliminated altogether;
- use of renewable energy sources such as wood-fuelled CHP (combined heat and power);
- triple-glazed windows.

Measures to improve energy efficiency could also be met by improving the regulation of the heating system (e.g. programmable room thermostats, thermostatic valves on all radiators and an automatic bypass valve) and greater boiler efficiency. Indeed, *aspirational* standards could only be achieved with, at least, the installation of a condensing boiler.

3.2.2 Appliances

To meet both *achievable* and *aspirational* standards, either energy efficient appliances (washing machine, fridge/freezer, dishwasher, etc) would need to be installed or sufficient information on these products would need to be provided within the new home itself to encourage householders to seriously consider purchasing them. Of course, water efficient appliances are complementary to energy efficiency, as heating water is the main energy use in washing machines and dishwashers. Indeed, the 2005 amendments to Building Regulations Part L would mean that the energy for water heating in new homes will be greater than that used for heating space. A secure drying space to reduce the use of tumble-dryers would also probably be required.

3.2.3 Lighting

Meeting both *achievable* and *aspirational* standards would require energy efficient lighting specified for 100 per cent of internal lighting. This could be achieved by the specification of dedicated light fittings only capable of receiving high efficiency lamps. External lighting fixed to the dwelling should also only take energy efficient lamps or have controls to turn the lamps off when not required.

The likely minimum energy efficiency requirements of moving to *achievable* and *aspirational* standards are summarised in Table 3.3.

Table 3.3 Summary of energy efficiency requirements

Energy component	Baseline	Achievable	Aspirational
Fabric U-values (W/m^{2}K):			
Roof	0.16	0.13	0.08
Walls	0.35	0.25	0.15
Floors	0.25	0.20	0.10
Windows and doors	2.0	1.80	1.50
Boiler (min SEDBUK[1] rating)	78–85%	78–85%	86–89% (condensing)
Lighting (percentage energy efficient fittings)	50%	100%	100%
Appliances	Standard	Low energy	Low energy
Secure drying space	None	Provided	Provided

[1]Seasonal Efficiency of Domestic Boilers in the UK

The standards discussed above are largely based on the EST's *good practice* guidelines. They are comparable to the energy-related credits for carbon dioxide, building fabric, eco-labelled goods and external lighting attainable under the ecohomes system. Our baseline of 2002 Building Regulations would result in four credits being awarded. Meeting *achievable* standards would increase this to five and *aspirational* to six.

3.3 Domestic waste

The average household generates around 23.8 kg of waste each week. While 3.4 kg is recycled, 3.9 kg goes to Civic Amenity sites and a further 1.2 kg goes to other sources, 15.2 kg (63 per cent) goes to landfill or is incinerated (Defra, 2003). A target to recycle or compost 25 per cent of household waste by 2005 was set by the UK's Waste Strategy (Strategy Unit, 2002). This was used as our *achievable* target for domestic waste generation. To meet this, domestic recycling and composting rates would have to rise from their current level of around 17 per cent. This could be most effectively met through the establishment of a local authority recycling scheme for different types of recyclable waste. To encourage recycling by householders, three internal storage bins (for paper/cardboard, plastic, glass and metals) should be provided with a minimum total capacity of 30 litres and no individual bin smaller than 7 litres (BRE, 2003b). All bins should be in a dedicated position, either in a kitchen cupboard or under the sink, or in a utility room or adjacent garage with easy access. Three external bins should also be provided with a minimum total capacity of 180 litres and no individual bin smaller than 40 litres. These should also be in a dedicated hard-standing position within 10 metres of the external door.

Our *aspirational* target ranges from 33 per cent recycling (target for 2015, Strategy Unit 2002) to a long-term target of 100 per cent (such a zero waste to landfill strategy is part of the *Z-squared* philosophy). At the lower end, this would require progressive changes in behaviour but no further recycling facilities in the home (although adequate local waste facilities and a ready market for recycled/recovered materials would be a prerequisite). At the upper end, local anaerobic bio-digesters for sewage sludge and putrescible matter would be required, as well as further behavioural change among occupants to achieve high levels of waste minimisation and separation of wastes. These wastes could also be used to create biogas and fuel a CHP plant, providing the added benefit of reduction in methane emissions (which arise as organic waste decomposes in landfill sites), a greenhouse gas several times more potent than CO_2.

Meeting *achievable* and *aspirational* standards for internal and external storage and provision of recycling facilities would also achieve the ecohomes credit available under this category (BRE, 2003a).

4. Costs of higher resource efficiency standards

Any increased costs of building to higher resource efficiency standards are related to:
- increased costs of design and construction;
- increased costs of higher specification and performance materials, components and appliances;
- costs associated with the design and infrastructure of the development more generally.

We summarise the range of estimates of total costs in Section 4.5. First, in Sections 4.1 to 4.4, we consider some of the components that may affect any cost differential between conventional and more resource efficient homes.

4.1 Costs of water efficiencies

4.1.1 Achievable standards

The cost of *achievable* water efficiencies is insignificant (WWF, 2003b). An Environment Agency report (2003), which is perhaps the most comprehensive report on this subject, shows that there is rarely a positive correlation between costs of fittings and appliances on one hand and water efficiency on the other. Indeed, in some cases the cost of efficient units is less than conventional or standard items. Where water efficient appliances are more expensive, much of the extra cost is due to improved quality and features, with efficiency being a by-product of good design rather than a bolt-on feature with an extra cost attributable to it (Grant, 2002). More expensive appliances tend to be more reliable and demonstrate better overall performance, but they don’t necessarily use less water. Perhaps the only potential extra cost associated with meeting *achievable* standards might be an external water butt for garden use, which would save around 1 per cent of household water use and cost around £20 (BRE, 2003b).

4.1.2 Aspirational standards

There *is* a cost premium in achieving more *aspirational* measures in new build homes. Rainwater harvesting and conservation systems, for example, add around £2,000 per unit for purchase and installation, depending on size. However, manufacturers’ literature suggests that this cost could readily be halved if implemented on a communal basis rather than individually. The operating costs of such systems are minimal, since maintenance simply requires the user to occasionally clean the filter. For a communal system manufacturers claim the annual maintenance and operation cost is unlikely to exceed £300 per year.

The total extra costs of moving to higher water efficiency standards are shown in Table 4.1. This illustrates that the majority of water efficiency improvements in the home are costless.

Table 4.1 Extra cost of enhanced water efficiency standards (£ per unit)

Water use component	Achievable	Aspirational
Low/dual-flush toilet	0	0
Regulated-flow shower	0	0
Reduced size bath	0	0
Flow regulators on taps	0	0
A-rated washing machine[1]	0	0
A-rated dishwasher[1]	0	0
Water butt	20	0
Rainwater harvesting and conservation system	NA	1,000–2,000
Total	**20**	**1,000–2,000**

[1]While A-rated appliances relate to energy and do not necessarily correspond to lowest water use, there is some correlation and it is likely that an ‘A’ energy rating will span the top three bands of any water labelling scheme.

4.2 Costs of energy efficiencies

We saw in Section 3.2 that there are several ways of reducing domestic carbon emissions and the potential costs of meeting higher standards therefore vary significantly. Costs also depend on both the house type and method of construction (masonry or timber-framed). Despite these issues, it is possible to make some broad estimates.

4.2.1 Achievable standards

Reductions in U-values sufficient to meet *achievable* standards could be attained without incurring significant additional financial cost if energy saving features, such as maximising passive solar gain through correct orientation and room layout and appropriate sizing and placement of windows, are designed into homes early on. Reducing carbon emissions by specifying materials and fittings of a higher quality than is typically the case may lead to an additional cost of a few hundred pounds (BRE, 2003b). A project in the West Midlands found that the premium for thermal insulation was around £580 per unit in comparison with current Building Regulations and there was no premium for specifying CFC/HCFC free insulation. Overall, the scheme costs were very competitive with traditional construction, in spite of the prototype nature (Sustainable Homes, 2003).

We have already seen that energy efficient appliances can be bought for no additional cost. The estimated cost of specifying low energy internal and external lighting fittings is around £100 per unit (BRE, 2003b; Environment Agency, 2003).

Overall, *achievable* energy efficiency measures could be met with an additional cost of only around £680 for a typical 3-bedroomed semi-detached house. This estimate is in keeping with the experience of a number of case studies (Sustainable Homes, 2003). It is greater than the premium found by some organisations such as English Partnerships, who have specified ecohomes *very good* for new developments without any significant price impact. The Housing Corporation identified additional energy efficiency costs for social housing to meet the *excellent* standard of just £130 per home (Housing Corporation, 2003).

4.2.2 Aspirational standards

Condensing boilers had, until recently, a capital cost premium of around 15–30 per cent, but the cost has fallen rapidly with advances in technology. Some regular condensing boilers now cost no more than a regular boiler, although in general they still cost up to £320 more (EST, 2003; National Energy Services, 2004).

However, *aspirational* improvements in energy efficiency would also require significant further investment in technologies designed to reduce heating use and heat loss. Some of these micro-infrastructures can be expensive. For example, micro-wind turbines, supplying sufficient energy for domestic needs, cost from £900. Photovoltaics and solar thermal heating systems currently cost between £2,000 and £10,000. However, over 50 per cent of the costs arise from scaffolding for roof mounting and installation (Green Alliance, 2004). If this technology were integrated into new developments at the beginning of the process, these costs would be saved. Installing a combined heat and power (CHP) plant on site would also currently cost several thousand pounds per unit and in addition there are maintenance costs to consider (Sustainable Homes, 2003).

Overall, *aspirational* measures would typically involve an extra cost of approximately £1,000 to £10,000 at current prices for most types of housing unit. This is broadly in line with other estimates to achieve similar increases in efficiency (BRE, 2003b). The large range reflects the number and diversity of measures that are available to improve efficiency (although not all the measures would be required) and the fact that many of the measures are associated with small emerging markets. The extra costs associated with higher energy efficiency standards in new homes are summarised in Table 4.2.

Table 4.2 Extra cost of enhanced energy efficiency standards (£ per unit)

Energy use component	Achievable	Aspirational
Design and layout	0	0
Insulation	580	580
Condensing boiler	-	320
Energy efficient appliances	0	0
Low-energy light fittings	100	100
Micro-wind turbines[1]	-	(900)
Solar water heating[1]	-	(2,500–4,000)
Photovoltaics[1]	-	(2,000–10,000)
CHP plant[1]	-	(4,000–8,000)
Total	**680**	**1,000–10,000**

[1]Not all of these technologies would be required on a single dwelling to meet the standard and these costs are provided for illustrative purposes only.

We would expect many of the costs shown in Table 4.2 to fall significantly as technology develops and as volume increases. Indeed, energy efficiency is a particular area where volume house builders can overcome initial cost obstacles in commercial-scale projects. For example, Green Alliance (2004) estimated that the costs of photovoltaic (PV) systems could fall by 20–30 per cent as the technology matures and production volume increases. The costs of PV systems in Germany and Japan, where the industry is far more advanced as a result of government support and economies of scale, are far lower even than this. Box 4.1 shows, as an illustration, how innovation has led to falling costs for cold domestic appliances.

Box 4.1 Costs and innovation – the case of cold domestic appliances

Cold domestic appliances (refrigerators, freezers and fridge-freezers) consume around 18 per cent of household electricity. UK households spend £1.2 billion worth of electricity every year on refrigeration and freezing. Improvements in efficiency mean that new products consume up to 50 per cent less energy compared to 10 or 15 years ago. New standards came into force in 1999, which meant that appliances (with the exception of chest freezers) have to achieve a minimum class C in the EU energy labelling system. However, the introduction of the minimum standard did not result in an increase in the retail price of appliances and real prices continued to fall. This is shown in Figure 4.1.

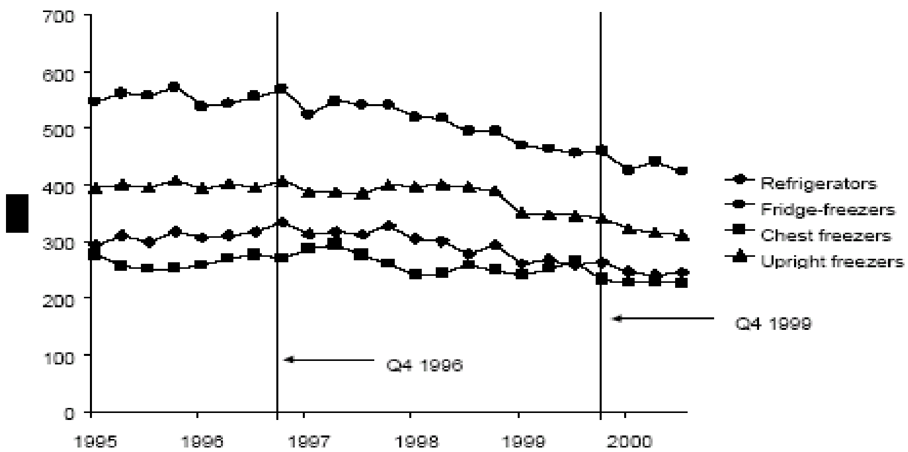

Figure 4.1 The falling cost of cold domestic appliances meeting minimum efficiency standards (£). ***Source: Schiellerup (2002)***

4.3 Costs of waste efficiencies

4.3.1 Achievable standards

Internal waste recycling storage vessels cost approximately £20 per dwelling, while external vessels would cost around £70 plus £10 for the hard-standing area (BRE, 2003b). The establishment of a local authority recycling scheme for new housing developments would involve no direct cost for developers. Once separation habits and a recycling scheme are established, the running costs are likely to be trivial and may even generate revenue for the local authority. The total costs of meeting *achievable* standards are therefore in the region of £100 per unit.

4.3.2 Aspirational standards

The lower end of our target for *aspirational* waste efficiencies could be achieved at similar cost to that outlined above. This would come from a combination of less waste generated and more composting and recycling.

However, as with energy, the costs of meeting waste efficiencies tend to escalate as standards are tightened. Converting waste to energy via gasification CHP would currently add several thousand pounds per unit and anaerobic bio-digesters are generally only considered viable on a large scale (as proposed in the *Z-squared* Thames Gateway development). Given the scale and nature of these uncertainties, deriving estimates of the cost of meeting *aspirational* standards is difficult, but the cost is likely to be of the order of £5,000 to £10,000 per unit (WWF, 2003a; BioRegional, 2004).

4.4 Wider 'system' and infrastructure costs

Some costs associated with higher resource efficiency standards relate not to the fabric of the house itself or its *direct* resource use but to the wider design of the development. These *indirect* costs apply only to *aspirational* standards where changes to the behaviour of householders are required to reduce resource use. While it is difficult to enforce such changes, they can be facilitated and encouraged through a number of measures such as:

- pedestrian and community friendly public spaces;
- ensuring houses are close to bus stops and local amenities;
- well-lit footpaths;
- secure cycle storage;
- car club schemes;
- provision of electric and telephone sockets to facilitate home working.

Most of these improvements can be incorporated at the design stage or agreed with local planning authorities and involve no significant extra cost. Indeed, their inclusion in the development may mean planning permission is easier to obtain. One potential cost relates to the setting up of integrated car club schemes that enable householders to reduce their use of and reliance on private motorised transport. The costs of such schemes are generally covered by members' fees and are discussed further in Section 5.4. Another potential cost relates to safe and secure cycle storage, which amounts to around £100 per unit (E^2S, 2002).

4.5 Total cost of higher standards

The total costs associated with building homes to both *achievable* and *aspirational* resource efficiency standards are summarised in Table 4.3.

Table 4.3 Total extra costs of enhanced resource efficiency standards (£ per housing unit)

Component	Achievable	Aspirational
Water efficiency	20	1,000–2,000
Energy efficiency	680	1,000–10,000
Waste reductions	100	5,000–10,000
System costs	-	100
Total	**800**	**7,100–22,100**

Table 4.3 shows that *achievable* standards of resource efficiency could be met at relatively low cost and that, for water and waste, such standards could be achieved with virtually no cost premium. This is particularly likely to be the case when improvements are designed into developments early in the process and efficient fittings and appliances are sought out.

This is largely in line with previous findings. A number of studies have concluded that the costs of achieving ecohomes *good* or *very good* are small, particularly if site-specific credits related to transport, land use and so on can be obtained (E^2S, 2002; BRE, 2003b; WWF, 2003b). For example, Sustainable Homes (2003) estimate that a *good* rating can be achieved for less than £200 per unit, while a *very good* rating could add up to £1,400.

Similar results have been found in other countries. Kats (2003) studied experience in the USA and found that the average premium for green buildings compared to conventional design was slightly less than 2 per cent. The majority of this cost was due to the increased architectural and engineering design time, modelling costs and time necessary to integrate sustainable building practices into projects. Kats also found that the cost of green design has dropped in the last few years as the number of green buildings has risen.

Table 4.3 also shows that the costs of meeting more *aspirational* resource efficiency standards are likely to be in the region of several thousand pounds. However, efficiencies towards the top end of this range would involve significant investments in micro-infrastructure on top of expenditures within the homes themselves. Furthermore, numerous case studies have concluded that these costs are likely to fall sharply as technological advances and economies of scale associated with bulk purchasing and efficiency gains enable them to be implemented across a much larger area. We therefore believe that the lower end of this range is likely to be most appropriate when considering the cost-effectiveness of enhanced standards.

The estimates for *aspirational* standards outlined here are generally higher than those in previous studies for achieving high environmental standards, but this reflects the fact that the standards we have described are very rigorous. For example, the costs of obtaining an *excellent* ecohomes rating are generally estimated to range from about £2,000 to £10,000 per unit, depending on whether site-specific credits are included (E^2S, 2002; Sustainable Homes, 2003; WWF, 2003b). In one large case study, an *excellent* rating cost around 12 per cent more than conventional homes (approximately £12,000 per unit), but this does not take into account the special features of the site (piled foundations) and other special design features (Gallions Ecopark in Thamesmead, 2004). Again, the authors conclude that, in a larger scheme with greater economies of scale, it should be possible to reduce this to £6,000 to £9,000. Finally, preliminary cost calculations by BioRegional (2004) suggest that the net incremental cost of building to *Z-squared* standards (similar to the upper end of our *aspirational* standard) in the Thames Gateway will be around £8,000 per unit. It should be noted, however, that the planned infrastructure will also support a primary and secondary school and nursery facilities, a health centre, leisure facilities (including a swimming pool), offices, shops and a supermarket.

5. Benefits of higher resource efficiency standards

Possible financial and social benefits of higher resource efficiency savings in homes include:

- reduced operational costs of homes (lower utility bills);
- knock-on effect of a reduction of the number of people and households in fuel and water poverty;
- reduced transport costs;
- retained value in the house if it outperforms the 'mainstream' market;
- reduced macro-infrastructure requirements;
- improved health of householders;
- environmental benefits from reduced pollution and resource use.

The main direct financial benefits from the efficiencies described in Section 3 will come from reduced water and energy bills, and these are discussed in Section 5.1.[4] Related to this is the main social benefit arising from higher standards, that of reducing the number of people in fuel or water poverty. This is the subject of Section 5.2. Other possible financial benefits relate to retained value in the house and to transport costs. We look at these in Sections 5.3 and 5.4. There are also potential financial benefits from higher standards in terms of reduced need for macro-infrastructure and this is discussed in Section 5.5. Finally, a number of less tangible benefits, relating to health, society and the environment, could follow from higher standards and these are touched on in Section 5.6 before we summarise the total benefits in Section 5.7.

5.1 Reduced water and energy bills

In the five years from April 2005, average household water bills in England and Wales will increase 18 per cent by £46 from £249 to £295 per year (Ofwat, 2004), with an average increase of £21 in the first year (2005). Average household gas and electricity bills are around £320 and £235 respectively (Ofgem, 2003). However, this figure is based on existing UK homes (the majority of which would not pass current Building Regulations) and hence is not representative of new homes. Average household bills in conventional new houses built to 2002 Building Regulations are likely to be around £232 and £170 respectively, approximately 25 per cent lower than previous good practice (WWF, 2003b).

5.1.1 Achievable standards

It is estimated that the 25 per cent or so water efficiency savings from moving to *achievable* standards could save metered homeowners around £55 a year without changing their lifestyles (Environment Agency, 2003).

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[4] Reducing waste generation may alleviate local authority expenditure and have a medium-term effect on council tax bills but this is unlikely to be significant and is not discussed here.

Reducing energy use by building new homes to Energy Saving Trust (EST) *best practice* standards (comparable to our *achievable* standard) would lower fuel bills by up to £83 per year compared to 2002 Building Regulations depending on house type (EST, 2003).

An example of the net savings in fuel costs from condensing boilers is shown in Figure 5.1.

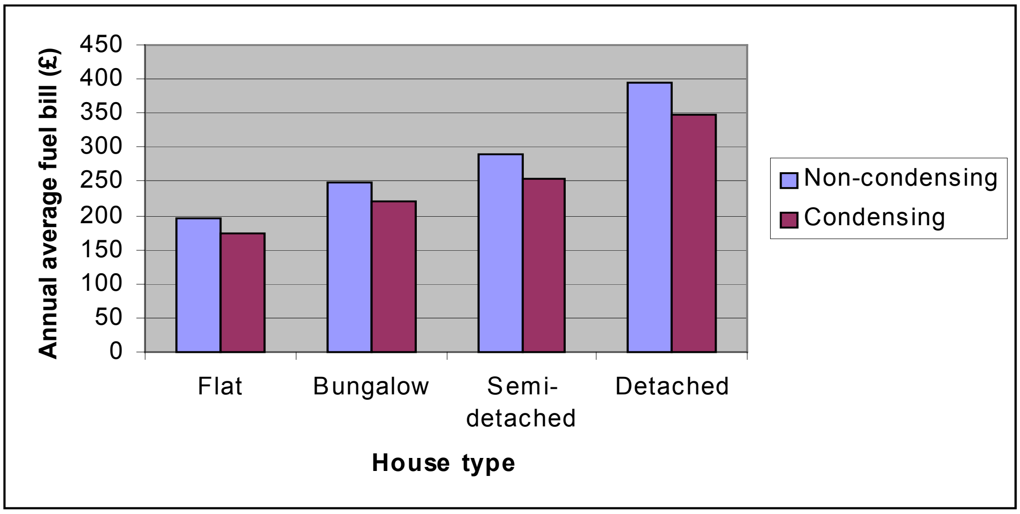

Figure 5.1 Annual average fuel bills by boiler type. ***Source: EST (2003)***

5.1.2 Aspirational standards

Further improvements in water efficiency could result in water savings of up to about 50 per cent and reduce average bills by £88 a year, depending on changes in consumer behaviour (Environment Agency, 2003).

In terms of energy bills, efficiencies to meet the EST's *advanced best practice* standards (comparable to the lower end of our *aspirational* standards) could reduce annual bills by up to £108 (EST, 2003). Measures at the upper end of the standard to generate some or all of domestic energy needs on site could eliminate fuel bills altogether or lead to a financial gain if surplus energy is sold back to the National Grid. This would mean a financial benefit to the householder of at least £402 per year.

5.2 Reduced fuel and water poverty

Consumption of energy and water in poorer households is disproportionately high in relation to their income (Ekins and Dresner, 2004). For example, the poorest 20 per cent of the population spend three times as much of their income on fuel as the wealthiest 20 per cent. A fuel poor household is defined as one that cannot sustain reasonable heat (21°C in the living room, 18°C in the rest of the house) at a reasonable cost (<10 per cent of income). There are four main causes of fuel poverty: energy inefficient dwellings, low incomes, under occupancy and the cost of fuel. Improving the energy efficiency of a dwelling is the most cost-effective way to take a household out of fuel poverty (EST, 2003).

In the UK, there are an estimated 2.5 million households in fuel poverty, a fall from 5.5 million in 1996, although this is primarily due to reductions in energy costs rather than increased energy efficiency. However, recent rises of around 10 per cent in energy prices may push an extra 500,000 people into fuel poverty (Fuel Poverty Advisory Group, 2004). Fifty per cent of fuel poor households contain people over 60 years old and 20 per cent house children. There are estimated to be 20,000–50,000 excess deaths in the UK between December and March each year and a significant proportion of these relate to fuel poverty. Contributory causes include respiratory disease, heart disease, domestic accidents, and problems of immobility and social isolation. The Government, in its Energy White Paper, has expressed its aims of ensuring that every home is adequately and affordably heated with nobody living in fuel poverty by 2016–2018.

While the situation for water is less critical, affordability issues are still a concern. Water affordability is one of Defra's sustainability indicators and there are still around 9 per cent of UK households spending more than 3 per cent of total household income on water charges (Defra, 2004).

Clearly, without information on occupants, demolition rates for existing stock, etc, it is difficult to determine the extent to which building more resource efficient houses may affect the number of fuel and water poor households. Nevertheless, as fuel and water prices increase, it seems likely that such efficiency improvements could play a significant role in tackling a major social problem.

5.3 Retained value

There is demonstrable consumer demand for more sustainable homes. Research undertaken by WWF, the Commission for Architecture and the Built Environment (CABE) and the Halifax Building Society found that 87 per cent of respondents wanted to know the environmental rating of a home they were considering buying, in order to help them make an informed decision. Furthermore, 84 per cent of people said they would be willing to pay an average 2 per cent more on the purchase price for a sustainable home (WWF, 2003b). In another survey, British Gas found that house hunters would pay up to £3,200 extra for an energy efficient 'green' home (British Gas, 2004).

A study by Mulholland (2004) showed that these premiums are indeed real and that buyers will pay up to 20 per cent more for innovative design and 'green' features such as those at the BedZED development (see Table 5.2).

Table 5.2 Estimated value of houses built to higher resource efficiency standards

Unit type	Average current sales (Aug 2003)		% difference
	Local market	BedZED (estimated)	
1 bed flat	£125,000	£150,000	20.0
2 bed flat	£175,000	£190,000	8.6
3 bed flat/terraced house	£225,000	£265,000	17.8
4 bed semi	£300,000	£350,000	17.8
Average	**£206,250**	**£238,750**	**15.8**

Source: Mulholland (2004)

However, while it is clear that homes of a higher environmental standard do command a premium, the reasons for this are less obvious. Often, the product is quite different in terms of design and overall quality, as well as environmental performance. These factors combine to generate a certain ‘feel’ associated with the development, which attracts a niche market, keen perhaps to live according to their principles or to stand out from the crowd. These difficulties in separating out the reduced resource use element mean that we have not attempted to place monetary values on this aspect of benefits.

5.4 Reduced transport costs

Government data states that the average weekly household bill for transport (including the purchase of vehicles, associated running costs, insurance and spending on public transport) is approximately £81 in the South East (ONS, 2002). This suggests an annual bill of around £1,600 per person. More resource efficient households and communities mean that people are likely to limit their use of private cars and travel less distance overall. This is because other modes of transport are encouraged and because work and amenities may be closer at hand.

Data in this area is mixed. BioRegional (1999) found that, in London, transport costs associated with developments of a higher environmental standard could actually rise if the household increases its use of public transport but continues to run a car. However, they also calculate that BedZED residents with an annual mileage of 11,000–13,000 km who give up a private car to join the car pool and increase walking, cycling and public transport use would be better off by £522 per year, net of car club membership costs. Such savings are likely to be associated with more *aspirational* type developments only, as car parking and the role of the private car is likely to be restricted on such developments. We therefore include this benefit with *aspirational* housing types only.

5.5 Reduced macro-infrastructure requirements

Building to higher resource efficiency standards reduces the need to invest in new macro (off-site) electricity generating and distribution infrastructure, waste landfill capacity and water supply and wastewater treatment facilities. This is particularly the case with the higher end of resource efficiency standards, where micro-infrastructure may even replace entirely the need for off-site facilities.

To illustrate the potential savings, in the absence of reducing existing demand it is estimated that water companies will need to invest between £3,000 million and £6,000 million up to 2031 to provide additional supply and wastewater disposal to new homes (Environment Agency, 2003). WWF (2003b) estimated that incorporating environmental considerations in the Thames Gateway could reduce the expected infrastructure costs of £1.2 billion per year by between 2 and 10 per cent. BioRegional (2004) estimated that, by implementing *Z-squared* principles across just 50 per cent of the Thames Gateway (bringing energy generation on-site, treating waste water locally and maximising re-use, recycling and recovering energy from waste), the annual benefit of reduced capital investment is more than £2 million per year. Over a 30-year period, the economic benefit would be in excess of £1 billion.

Of course, some of the direct financial savings associated with such reductions have already been reflected in lower utility bills for new homes, discussed in Section 5.1. Adding infrastructural savings would therefore involve a degree of double-counting. Nevertheless, utility companies generally incorporate new infrastructure needs into their long-term planning. Since new homes would only be a small part of all homes supplied by the company, most of the money to pay for this may, subject to consideration by the appropriate regulator, come from increases in the bills of existing customers. Such increases would be mitigated if fewer or smaller facilities were required.

There are also other benefits from reduced macro-infrastructure that we have not included and which are not currently captured within the financial framework of the marketplace. These include health and environmental benefits and these are discussed further in the next section.

Overall, given the difficulty of quantifying the benefits described above, we have not, at this stage, attempted to attach monetary estimates to them in the current framework. But this is an area where we are undertaking further investigation (see Section 5.6.2) and where we have identified a need for further information.

5.6 Other benefits

There are other (largely external and less tangible) potential benefits associated with building new homes to enhanced resource efficiency standards. While it is currently difficult to quantify these in any meaningful sense or to relate them specifically to our measures of improved standards, they are nonetheless potentially very important and should therefore be taken into consideration.

5.6.1 Improved health

Building homes to higher resource efficiency standards is likely to make people more aware of environmental issues. Particularly if the infrastructure of the community is favourable (e.g. increased access to, and use of, green spaces), this may lead to increased use of bicycles, walking and public transport compared to the private car. The overall need for journeys and transport may also fall if developments were planned so that people live near jobs, goods and services. This could provide real benefits in terms of mental health and adding years of healthy life to individuals, both through increased exercise and improved air quality (a major factor in respiratory diseases and a direct cause of around 20,000 deaths each year in the UK). It would also cut the number of traffic accidents, a major cause of death in many 'traditional' neighbourhoods, and reduce pressure on the National Health Service.

CABE (2002) estimated that more money (as much as £2 billion per year) is spent on treating illnesses arising from poor housing conditions than is spent by local authorities on their own housing stock. National annual estimates of the increased costs associated with the 7.6 per cent of public sector homes considered unfit for habitation are £3 billion due to poor health, £1.8 billion due to increased crime and £120 million for the cost of fire services. Although not definitive figures, they show the extent of the problem.

If a development is designed to be resource efficient and promotes a greater sense of community, this is likely to increase citizen participation in all aspects of the community. This is important in terms of nurturing social capital, possibly reducing the incidence of depression. An increased sense of community can also reduce levels of antisocial behaviour and crime, anxiety about which is often cited as a cause of ill health. For example, the proposed *Z-squared* development in the Thames Gateway will be designed to be 'people-friendly' with safe areas for walking and cycling, play areas for children and a mixture of facilities to promote street life, such as outdoor events in summer, cafes and a farmers' market.

Global health benefits would also accrue from more sustainable communities. These would include a contribution to climate change mitigation. Climate change is associated with many adverse environmental and health consequences, although most of these relate to people living in the poorer areas of the world.

Of course, it should be remembered that many of these benefits largely relate to the design of the development in general rather than the efficiency of the homes themselves.

5.6.2 Environmental benefits

In parallel with this report, we are carrying out a project looking at the reduced environmental impact associated with higher building standards for new homes. We plan to use the results of this project to quantify some of the benefits from such standards. These include:

- Reduced CO_2 emissions from lower and more efficient energy use. The Government's own Energy White Paper indicates that a reduction of 4–6 million tonnes of carbon per annum could be achieved through greater energy efficiency in our homes. This would help meet the Government's target of a 60 per cent reduction in emissions by 2050.
- Reduced water abstractions, alleviating the pressure on resources already stretched in the South East. Indeed, where water availability is a limiting factor to development, the scale and pace of development could increase if less water is used. There is therefore a greater likelihood of more homes being constructed more quickly and easily if they are water efficient.
- Less water abstraction would also mean fewer low-flow occurrences. Low flow can, subject to permitting limits and other legislation, have negative effects on water quality and on the ecology and amenity of waterways. Rainwater harvesting

associated with *aspirational* standards would have additional environmental benefits of controlling storm-water run-off and reducing flood risk.
- Reduced water use would also have a significant impact on energy use, since the water industry is one of the biggest consumers of energy in the UK.
- Reduced waste going to landfill or being incinerated. As well as domestic waste, this may also apply to construction, demolition and earthworks waste if sustainable principles are applied to new developments more generally.
- Reduced flood risk if new developments within floodplain areas are designed to allow sufficient areas for flood storage and flood flow routes, leading to avoided insurance costs for householders. Of course, if development is necessary in the floodplain for overriding social, economic or environmental reasons, then any house built there *must* be designed and installed with all relevant flood resilience measures. In addition, proper siting and design can achieve multiple community benefits, not only flood avoidance and resilience but also nature conservation, open space and amenity.
- Reduced effect on biodiversity if new developments incorporate more green space or are built at higher densities.

The most comprehensive study to date of the environmental effects of new housing was undertaken for Defra by Entec (2004). Among the report's main findings were:
- some 200 million tonnes of CO_2 emissions per year could be avoided if homes were built to ecohomes *excellent* standard, avoiding external costs of the order of £2.9 billion;
- achieving this standard could result in savings from waste going to landfill of £19 million per year.

In a separate report, WWF (2003a) demonstrate the benefit of developing 200,000 new homes in the Thames Gateway to a minimum of ecohomes *very good* standard (broadly equivalent to our *achievable* standard). While no attempt was made to monetise (place monetary values) on the external benefits associated with the reduced resource use, the report estimated that the following savings could be made when compared with homes built to current Building Regulations:
- 32 per cent reduction in CO_2 emissions from energy use in the home;
- 39 per cent reduction in water use;
- up to 25 per cent reduction in the amount of household waste sent to landfill.

In addition, developing all homes in the Thames Gateway to *Z-squared* standards (the upper end of our *aspirational* standard) could make even greater savings:
- 99 per cent reduction in CO_2 emissions from energy use in the home;
- 65 per cent reduction in water use;
- 76 per cent reduction in the amount of household waste sent to landfill.

5.7 Total benefits

The total monetised and non-monetised financial benefits associated with building homes to *achievable* and *aspirational* resource efficiency standards are summarised in Table 5.3.

Table 5.3 Total benefits of enhanced resource efficiency standards

Component	Monetised benefits		Non-monetised benefits
	Achievable (£ per unit)	**Aspirational** (£ per unit)	
Reduced water bills (per year)	55	88	-
Reduced fuel bills (per year)	83	108–402	-
Reduced fuel/water poverty	-	-	Fewer people in fuel/water poverty
Retained value	-	-	8–20% premium on house price
Reduced transport costs (per year)	-	522	-
Reduced macro-infrastructure costs	-	-	Reduced bills for existing customers
Improved health	-	-	Reductions in respiratory and heart diseases, traffic accidents
Environmental benefits	-	-	Reduced CO_2 emissions, pressure on water, waste, flood risk and effects on biodiversity
Total benefits (per year)	**138**	**718–1,012**	**-**

Table 5.3 shows that the annual quantifiable benefits associated with building new homes to enhanced resource efficiency standards could be in the region of £140 per household for *achievable* standards but up to more than £1,000 per household for the more stringent *aspirational* standards. For the former, these savings are made up entirely of reductions in utility bills, while, for the latter, household savings on transport costs become the dominant benefit.

These estimates are similar to those found in earlier work. For example, BRE (2003b) found that the reduction in bills for efficiencies comparable to our *achievable* standard would be around £70 per year. However, they acknowledge that this 'is based on limited data and should be considered as an example of the potential savings that are achievable'. BioRegional (1999) estimated that BedZED residents achieve utility bill savings of around 25 per cent compared to a typical home, similar to that for our *aspirational* standard.

6. Summary of impacts

Clearly, the costs of higher resource efficiency standards identified in Section 4 fall at the beginning of the development project while the benefits accrue annually as a stream into the future. To make these comparable, we need to capitalise annual benefits.[5] All benefits that can be monetised are *private* benefits accruing to householders. Therefore, to reflect both average private mortgage-type borrowing costs as well as wider societal preferences, we discounted future benefits at both the Bank of England base rate of 4.75 per cent and the Treasury rate of 3.5 per cent.[6] This gives the total benefits. Table 6.1 shows how these benefits compare with the costs over 25 years, corresponding approximately to both the average mortgage term and the end date of the Sustainable Communities Plan.

Table 6.1 Costs and discounted benefits of higher resource efficiency standards (£ per unit)

Costs/benefits	Type	Achievable	Aspirational
Costs	Water efficiency	20	1,000–2,000
	Energy efficiency	680	1,000–10,000
	Waste reductions	100	5,000–10,000
	System costs	-	100
Benefits	Reduced water bills (per year)	55	88
	Reduced fuel bills (per year)	83	108–402
	Reduced fuel/water poverty	Fewer people in fuel/water poverty	
	Retained value	8–20% premium on house price	
	Reduced transport costs (per year)	-	522
	Reduced macro-infrastructure costs	Reduced bills for existing customers	
	Improved health	Reductions in respiratory and heart diseases, traffic accidents	
	Environmental benefits	Reduced CO_2 emissions, pressure on water, waste, flood risk and effects on biodiversity	
Total costs		**800**	**7,100–22,100**
Total monetised benefits (per year)		**138**	**718–1,012**
Benefits over 25 years at 3.5% discount rate		**2,274**	**11,834–16,679**
Benefits over 25 years at 4.75% discount rate		**1,995**	**10,378–14,627**

[5] Issues surrounding who benefits from higher standards and who is expected to pick up the cost are dealt with in Section 7.2.

[6] The formula to do this is: *Total benefits* =

$$B * \left[\frac{1 - \left(\frac{1}{1 + r} \right)^t}{r} \right]$$

where: *B* = initial benefits (year 1), *t* = last year of benefits, *r* = discount rate.

Table 6.1 shows that, if *achievable* standards are met, the total benefits after 25 years will definitely be greater than costs. If *aspirational* standards are met, the total benefits after 25 years will be within the range of costs. The year-on-year change in total net benefits (discounted benefits minus costs) for *achievable* standards using a 3.5 per cent discount rate can be seen in Figure 6.1.

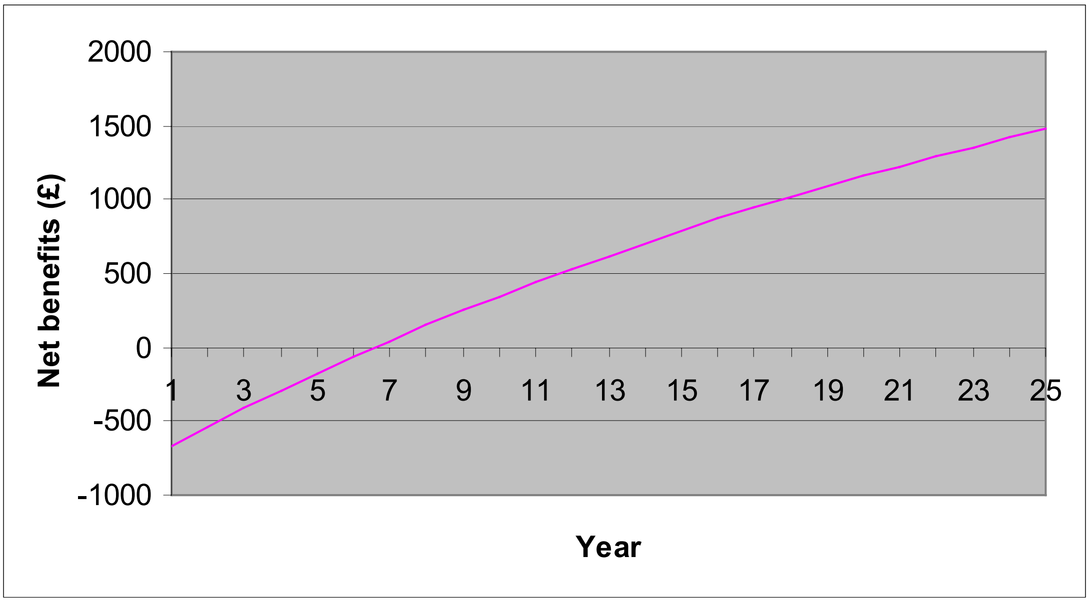

Figure 6.1 Net benefits of *achievable* standards over 25 years (3.5% discount rate)

Figure 6.1 shows that net benefits of achievable standards become positive before seven years. They increase gradually to nearly £1,500 per household by year 25. For *aspirational* standards, costs will outweigh benefits each year if we look at the high estimates of benefits and costs. But using the low estimates, benefits outweigh costs from year 13 using a 3.5 per cent discount rate (year 14 using a 4.75 per cent rate).

7. Implementation issues

We have shown that some degree of resource efficiency improvement is almost certainly worthwhile from a purely financial and social perspective. However, actually implementing higher standards requires a consideration of two key issues:

- What instruments are available to force or encourage the adoption of the standards?
- Who bears the additional cost (if any) and who benefits?

7.1 Instruments for achieving higher standards

A great deal of work has already been done on the different means that could be used to promote resource efficiency and the benefits of more efficient homes (see, for example, WWF, 2002; SBTG, 2004). These instruments can be broadly classified into four categories:

1 Information
This covers the labelling of more efficient appliances, home information packs detailing the environmental performance of the home, the Code for Sustainable Buildings, etc.

2 Regulation and standards
These include the tightening of Building Regulations, planning legislation and controls, Section 106 agreements, etc.

3 Financial incentives and economic instruments
Measures here might include the reduction or removal of VAT on more efficient products, product charges on non-sustainable building materials and equipment, tariff structures with seasonal or peak use charges, the lowering of stamp duty or council tax on homes built to higher standards, subsidies for the installation of sustainable equipment and preferable rate mortgages or the reintroduction of MIRAS for resource efficient homes.

4 Government-led procurement
If the public sector took the lead in requiring all its building projects, including housing, to meet higher standards of resource efficiency, this would accelerate the pace of innovation and lead to enhanced standards becoming mainstream more quickly, helping to bring costs down.

7.2 Who benefits from and pays for higher standards?

Most of the benefits from higher resource efficiency standards that we have identified in this report accrue to the householder. Reductions in waste may benefit the local authority, while some benefits, discussed in Section 5.6, accrue to wider society or the environment. The situation for costs, however, is less clear-cut. In fact, the answer to the question of who pays depends crucially on the instrument used to improve resource standards.

1 Information

If higher standards are brought about through information and labelling, it is likely that the consumer (householder) will pay any price premium for the environmentally superior product or service. Indeed, we saw in Section 5.3 that homes distinguishable from the mainstream as a result of higher resource efficiency standards or general environmental performance can command a significant premium. The key problems are persuading developers that the cost of higher standards can be recouped and ensuring that householders take account of future benefits in their purchasing decision so that they will be prepared to pay or borrow more to meet the additional costs. Again, providing sufficient information on the benefits may help overcome these issues.

If the householder does pay for the higher standards, the additional mortgage costs can be small. For example, an extra £800 associated with *achievable* standards would add approximately £4 per month (£48 per year) onto a typical £100,000 mortgage. This compares to £138 per year in reduced bills. The extra £7,100 to £22,100 associated with *aspirational* standards would add between £40 and £125 per month (£480 to £1,500 per year) to the same mortgage. At the lower end of this range, the annual benefits of £718 would mean the householder was better off, while at the upper end the annual benefits of £1,012 would mean the householder was worse off financially.

2 Regulation and standards

Where higher standards are achieved through nationwide regulation and standards, the developer will initially have to pay any increased cost. However, particularly at a time when the housing market is slowing and profits are reduced, they will attempt to pass this on in one of two ways. The first would be to pay a reduced price for the land. Assuming the standards affect all new developments equally, this would be the rational response of developers, and landowners would have little choice but to accept this. This was a finding of the Barker Review, which argued that the UK house-building industry is essentially based on supply and that the price of houses on new developments would be unaffected by the tightening of regulations or new standards. The second applies where the supply of new homes is restricted or where the developer can use the environmental credentials of the houses to differentiate them from conventional homes. In this case, any increased cost may be passed on to the house buyer through a higher selling price.

In addition to any nationwide regulations and standards to which new housing has to conform, local planning authorities may also impose restrictions or requirements on developments. When planning restrictions are tight, developers may try to seek some concession from the local authority in return for higher standards. This may be a reduced level of negotiated planning gain, a mechanism under which a developer is permitted by the local authority to increase development in exchange for funding or providing infrastructure or local services or meeting agreed environmental targets as part of a green transport strategy. For example, around 35 per cent of the higher costs on the BedZED development were recouped by the fact that stringent environmental standards meant that many more units were permitted (BioRegional, 2002). The incorporation of a car pool scheme also meant that the local authority required fewer parking spaces. If the contribution to planning gain is reduced in this way, some of the costs of higher standards may accrue to the local authority and they will need to plug any subsequent gap in infrastructural funding. However, as we saw in Section 5.5, this is likely to be offset by the fact that less infrastructure would be required.

Even if the developer did shoulder some of the increased cost, this needs to be weighed against the fact that, as well as making it easier to obtain planning permission, there are several potential benefits to the developer from building to enhanced resource efficiency standards. These are:

- Potential waste reductions associated with the construction process. The construction sector produces 151 million tonnes of waste each year – three times the waste produced each year by all the UK's households combined. About 13 million tonnes is material delivered to site that is never used. During the construction of Greenwich Millennium Village, halving the waste produced and segregating it for recycling realised savings of £524 per home or a total of £150,000 over the first two phases of the project (BRE, 2003b).
- Demonstration of sustainability credentials to local authorities, investors and consumers.
- Enhanced employee relations in terms of reduced staff turnover, improved loyalty, more motivated employees, improved productivity, broader and improved skills base, higher client satisfaction, and so on. This is particularly important since the Construction Industry Training Board estimates that some 370,000 new employees need to be recruited and trained if the UK property sector is to grow successfully (CITB, 2003).
- Added value and performance against competitors (competitive advantage), if the developer can establish a position as a market leader in developing sustainable homes.
- Getting ahead of likely forthcoming new regulations and legislation (e.g. Building Regulations).

3 Financial incentives and economic instruments

When financial or economic incentives are used to encourage higher resource efficiency standards, it is likely to be the general taxpayer who picks up the bill. This may seem unreasonable if most of the benefits accrue to private householders. However, such redistribution could be justified since the resource savings reduce externalities associated with new housing that would otherwise fall on (and be paid for by) the local or national population. In addition, since poorer households tend to benefit most from reduced utility bills (as these make up a greater proportion of their income), such a redistribution may be seen as desirable.

4 Government-led procurement

Once again, in this case, the costs of higher resource efficiency standards would fall on the public sector and the taxpayer. The same arguments as those set out above therefore apply. This approach has already been adopted by a number of local authorities. For example, Merton Borough Council in London is funding a network of district combined heat and power (CHP) plants. By being in a position to consider the longer-term costs and benefits of such projects, they have shown that the costs of such schemes can be offset by future benefits to the region and businesses.

8. Conclusions and recommendations

Our results suggest that, in terms of reductions of utility bills alone, the payback period for *achievable*-type standards is less than the seven-year average stay in a house. For *aspirational* standards, the payback period is at least 13 years. These findings are similar to those found for specific efficiencies by others. The Energy Saving Trust, for example, found that the payback period for condensing boilers is between 0 and 4 years (EST, 2003). WWF (2003b) calculated that the payback period for reaching ecohomes *very good* standard (broadly equivalent to our *achievable* standard) is 2 to 5 years. And Environment Agency (2003) found that the payback period for good quality domestic rainwater harvesting and storage systems (necessary to reach *aspirational* standards) is around 10 to 15 years.

Any additional costs associated with higher resource efficiency standards are likely to be reflected in lower land prices, and the price of houses on new developments would probably be unaffected. The benefits of higher standards largely accrue to the householder and enhanced standards will therefore significantly improve the affordability of new homes.

Of course, we have only quantified a proportion of potential benefits. The environmental benefits of higher resource efficiency standards in particular are likely to be very significant. If we were able to place monetary values on some of these other categories of benefits, the wider financial case for *achievable* standards would almost certainly be unequivocal and that for *aspirational* would be far more favourable, perhaps to the extent that the benefits outweigh the costs under all scenarios. Indeed, this is in line with RSPB (2005), which concluded that, once external environmental costs are taken into account, the benefits from reduced energy use of building to ecohomes *excellent* standard are six times greater than the costs.

Nevertheless, it is clear that, simply looking at the effect on utility bills alone, there is a strong argument for improving the resource efficiency standards of new homes. In addition, as the cost of enhanced standards falls with technological development and economies of scale, and as utility bills continue to rise, failing to invest sufficiently in more resource efficient housing now would forego significant benefits to households, society and the environment. Investments now would also avoid costly corrective measures later.

Therefore, we believe that the 25 per cent or so resource efficiency improvements associated with *achievable* standards should be incorporated into the current proposed amendments to the Building Regulations and that the Code for Sustainable Buildings should be set at standards above these. In addition, the Government should make it clear that Regulations will be tightened further over the next 10 to 15 years, such that our *aspirational* standards become the norm and housing developments as wider systems become more sustainable. This would stimulate innovation and bring costs down sharply. It would also be in line with the sentiment expressed in October 2003 by the Secretary of State for Trade and Industry, Patricia Hewitt, at the Better Buildings Summit:

> *Micro-generation has to become the norm, not the exception*.

As well as highlighting the financial imperative of moving to improved resource efficiency standards in new homes, a major contribution of this report has been to demonstrate a number of gaps in current knowledge where further research and case study work would be useful. In particular, we would suggest that, to help inform future housing policy, research and development in this area focuses on five main themes:

- The clarification of resource efficiency standards that are (or within a short time are likely to become) economically feasible and the impact that such standards could have on the issues we have discussed. This would help narrow the range associated with our *aspirational* standards and inform future changes and amendments to the Building Regulations, the Code for Sustainable Buildings (CSB), etc.
- Improved information on the costs of meeting these standards. In particular, estimates of the costs of micro-infrastructure and the resultant savings in macro-infrastructure need to be improved.
- An examination of the incentive mechanisms for micro-infrastructure, who pays, who benefits, etc. This should link to the current debate on the reform of developer contributions (Section 106 agreements) and the proposed Planning Gain Supplement.
- The relative contribution to resource efficiency savings of building new homes to higher standards compared to retrofitting in the existing stock.
- The implications of climate change for standards, their costs and benefits, and the potential costs of corrective measures if standards are not improved.

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