Communities and Local Government

Cost of building to the Code for Sustainable Homes

Updated cost review

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Element Energy

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August 2011
Department for Communities and Local Government

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This report was prepared by Element Energy and Davis Langdon.

1 Summary

1.1 Overview

The Code for Sustainable Homes is the national standard for assessing the sustainability of new housing in England, Wales and Northern Ireland. The Code was introduced in 2007 as a voluntary standard, measuring the sustainability of homes against nine design categories and providing a rating on a six star system (the six Code levels).

The purpose of this study is to update the two previous Code cost reports, based on a much larger availability of market-tested industry data.

In summary, this study seeks to:

- Identify the solutions that home builders typically adopt to achieve credits under the various Code issues and the costs associated with each issue.
- Understand the approaches typically taken by home builders to achieve each Code level and how these approaches are influenced by the characteristics of a development.
- Understand the additional costs that home builders have typically incurred in achieving each Code Level, how these costs vary between types of dwelling and depending on the nature of the development.
- Identify how Code costs have changed since introduction of the standard and provide insights into how they might change in the future.

1.2 Study methodology

The findings of this study are based on a consultation with home builders combined with an analytical cost modelling exercise. The consultation was completed over the period from August to October 2010. Twelve home building companies from a range of scales and locations were interviewed to gather their experience of building to the Code policy (see Appendix E). The group included a mix of private market and social housing builders.

The issue-level cost dataset obtained through the consultation was fed into a Code cost model. This model was developed to derive overall Code extra-over costs from the issue level cost data for the standard dwelling and development types.

The model was used to produce Code cost estimates for four standard dwelling types – a two-bed flat, two-bed terraced house, three-bed semi-detached and four-bed detached house. These basic dwelling types were combined to create five representative development scenarios, differing by number of dwellings, density, dwelling mix and green or brownfield. The development scenarios are defined in the table below:

Table 1: Description of the five development scenarios in terms of scale (total number of dwellings) and composition by dwelling type (B = Brownfield, G = Greenfield)

Development scenarios	Type	Scale (N° dwellings)	Density (dwelling/ha)	Dwelling mix (% of total dwellings)			
				Two-bed flat	two-bed terrace	Three-bed semi	Four-bed detached
Small Brownfield	B	20	40	0%	40%	40%	20%
City infill	B	40	150	100%	0%	0%	0%
Edge of town	G	100	40	24%	30%	30%	16%
Strategic greenfield	G	2,000	40	10%	30%	30%	20%
Urban regeneration	B	2,000	150	70%	20%	5%	5%

All Code costs presented in this report are extra-over costs, i.e. they are the costs for achieving the Code level (or individual Code credit) over the cost of building to the baseline building specification.

An important point to note is that throughout this study (unless otherwise indicated), the cost of constructing a Part L 2006 compliant building has been taken as the baseline from which the extra-over costs are measured. This is because few dwellings had been constructed to the recently introduced Part L 2010 standard at the time the research was conducted, and the extra-over cost data provided by developers through the consultation was with reference to a Part L 2006 baseline. Future Code cost work will be expressed wholly in terms of Part L 2010.

To illustrate the change to Code extra-over costs resulting from the introduction of Part L 2010, the key cost results section presents costs relative to both a Part L 2006 and Part L 2010 baseline (see Sections 1.4.1 and 1.4.2 respectively).

1.3 Major drivers of Code costs

1.3.1 THE MANDATORY DWELLING EMISSIONS RATE

A significant fraction of the costs of building to Code standards are incurred under the Energy and CO_2 category of the Code. Within the Energy and CO_2 category, a large part of the spending is related to the energy solutions adopted in order to meet the mandatory Dwelling Emissions Rate (dwelling emission rate) standards set out under issue Ene 1 of the Code.

The consultation with home builders has revealed a relatively homogeneous approach to date across the industry to achieve the Code level 3 dwelling emission rate standard. **Typically meeting Code 3 requirements has involved improvement of the building fabric in combination with a solar thermal system or small PV array.** The Code level dwelling emission rate standard can be achieved through fabric improvement alone at a similar extra-over cost to strategies involving low carbon generation and several home builders cited a preference to avoid installing generator technologies on grounds of simplicity.

With the adoption of Code level 3 dwelling emission rate standard as the minimum requirement of Part L (through the 2010 revision), a fabric only approach at Code level 3 may become the norm.

There was significantly less experience of building to Code level 4 and so standardised approaches were more difficult to discern. **To achieve the Code Level 4 dwelling emission rate standard, the common approach seems to be a further improvement in fabric standard, combined with a PV array.** The CO_2 reduction delivered by solar thermal is too limited for the technology to be used in a Code level 4 compliant energy strategy and while achieving the dwelling emission rate requirement through fabric improvement alone may be technically achievable, it is very challenging. The AimC4 project, led by a consortium of house-builders, research institutions and building materials providers, has set out to address this challenge. The consortium is pioneering the use of innovative materials and processes to develop homes that meet the Code Level 4 dwelling emission rate standard through fabric solutions alone. The consortium aims to demonstrate a route to volume production of affordable Code Level 4 homes and believes that a 'fabric first' approach is the key achieving that goal[1]. Initial results from AimC4 are available.

The consultation revealed too little experience of building to Code level 5 or 6 for any common approaches to be identified. In the absence of industry data, technical and cost modelling was performed to estimate the extra-over costs of a range of energy systems options, sized appropriately to the higher levels of the Code. These energy system options included combinations of various fabric improvement standards with a range of low carbon technologies, either employed at the dwelling scale – heat pumps, biomass boilers and photovoltaic – or at a community scale – gas combined heat and power, biomass boilers and biomass combined heat and power (each in combination with a community heating network).

At Code levels 1 to 4, the least cost energy strategies to meet the mandatory dwelling emission rate requirements involve fabric improvement combined with technologies installed at the dwelling scale. At Code level 5 and 6, biomass-based community energy strategies tend to be more cost-effective, particularly in the larger-scale, higher density development scenarios. The extra-over costs of the lowest cost energy strategies and the technology combinations making up those strategies for each Code level and development type are shown below.

[1] More information on the work of the AimC4 consortium can be found on their website www.aimc4.com/index.jsp

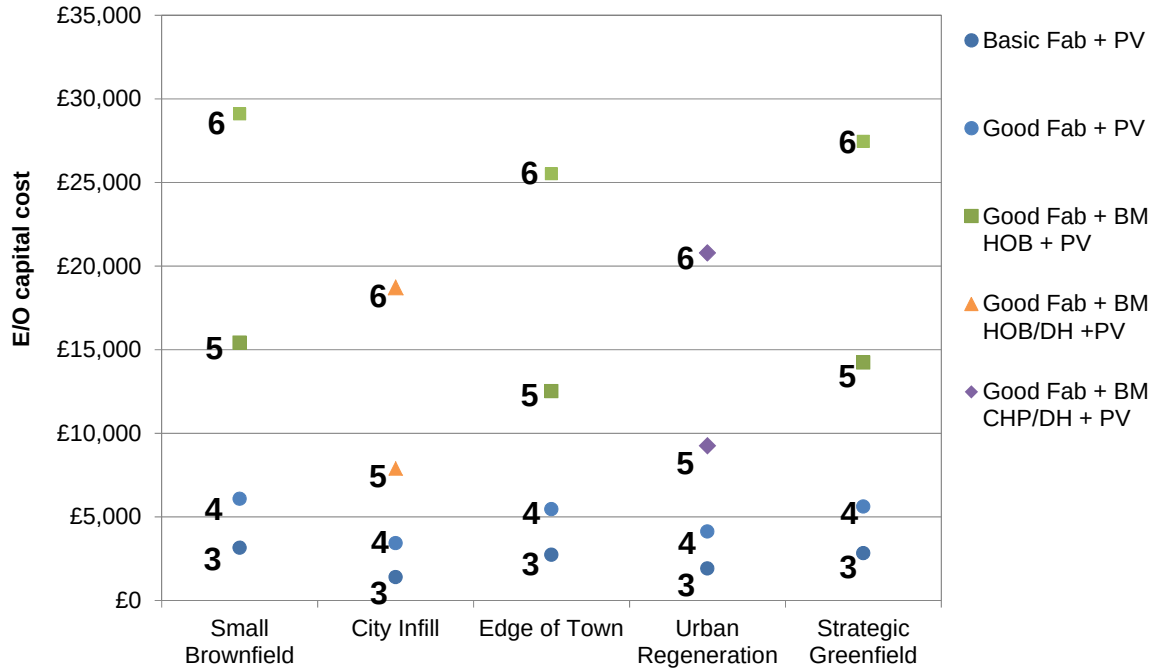


Figure 1: Extra-over costs of the least cost energy strategy at Code levels 3 to 6 for each development scenario. The data point labels denote the target Code level and the legend identifies the nature of the energy strategy. This table uses Part L 2006 baseline data.

The analysis of suitable energy strategies for the higher Code levels identifies a number of issues. Firstly, **the dwelling emission rate improvements required at the highest levels of the Code are very challenging to achieve and, even where biomass is used as the primary heating fuel, large quantities of renewable electricity generation are required**. Where this cannot be achieved centrally, for example using a central combined heat and power plant, it leads to a requirement for large amounts of photovoltaics, which may be difficult to accommodate in the available roof area – between 3.5 to 6.5 kWp of photovoltaic is required for the Code level 6 energy strategies included in the Figure 1, depending on dwelling and development type.

A further issue is the reliance on biomass in the lowest cost energy strategies at Code Levels 5 and 6. There are several concerns regarding widespread use of biomass, principally the current nascent state of the supply chain, the air quality restrictions on its use in some areas (note that use of biomass is expected to result in lost credits under the Pollution category) and ultimate limitations on the resource availability. **The use of on-site wind could provide a cost-effective alternative to supply of low carbon electricity, but its applicability is also heavily limited**, by site constraints and geographic variability of the wind resource.

1.3.2 OTHER FACTORS DRIVING CODE COSTS

While the cost of the energy solution is a major driver of Code costs, significant costs are incurred under the other Code categories and increasingly so as higher Code levels are addressed. An example of the breakdown of Code costs between category is shown in the figure below for a three-bed semi dwelling type (Energy category costs are shown on separate axes for clarity).

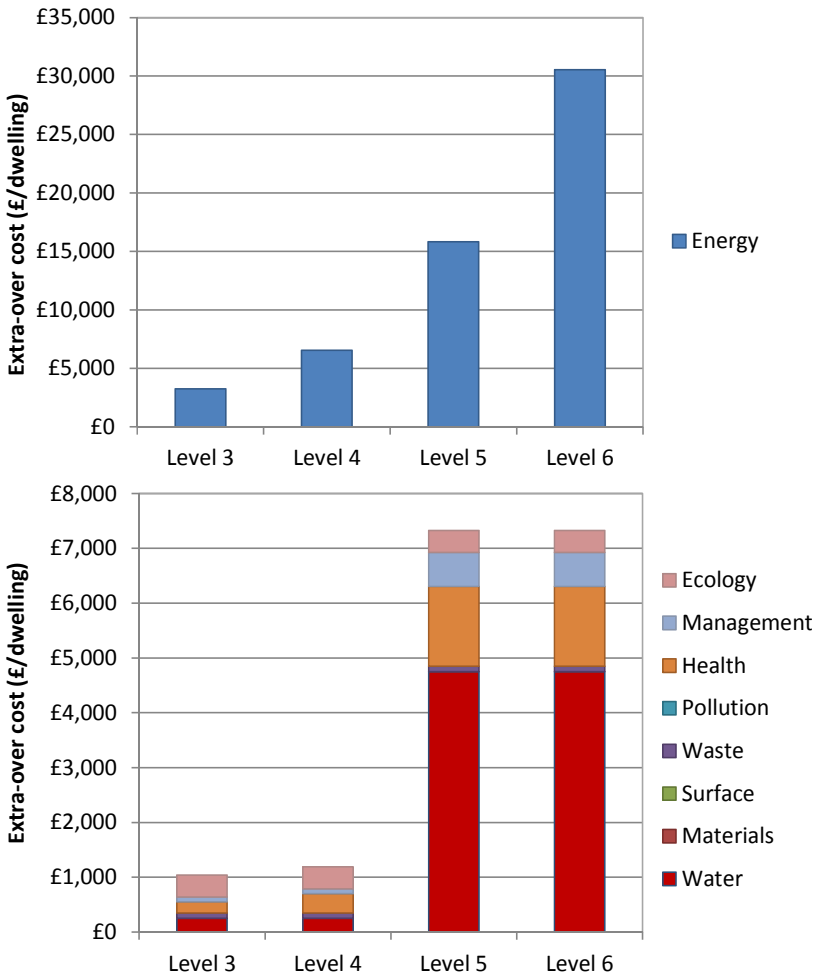


Figure 2: Code extra-over cost by category for Code Levels 1 to 3 for the three-bed semi dwelling type in a small brownfield development. (Baseline Part L 2006)

The spending in the Energy category increases sharply from Code level 4 to 5 and again in progressing from levels 5 to 6. This is in large part due to the increasing energy strategy cost, as discussed above, but also because as high Code levels are targeted other high cost issues under the Energy category need to be addressed, including provision of cycle storage and fitting of energy efficient white goods (assuming these aren't supplied as part of the standard fittings). **The other largest cost category at Code levels 5 and 6 is Water.** The Code stipulates a common mandatory water consumption limit at Code levels 3 and 4 of 105 l/p/d and a more stringent common mandatory standard at Code level 5 and 6 of 80 l/p/d. While the Code level 3/4 standard can be achieved by providing low-flow water fittings, the advanced standard necessitates installation of a greywater recycling system, which incurs a substantial additional cost.

In addition to Energy and Water, there are further mandatory issues to be addressed in the Materials, Waste and Surface Water categories. The mandatory Waste and Materials issues can be addressed at low cost. Substantial costs may be incurred in meeting the mandatory requirements for mitigation of surface water discharge, although it has been considered here that this would be a requirement of planning and the Environment Agency, so is not included as a Code extra-over cost.

In terms of overall approach to the Code, there are low cost credits available under the Materials, Pollution, Management and Waste categories, which home-builders are likely to address at all Code levels. **Once these low cost credits have been exhausted, the more costly issues remaining under the Energy, Health and Well-being, Management and Ecology categories will need to be progressively addressed as the target standard advances beyond Code level 3.**

The Ecology issue could have a significant influence on the overall costs of meeting the Code and one that is highly site specific. There are a substantial number of heavily weighted credits available in this category, many of which may be relatively easily achieved on brown field sites of low inherent ecological value (for example because there are few ecological features to protect and a low base from which to improve biodiversity). For greenfield developments, however, these credits may be very costly or not feasible to achieve. Developers of these sites will need to invest more to achieve these credits, or resort to higher cost credits under the other heavily weighted categories. This may result in Code homes being built to Lifetime Homes and Secured by Design standards, for example, at lower Code levels than would be expected in brownfield developments (with the exception of social housing, where these credits may be required in the base build specification).

1.4 Code cost results

The results of the Code cost modelling are presented in the following. The Code extra-over costs are presented relative to a Part L 2006 baseline (Section 1.4.1) and relative to a Part L 2010 baseline (Section 1.4.2). In the latter case, the extra-over costs associated with meeting the mandatory dwelling emission rate standards is reduced, as the cost of achieving the Code Level 3 mandatory dwelling emission rate is part of the baseline cost of construction of the dwelling (i.e. it is a regulatory cost) rather than an extra-over cost associated with the Code.

1.4.1 CODE COSTS RELATIVE TO A PART L2006 BASELINE

The extra-over costs of building to the Code are shown in the charts below for the two-bed flat and three-bed semi dwelling types, in a range of development scenarios. The costs are relative to a Part L 2006 baseline and hence are representative of the extra-over costs incurred by house-builders to-date compared to the regulatory minimum standard.

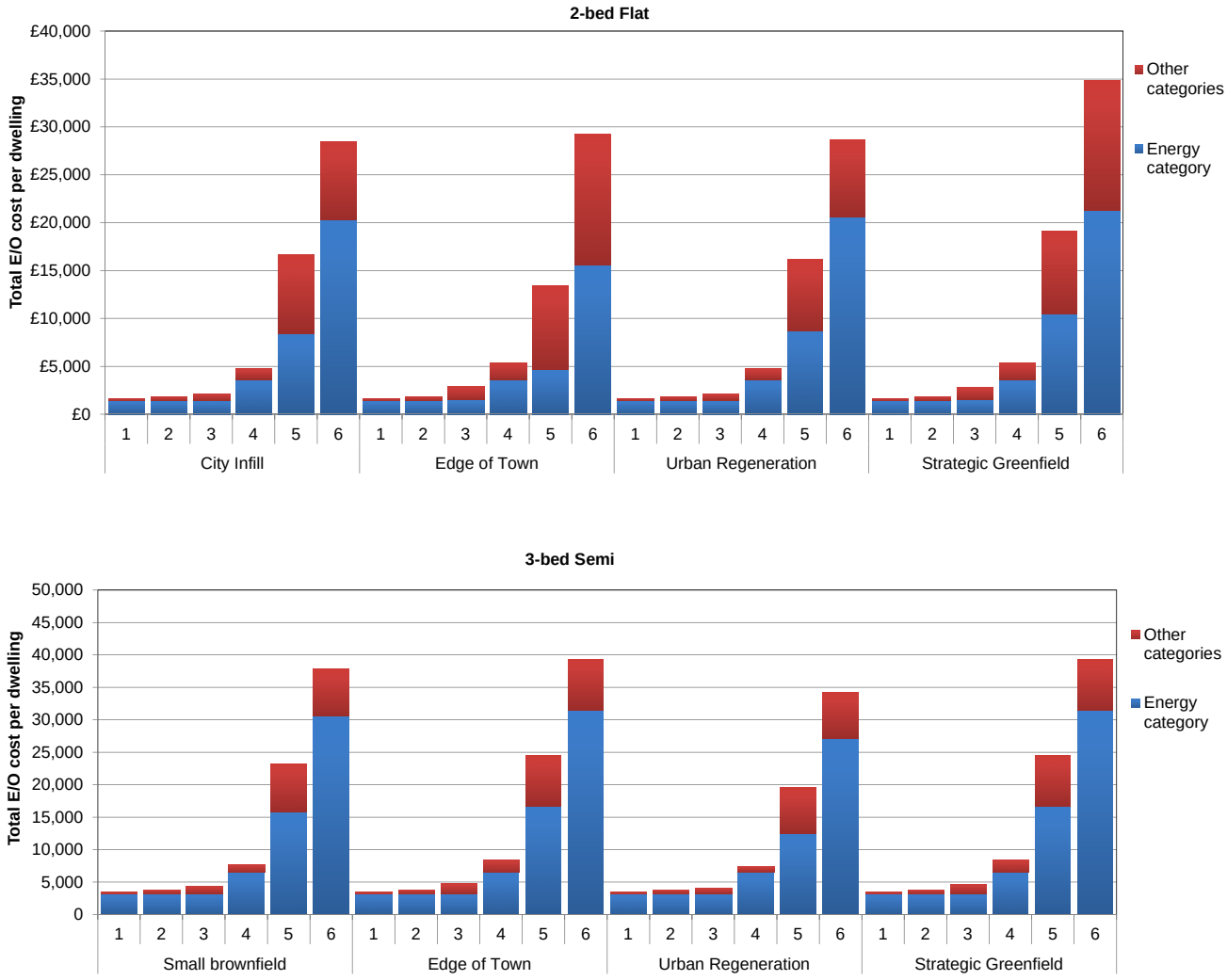


Figure 3: Code extra-over costs for two-bed flat and three-bed semi dwelling types in a range of development scenarios. Extra-over costs are split between those incurred under the Energy and CO_2 category and other Code categories. (Part L 2006 baseline)

The complete set of Code extra-over costs for each dwelling type and development scenario are tabulated below.

Table 2: Code extra-over costs for each dwelling type and development scenario (Part L 2006 baseline)

Code Level	2b-Flat		2b-Terrace		3b-Semi		4b-Detached		Average dwelling	
	E/O cost	%	E/O cost	%	E/O cost	%	E/O cost	%	E/O cost	%
Small brownfield (20 dwellings at 40 dph)										
1	-	-	£3,290	4.3%	£3,460	4.2%	£3,860	4.3%	£3,472	4.2%
2	-	-	£3,530	4.6%	£3,700	4.4%	£4,110	4.6%	£3,714	4.5%
3	-	-	£3,810	4.9%	£4,300	5.2%	£4,550	5.1%	£4,154	5.1%
4	-	-	£6,470	8.4%	£7,730	9.3%	£8,690	9.8%	£7,418	9.1%
5	-	-	£21,640	28.1%	£23,140	27.8%	£24,910	28.0%	£22,894	28.0%
6	-	-	£34,840	45.2%	£37,860	45.5%	£41,720	46.8%	£37,424	45.7%
City Infill (40 dwellings at 160 dph)										
1	£1,620	3.0%	-	-	-	-	-	-	£1,620	3.0%
2	£1,870	3.5%	-	-	-	-	-	-	£1,870	3.5%
3	£2,140	4.0%	-	-	-	-	-	-	£2,140	4.0%
4	£4,800	9.0%	-	-	-	-	-	-	£4,800	9.0%
5	£16,620	31.2%	-	-	-	-	-	-	£16,620	31.2%
6	£28,440	53.4%	-	-	-	-	-	-	£28,440	53.4%
Edge of town (100 dwellings at 40 dph)										
1	£1,620	3.0%	£3,290	4.3%	£3,460	4.2%	£3,860	4.3%	£3,031	4.0%
2	£1,870	3.5%	£3,530	4.6%	£3,700	4.4%	£4,110	4.6%	£3,275	4.4%
3	£2,870	5.4%	£4,330	5.6%	£4,730	5.7%	£4,920	5.5%	£4,194	5.6%
4	£5,340	10.0%	£7,250	9.4%	£8,500	10.2%	£9,470	10.6%	£7,522	10.0%
5	£13,450	25.3%	£22,960	29.8%	£24,470	29.4%	£26,240	29.5%	£21,655	28.8%
6	£29,260	55.0%	£36,310	47.1%	£39,330	47.3%	£43,200	48.5%	£36,626	48.8%
Urban Regeneration (1000 dwellings at 160 dph)										
1	£1,620	3.0%	£3,290	4.3%	£3,460	4.2%	£3,860	4.3%	£2,158	3.5%
2	£1,870	3.5%	£3,530	4.6%	£3,700	4.4%	£4,110	4.6%	£2,406	3.9%
3	£2,070	3.9%	£3,670	4.8%	£4,050	4.9%	£4,300	4.8%	£2,601	4.2%
4	£4,730	8.9%	£6,180	8.0%	£7,440	8.9%	£8,470	9.5%	£5,343	8.7%
5	£16,180	30.4%	£18,180	23.6%	£19,550	23.5%	£21,290	23.9%	£17,004	27.7%
6	£28,670	53.9%	£31,380	40.7%	£34,270	41.2%	£38,100	42.8%	£29,964	48.9%
Strategic Greenfield (2000 dwellings at 40 dph)										
1	£1,620	3.0%	£3,290	4.3%	£3,460	4.2%	£3,860	4.3%	£3,121	4.1%
2	£1,870	3.5%	£3,530	4.6%	£3,700	4.4%	£4,110	4.6%	£3,365	4.4%
3	£2,850	5.4%	£4,320	5.6%	£4,710	5.7%	£4,900	5.5%	£4,259	5.6%
4	£5,330	10.0%	£7,230	9.4%	£8,490	10.2%	£9,450	10.6%	£7,672	10.0%
5	£19,140	36.0%	£22,950	29.8%	£24,450	29.4%	£26,220	29.4%	£23,292	30.4%
6	£34,870	65.5%	£36,290	47.1%	£39,320	47.3%	£43,180	48.5%	£38,293	50.0%
Large edge of town (3,300 dwellings at 40 dph)										
1	£1,620	3.0%	£3,290	4.3%	£3,460	4.2%	£3,860	4.3%	£2,937	4.0%
2	£1,870	3.5%	£3,530	4.6%	£3,700	4.4%	£4,110	4.6%	£3,182	4.3%
3	£2,850	5.4%	£4,320	5.6%	£4,710	5.7%	£4,900	5.5%	£4,073	5.5%
4	£5,330	10.0%	£7,230	9.4%	£8,490	10.2%	£9,450	10.6%	£7,356	10.0%
5	£19,140	36.0%	£22,820	29.6%	£24,340	29.3%	£26,140	29.3%	£22,684	30.8%
6	£35,070	65.9%	£36,170	46.9%	£39,210	47.1%	£43,090	48.4%	£37,832	51.4%

The manner in which the additional expenditure on Code credits is distributed between the Code categories is shown in the table below. The cost results shown relate to the three-bed semi dwelling type.

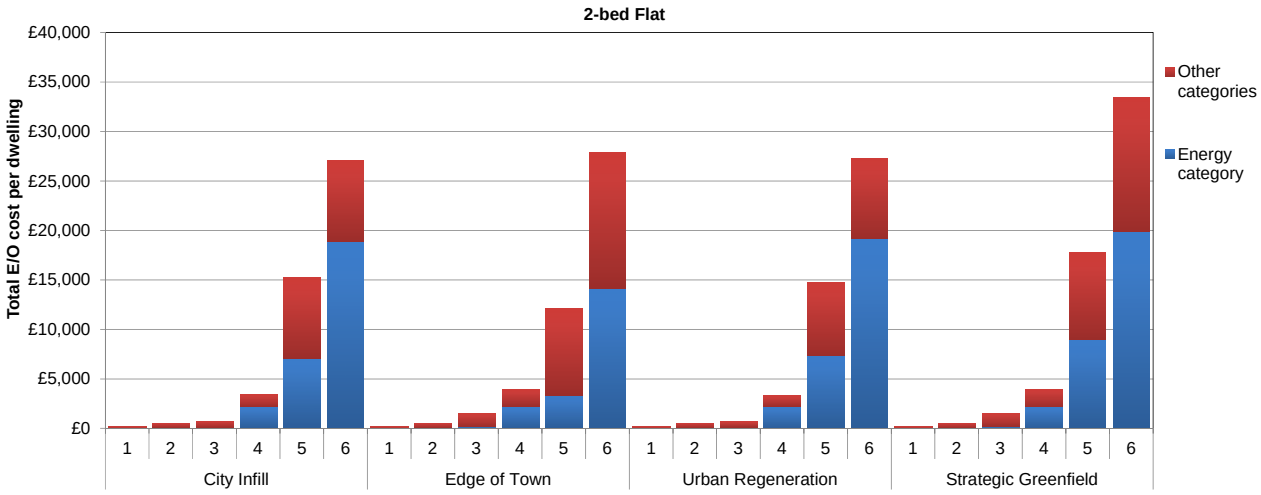
Table 3: Breakdown of Code extra-over costs by Code category – three-bed semi (Part L 2006 baseline)

Code Level	1		2		3		4		5		6	
	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost
Small Brownfield												
Energy	9	£3,168	13	£3,263	13	£3,263	18	£6,536	25	£15,816	28	£30,536
Water	3	£200	4	£250	4	£250	4	£250	6	£4,750	6	£4,750
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	6	£50	7	£100	7	£100	7	£100	7	£100	7	£100
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	2	£0	2	£0	8	£200	8	£350	12	£1,455	12	£1,455
Management	5	£40	7	£90	7	£90	7	£90	9	£620	9	£620
Ecology	0	£0	0	£0	6	£400	6	£400	6	£400	6	£400
Total	**45**	**£3,458**	**53**	**£3,703**	**65**	**£4,303**	**70**	**£7,726**	**82**	**£23,141**	**89**	**£37,861**
Edge of Town												
Energy	9	£3,168	13	£3,263	12	£3,263	19	£6,536	27	£16,666	29	£31,531
Water	3	£200	4	£250	4	£250	4	£250	6	£4,750	6	£4,750
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	6	£50	7	£100	6	£50	7	£100	7	£100	7	£100
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	2	£0	2	£0	8	£200	8	£650	12	£1,455	12	£1,455
Management	5	£40	7	£90	7	£18	7	£18	9	£548	9	£548
Ecology	0	£0	0	£0	5	£950	5	£950	5	£950	5	£950
Total	**45**	**£3,458**	**53**	**£3,703**	**62**	**£4,731**	**70**	**£8,504**	**83**	**£24,469**	**89**	**£39,334**
Urban Regeneration												
Energy	9	£3,168	13	£3,263	12	£3,198	17	£6,536	25	£12,473	28	£27,193
Water	3	£200	4	£250	4	£250	4	£250	6	£4,750	6	£4,750
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	6	£50	7	£100	6	£50	7	£100	7	£100	7	£100
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	2	£0	2	£0	8	£200	8	£200	12	£1,345	12	£1,345
Management	5	£40	7	£90	7	£2	7	£2	9	£532	9	£532
Ecology	0	£0	0	£0	7	£350	7	£350	7	£350	7	£350
Total	**45**	**£3,458**	**53**	**£3,703**	**64**	**£4,050**	**70**	**£7,438**	**83**	**£19,550**	**90**	**£34,270**
Strategic Greenfield												
Energy	9	£3,168	13	£3,263	12	£3,263	19	£6,536	27	£16,666	29	£31,531
Water	3	£200	4	£250	4	£250	4	£250	6	£4,750	6	£4,750
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	6	£50	7	£100	6	£50	7	£100	7	£100	7	£100
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	2	£0	2	£0	8	£200	8	£650	12	£1,455	12	£1,455
Management	5	£40	7	£90	7	£1	7	£1	9	£531	9	£531
Ecology	0	£0	0	£0	5	£950	5	£950	5	£950	5	£950
Total	**45**	**£3,458**	**53**	**£3,703**	**62**	**£4,714**	**70**	**£8,487**	**83**	**£24,452**	**89**	**£39,317**

1.4.2 CODE COSTS RELATIVE TO A PART L 2010 BASELINE

Part L 2010 of the Building Regulations was introduced in October 2010. This requires that all new dwellings achieve a dwelling emission rate that is a 25 per cent improvement on the Part L 2006 standard. In other words, the minimum regulatory standard is now equivalent to the mandatory requirement of Code Level 3. For homes that are built under Part L 2010, therefore, the cost of achieving the mandatory dwelling emission rate standard should be considered a regulatory cost, rather than an extra-over cost of the Code. This means that there is no extra-over cost associated with meeting the minimum Ene 1 requirement at Code levels 1 to 3 and that the extra-over cost associated with meeting the mandatory dwelling emission rate requirement at higher levels of the Code is reduced (it is the marginal cost of advancing from the Code 3 standard rather than the cost of improvement from Part L 2006).

The charts below show the extra-over cost of achieving each Code level from a Part L 2010 baseline for the two-bed flat and three-bed semi, in a range of developments scenarios.



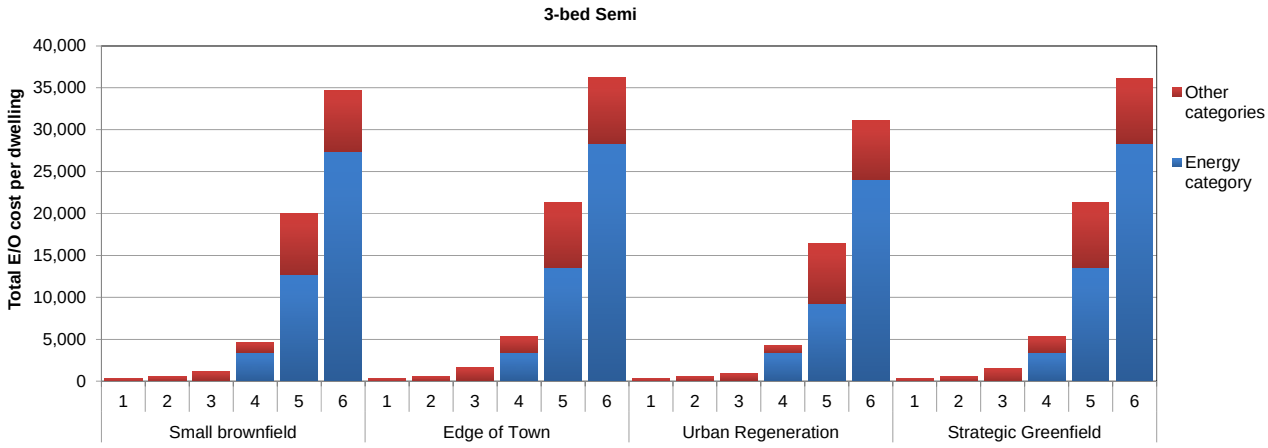


Figure 4: Extra-over cost of achieving each Code level measured from a Part L2010 baseline. Results are shown for the two-bed flat and three-bed semi dwelling types in a range of development scenarios

When measuring Code costs from a Part L 2010 compliant baseline, the Energy category extra-over costs at Code levels 1 to 3 become minimal. The small Energy category cost remaining at Code Level 3, for example, is related to the cost of gaining credits under the energy efficient appliances and external lighting issues. The Energy costs at the higher level of the Code have been reduced by an amount equivalent to the cost of achieving the Part L 2010 standard.

The extra-over costs for each dwelling type and each Code Level, measured from a Part L 2010 compliant baseline, are tabulated below:

Table 4: Code extra-over costs for each dwelling type and development scenario – Part L 2010 baseline

Code Level	2b-Flat		2b-Terrace		3b-Semi		4b-Detached		Average dwelling	
	E/O cost	%	E/O cost	%	E/O cost	%	E/O cost	%	E/O cost	%
Small brownfield (20 dwellings at 40 dph)										
1	-	-	£320	0.4%	£320	0.4%	£320	0.3%	£320	0.4%
2	-	-	£560	0.7%	£560	0.6%	£560	0.6%	£560	0.7%
3	-	-	£840	1.0%	£1,160	1.3%	£1,000	1.1%	£1,000	1.2%
4	-	-	£3,500	4.4%	£4,580	5.3%	£5,140	5.5%	£4,260	5.0%
5	-	-	£18,670	23.3%	£20,000	23.2%	£21,360	23.1%	£19,740	23.2%
6	-	-	£31,870	39.8%	£34,720	40.2%	£38,170	41.2%	£34,270	40.3%
City Infill (40 dwellings at 160 dph)										
1	£230	0.4%	-	-	-	-	-	-	£230	0.4%
2	£470	0.9%	-	-	-	-	-	-	£470	0.9%
3	£750	1.4%	-	-	-	-	-	-	£750	1.4%
4	£3,400	6.2%	-	-	-	-	-	-	£3,400	6.2%
5	£15,220	27.9%	-	-	-	-	-	-	£15,220	27.9%
6	£27,050	49.5%	-	-	-	-	-	-	£27,050	49.5%
Edge of town (100 dwellings at 40 dph)										
1	£230	0.4%	£320	0.4%	£320	0.4%	£320	0.3%	£298	0.4%
2	£470	0.9%	£560	0.7%	£560	0.6%	£560	0.6%	£538	0.7%
3	£1,470	2.7%	£1,360	1.7%	£1,590	1.8%	£1,370	1.5%	£1,457	1.9%
4	£3,950	7.2%	£4,280	5.3%	£5,360	6.2%	£5,920	6.4%	£4,787	6.2%
5	£12,060	22.1%	£19,990	25.0%	£21,330	24.7%	£22,690	24.5%	£18,921	24.3%
6	£27,870	51.0%	£33,340	41.7%	£36,190	41.9%	£39,650	42.8%	£33,892	43.5%
Urban Regeneration (1000 dwellings at 160 dph)										
1	£230	0.4%	£320	0.4%	£320	0.4%	£320	0.3%	£257	0.4%
2	£470	0.9%	£560	0.7%	£560	0.6%	£560	0.6%	£497	0.8%
3	£680	1.2%	£700	0.9%	£910	1.1%	£750	0.8%	£699	1.1%
4	£3,330	6.1%	£3,210	4.0%	£4,300	5.0%	£4,930	5.3%	£3,435	5.4%
5	£14,790	27.1%	£15,210	19.0%	£16,410	19.0%	£17,740	19.2%	£15,103	23.9%
6	£27,270	49.9%	£28,410	35.5%	£31,130	36.1%	£34,550	37.3%	£28,055	44.4%
Strategic Greenfield (2000 dwellings at 40 dph)										
1	£230	0.4%	£320	0.4%	£320	0.4%	£320	0.3%	£302	0.4%
2	£470	0.9%	£560	0.7%	£560	0.6%	£560	0.6%	£542	0.7%
3	£1,450	2.7%	£1,350	1.7%	£1,570	1.8%	£1,350	1.5%	£1,436	1.8%
4	£3,930	7.2%	£4,260	5.3%	£5,340	6.2%	£5,900	6.4%	£4,846	6.1%
5	£17,740	32.5%	£19,980	25.0%	£21,310	24.7%	£22,670	24.5%	£20,469	25.8%
6	£33,470	61.3%	£33,320	41.6%	£36,170	41.9%	£39,630	42.8%	£35,467	44.7%
Large edge of town (3,300 dwellings at 40 dph)										
1	£230	0.4%	£320	0.4%	£320	0.4%	£320	0.3%	£293	0.4%
2	£470	0.9%	£560	0.7%	£560	0.6%	£560	0.6%	£533	0.7%
3	£1,450	2.7%	£1,350	1.7%	£1,570	1.8%	£1,350	1.5%	£1,424	1.9%
4	£3,930	7.2%	£4,260	5.3%	£5,340	6.2%	£5,900	6.4%	£4,705	6.2%
5	£17,740	32.5%	£19,850	24.8%	£21,200	24.6%	£22,590	24.4%	£20,035	26.3%
6	£33,670	61.6%	£33,200	41.5%	£36,060	41.8%	£39,540	42.7%	£35,181	46.2%

The disaggregation of Code extra-over costs between the Code categories is shown in the table below for the three-bed semi dwelling type. As expected, the Energy and CO_2 category is a relatively marginal component of the overall Code extra-over cost for Code levels 1 to 3 (as the cost of meeting the dwelling emission rate standard is a regulatory cost), but it remains the dominant cost category at higher Code levels.

Table 5: Breakdown of Code extra-over costs by Code category – three-bed semi (Part L 2010 baseline)

Code Level	1		2		3		4		5		6	
	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost
Small Brownfield												
Energy	9	£25	13	£120	13	£120	18	£3,393	25	£12,673	28	£27,393
Water	3	£200	4	£250	4	£250	4	£250	6	£4,750	6	£4,750
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	6	£50	7	£100	7	£100	7	£100	7	£100	7	£100
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	2	£0	2	£0	8	£200	8	£350	12	£1,455	12	£1,455
Management	5	£40	7	£90	7	£90	7	£90	9	£620	9	£620
Ecology	0	£0	0	£0	6	£400	6	£400	6	£400	6	£400
Total	**45**	**£315**	**53**	**£560**	**65**	**£1,160**	**70**	**£4,583**	**82**	**£19,998**	**89**	**£34,718**
Edge of Town												
Energy	9	£25	13	£120	12	£120	19	£3,393	27	£13,523	29	£28,388
Water	3	£200	4	£250	4	£250	4	£250	6	£4,750	6	£4,750
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	6	£50	7	£100	6	£50	7	£100	7	£100	7	£100
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	2	£0	2	£0	8	£200	8	£650	12	£1,455	12	£1,455
Management	5	£40	7	£90	7	£18	7	£18	9	£548	9	£548
Ecology	0	£0	0	£0	5	£950	5	£950	5	£950	5	£950
Total	**45**	**£315**	**53**	**£560**	**62**	**£1,588**	**70**	**£5,361**	**83**	**£21,326**	**89**	**£36,191**
Urban Regeneration												
Energy	9	£25	13	£120	12	£55	17	£3,393	25	£9,330	28	£24,050
Water	3	£200	4	£250	4	£250	4	£250	6	£4,750	6	£4,750
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	6	£50	7	£100	6	£50	7	£100	7	£100	7	£100
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	2	£0	2	£0	8	£200	8	£200	12	£1,345	12	£1,345
Management	5	£40	7	£90	7	£2	7	£2	9	£532	9	£532
Ecology	0	£0	0	£0	7	£350	7	£350	7	£350	7	£350
Total	**45**	**£315**	**53**	**£560**	**64**	**£907**	**70**	**£4,295**	**83**	**£16,407**	**90**	**£31,127**
Strategic Greenfield												
Energy	9	£25	13	£120	12	£120	19	£3,393	27	£13,523	29	£28,388
Water	3	£200	4	£250	4	£250	4	£250	6	£4,750	6	£4,750
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	6	£50	7	£100	6	£50	7	£100	7	£100	7	£100
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	2	£0	2	£0	8	£200	8	£650	12	£1,455	12	£1,455
Management	5	£40	7	£90	7	£1	7	£1	9	£531	9	£531
Ecology	0	£0	0	£0	5	£950	5	£950	5	£950	5	£950
Total	**45**	**£315**	**53**	**£560**	**62**	**£1,571**	**70**	**£5,344**	**83**	**£21,309**	**89**	**£36,174**

2 Introduction

2.1 Background

The Code for Sustainable Homes is a national sustainability standard for the design and construction of new homes. The Code is administered by the Department for Communities and Local Government (DCLG), which is also responsible for planning policy and building regulation in England. In order to minimise the environmental impact of new homes, in particular energy use and CO_2 emissions, Building Regulations are to be tightened over the coming years to improve the energy efficiency of and reduce carbon emissions from new homes. The CO_2 performance standards in the Code mirror the proposed minimum mandatory levels that will be implemented through future revisions to Part L of the Building Regulations (which deal with energy use and CO_2 emissions). Thus the Code signals the direction of change towards zero carbon homes that will be mandated through the Building Regulations[2].

The Code is a voluntary standard and there are currently no plans to make it mandatory at the national level. However, the Code is increasingly being adopted by local authorities as a planning condition for new developments, and any social housing schemes seeking government funding must currently achieve at least level 3 of the Code[3].

Periodic updates to the Code are necessary to maintain alignment with other legislation such as Building Regulations and to take account of feedback from the house building industry. Any changes to the legislation must be informed by an impact assessment to evaluate the effects at the national level. Conducting the impact assessment requires an understanding of the costs of building to the Code and this report presents the findings of a consultation conducted in later summer 2010 to gather cost data from builders with experience of building Code homes.

2.2 Code overview

This section gives an overview of the Code for Sustainable Homes. Further information is given in the appendix (Appendix D) and full details can be found in the Code Technical Guide, available from DCLG's website[4].

2.2.1 CATEGORIES AND ISSUES

The Code for Sustainable Homes is a tool for improving environmental performance and reducing CO_2 emissions from new homes. The extensive framework provided by the Code sets challenging targets in a range of categories; from energy use and CO_2 emissions, to water consumption, to site ecology. New homes being assessed against the Code are evaluated against nine design categories:

[2] Note that based on current definitions there is a difference between a zero carbon Code for Sustainable Homes level 6 home and the proposed zero carbon standard. Both definitions lead to net CO_2 emissions of zero over the year, however Code for Sustainable Homes level 6 requires all emissions to be dealt with zero carbon definition is expected to require a minimum level of onsite emissions reduction (the Carbon Compliance level), with the remainder dealt with through 'Allowable Solution', which may include offsite measures. The Code has not been updated at Code Level 6 to reflect this, due to the ongoing work on definition of the zero carbon policy.

[3] The Housing Corporation's minimum target for the 2008–2011 National Affordable Housing Programme (NAHP) is level 3 of the Code for Sustainable Homes.

[4] www.communities.gov.uk

- Energy/CO_2
- Water
- Materials
- Surface water run-off
- Waste
- Pollution
- Health and well-being
- Management
- Ecology

Each category is further sub-divided into a number of discrete issues, for example, the Pollution category consists of two issues: Pol 1 (Insulant GWP), Pol 2 (NOx Emissions).

The number of issues per category varies, with a sum total of issues across all categories of 34. Credits are scored against issues, with higher performance being rewarded with more credits against any particular issue, up to the maximum number of credits available for the issue.

2.2.2 MANDATORY ISSUES

In order to achieve any of the Code levels from 1–6, certain mandatory requirements must be met; these are summarised below.

Table 6: Mandatory Code issues

Issue Code	Description	Code Level						
		1	2	3	4	5	6	
Mat 1	*Environmental impact*	Green Guide rating of A+ to D for at least three key elements (roof, window, external & internal walls, upper & ground floors)						Uncredited mandatory issues
	Mandatory Credits	-	-	-	-	-	-	
Sur 1	*Surface water run-off*	Ensure peak rate of run-off into watercourses will not increase as a result of development						
	Mandatory Credits	-	-	-	-	-	-	
Was 1	*Waste storage*	Allocate space for waste storage in line with BS 5906						
	Mandatory Credits	-	-	-	-	-	-	
Was 2	*Construction waste management*	Develop and implement a site waste management plan to monitor and report on waste generated on site						
	Mandatory Credits	-	-	-	-	-	-	
Ene 1	*% improvement on target emission rate*	10%	18%	25%	44%	100%	ZCH*	Mandatory issues
	Mandatory Credits	1	3	5	8	14	15	
Hea	*Comply with all principles of*	No	No	No	No	No	Yes	

4	***Lifetime Homes***						
	Mandatory Credits	-	-	-	-	-	4
Wat 1	***Maximum internal water use (litres/person/day)***	120	120	105	105	80	80
	Mandatory Credits	1	1	3	3	5	5

* ZCH = zero carbon home. Requires on-site emissions reductions to offset all regulated and unregulated emissions over the course of a year.

For the four uncredited mandatory issues a particular requirement must be met irrespective of Code level sought. Provided the minimum performance standards are met for each of the uncredited issues, further mandatory issues must be considered before a Code rating is granted. Minimum mandatory standards increase with Code level for the Ene 1 and Wat 1 issues (dwelling emission rate and indoor water use). The definition for zero carbon homes in the Code at level 6 corresponds to a decrease in dwelling emission rate to a sufficient level to offset all predicted electricity use in the dwelling, and is calculated in accordance with the Code Technical Guide.

2.2.3 CREDITS AND SCORING

The overall Code level attained is based upon the Total Percentage Points Score, subject to the mandatory requirements described above being met. The Total Percentage Points Score is calculated after credits are converted into points by applying environmental weighting factors. Different weighting factors apply for different categories, thus making credits in certain categories more valuable in terms of contribution to the overall score.

Table 7: Credits available and weighted value of credits by Code category

Category	Number of issues	Maximum number of credits available	Category weighting factor (%)	Weighted value of each credit
Energy/CO_2	9	29	36.4	1.26
Water	2	6	9	1.50
Materials	3	24	7.2	0.30
Surface Water	2	4	2.2	0.55
Waste	3	7	6.4	0.91
Pollution	2	4	2.8	0.70
Health and well-being	4	12	14	1.17
Management	4	9	10	1.11
Ecology	5	9	12	1.33

During a Code assessment the sum of the credits achieved in each category is divided by the total available for that category and multiplied by the category weighting factor, giving a percentage points score for the category. The Total Percentage Points Score is the sum of all the percentage points scores and the minimum Total Percentage Points Score requirement increases with Code level, as summarised below.

Table 8: Minimum total percentage points score by Code level

Code level	1	2	3	4	5	6
Minimum Total Percentage Points Score	36	48	57	68	84	90

2.3 Objectives

This study's objectives were to:

- Consult with the home building industry to gather data on the costs of building Code homes.
- Gain insight into the extent to which technical solutions for delivering Code homes have become/are becoming standardised.
- Understand to what extent the costs of building Code homes have changed as experience of building to the Code increases.

3 Methodology

3.1 Overall approach

The approach consisted of three steps.

STEP 1 HOUSEBUILDER INDUSTRY CONSULATION

The first step was to test the market for costs and assess how these had changed since the March 2010 report through face to face consultations with developers. The data needed to reflect a range of house types, Code levels and geographical regions; however, the scope of the study was limited with tight timescales. Therefore, the study needed a focus that would still yield robust data through consultation with a representative sample set that would reflect the changes in cost from the previous study and provide a broad enough study to cover various parameters. In agreement with DCLG, it was determined that the study would explore updating data taking into account the following variables:

- House types: Four standard dwelling types are explored – a two-bed flat, two-bed terraced house, three-bed semi and four-bed detached house (see Section 3.2.1). The consultation focused on the two-bed flat and three-bed semi dwelling type, in order to limit the number of variants under discussion
- Types of developers: Small developers, large developers and social housing developers (Please see Appendix E for a list of developers consulted).
- Geographical region: This would be covered by targeting at least one developer in the Wales region.

To assist with the developer consultation a prompt questionnaire was developed to facilitate and stimulate discussion (see Appendix). This questionnaire had a quantitative and a qualitative element. The main purpose of the quantitative element was to derive the current view on costs. The qualitative element's objective was to give a qualitative assessment of Code elements that were not possible or difficult to assess purely in terms of cost e.g. ecology credits. In addition, the qualitative elements attempted to establish the market's view on proposed changes to the Code and interactions with other policies e.g. changes to the Secured by Design issue, introduction of energy monitoring and the impact of financial incentives for renewable energy generation (the feed-in tariff and the renewable heat incentive). In addition, the market's view on evolution of approaches to building to the Code and any cost reductions since the last Code cost report were explored.

To encourage discussion and to provide a means of facilitating data assembly a 'straw man' document was produced, which informed the questionnaire but also provided an outline format/agenda. The 'straw man' presented the consultant team's ingoing assumptions on the costs of achieving Code levels 3 to 6, as a basis for the discussion.

Twelve developers were targeted with the intention of representing a broad cross-section of the house-building industry. However, due to time constraints and developers being unavailable for consultation, only 11 were eventually consulted. As

an incentive for developer's involvement, the information/data derived from the consultation meeting was issued to the developers in the form of meeting notes following the meeting to give them the opportunity to agree that the information accurately reflected what was discussed. The idea was to have a process of shared knowledge and transparency.

STEP 2 DATA ASSEMBLY AND VALIDATION

The next steps were to assemble and validate the data in order that an analysis could be undertaken. The meeting notes were used as the basis for data comparison. The data was assembled in the form of a 'tender analysis' where costs of each developer in terms of each issue were compared against each other. The reason for this was to 'normalise' the costs i.e. to arrive at a figure that was thought to realistically reflect the cost of the credit. In addition, this was necessary as some developers did not provide costs and this was a method to assemble the data and to fill in gaps.

Data was also presented in an alternative format in order that this could be used for input into Element Energy's costing model for the purposes of deriving an optimal solution in terms of lowest cost for required amount of credits for the various Code levels. In the consultation, as well as gathering data on costs, the developer's strategy in terms of targeted issues and credits were explored. Hence, data was organised in the format of issues, number of credits and costs. This would not reflect the cost of each subsequent credit but was based on what data we received from the developers.

From the data assembly it was assessed what costs were anomalies or were absent altogether. These costs were checked against our in-house database, pricing books or recent tenders on housing schemes. These costs were inputted into Element Energy's costing model and various development scenarios based on likely credits were also derived.

STEP 3 DATA ANALYSIS

The final step was to analyse the data to assess where the changes were since the March 2010 report, what the trends were and to potentially provide a cost forecast based on those trends. This was undertaken through a high level reconciliation comparing costs from the previous report to current costs from the recent study.

3.2 Base build costs and definition of extra over costs

All costs presented in this report are extra over costs compared to the baseline costs. Developer's baseline costs were included in the consultations; however, this did not yield a large response. Hence, as a further check and to assess how base build costs would have changed from the previous study, benchmarking on a similar scheme was undertaken. In addition, previous baseline costs were adjusted using tender price indices. Both benchmarked base build costs and inflation/deflation adjusted costs were compared against the developer's data. A 'normalised' figure was assessed.

3.2.1 BASIC DWELLING TYPES AND DEVELOPMENT SCENARIOS

Four basic dwelling types have been assessed. These dwelling types are consistent with those used in the May 2009 Code cost report, in terms of the floor areas and basic fabric assumptions. The base build costs have been updated since the last report to reflect the information gathered through the consultation and benchmarking exercise.

The base build costs and fabric specifications are summarised in the table below. The base build fabric specifications have been selected to be consistent with Part L 2006. All Code extra-over costs are measured as extra-over the cost of this base build specification.

Table 9: Summary of basic dwelling types – specifications and base build costs

House type	Two-bed flat	Two-bed terrace	Three-bed semi	Four-bed detached
Floor area	61	73	88	118
Base build cost (£/m^2)	930	1000	945	850
Total base build cost (£)	**53,221**	**77,052**	**83,175**	**89,084**
Base case fabric specification				
Wall U-value (W/m^2K)	0.35	0.28	0.28	0.28
Floor U-value (W/m^2K)	0.25	0.2	0.2	0.2
Roof U-value (W/m^2K)	0.25	0.18	0.18	0.18
Window U-value (W/m^2K)	2	1.8	1.8	1.8
Door U-value (W/m^2K)	2	1.8	1.8	1.8
Air permeability ($m^3/m^2/hr$)	10	10	10	10
Thermal Bridging (W/m^2K)	0.1	0.08	0.08	0.08
Mode of ventilation	Natural	Natural	Natural	Natural
target emission rate ($kgCO_2/m^2/yr$)	21.1	24.2	26.1	25.3

A number of the Code extra-over costs will vary depending on the type of development – in terms of the scale, density, mix of dwellings and whether the land is greenfield or previously developed. To enable assessment of the sensitivity of Code extra-over cost to the nature of the development, a range of representative development scenarios have been defined. The development scenarios are summarised in the table below.

Table 10: Summary of the development scenarios in terms of scale (number of dwellings) and dwelling mix (B = Brownfield, G = Greenfield)

Development scenarios	Type	Scale (N° dwellings)	Density (dwelling/ha)	Dwelling mix (% of total dwellings)			
				Two-bed flat	Two-bed terrace	Three-bed semi	Four-bed detached
Small brownfield	B	20	40	0%	40%	40%	20%
City infill	B	40	150	100%	0%	0%	0%
Edge of town	G	100	40	24%	30%	30%	16%
Strategic greenfield	G	2,000	40	10%	30%	30%	20%
Urban regeneration	B	2,000	150	70%	20%	5%	5%

4 Tackling the Code's mandatory issues

4.1 Energy and CO_2 emissions

The mandatory energy and carbon emissions standards constitute one of the most challenging and costly issues that need to be addressed to achieve a Code level, particularly when the higher Code levels are targeted.

The mandatory standards for reduction of CO_2 emissions set-out under Ene 1 – dwelling emission rate – are specified in terms of the minimum percentage reduction from the target emission rate[5] that must be achieved. This is the same performance metric as is used in Part L 2010 of the Building Regulations to specify the improvement of CO_2 emissions performance required, so it is clear how the mandatory dwelling emission rate standard at each Code level relates to the minimum standard required by Building Regulations.

Since the introduction of Part L 2010, the minimum dwelling emission rate standard required by regulation is a 25 per cent improvement on target emission rate. This is equivalent to the mandatory standard required at Code level 3 and more advanced than that required at Code level 1 and 2 (10 per cent and 18 per cent respectively). Effectively therefore a minimum dwelling emission rate/target emission rate reduction of 25 per cent is now required at Code levels 1 to 3. The mandatory dwelling emission rate standards at each Code level is shown in the table below.

Table 11: Mandatory reduction of dwelling emission rate from the Part L 2006 target emission rate at each Code level and number of credits awarded under Ene 1

Code Level	% reduction on target emission rate required	Credits
1 – 3	25%	5
4	44%	8
5	100%	14
6	Zero Carbon	15

The mandatory dwelling emission rate standard at Code level 4 is equivalent to the standard expected to be introduced as the regulatory minimum when the Building Regulations are revised in 2013. Therefore, in the same way that all housing falling under the 2010 revision of Part L must be built to a standard equivalent to Code level 3, whether a Code level is sought or not, from 2013 it is expected that all housing will be built to a standard that is equivalent to today's Code level 4 homes.

Of the developers consulted in the course of this research, all had experience of building to Code level 3 and most had some experience of building to Code level 4. Experience of building to Code level 5 and 6 was limited.

[5] Definition of target emission rate

Typically, the first step in the approach to building to Code level 3 has been to improve the standard of fabric efficiency compared to that required by Part L 2006. Broadly, two approaches to Code level 3 can be defined – either to improve the fabric standard to a sufficient extent to achieve the necessary reduction of dwelling emission rate through fabric measures alone, or to provide a more basic improvement in the fabric efficiency and install a low carbon energy generating technology to further reduce dwelling emission rate to within the mandatory requirement. In this latter case, solar thermal systems or photovoltaics have most commonly been selected as the low carbon generating technology.

To achieve the Code level 4 mandatory dwelling emission rate standard, a potential approach is to fix the fabric standard at that used in Code level 3 homes and increase the capacity of low carbon generating technologies installed. Consultation with developers revealed that a more common approach to Code level 4 is to further enhance the standard of fabric efficiency in order to reduce reliance on low carbon technology.

At higher Code levels, experience is limited. Developers targeting these levels are likely to further improve the fabric efficiency in order to limit the low carbon generating capacity required (indeed a mandatory fabric energy efficiency standard must be met at Code level 6[6]). Beyond a certain level of fabric improvement, however, a law of diminishing return applies whereby it becomes very costly to derive small reductions in the dwelling emission rate. Low carbon energy generation will certainly be required to achieve the Code level 5 mandatory dwelling emission rate standard and it is likely that both a low carbon heating and low carbon generation technology will be required.

4.1.1 FABRIC ENERGY EFFICIENCY IMPROVEMENTS

Through the consultation process, developers provided details on the specifications that are typically employed when designing to Code level 3 and Code level 4. Significant variations in the approaches adopted were observed between developers, even for a common Code level. Based on the ranges of specifications described by the developers and using SAP modelling of the impact of various fabric specifications on dwelling emission rate when applied to the standards house types (see Table 9), a range of fabric improvement packages have been defined. These packages are described in the table below, together with the dwelling emission rate improvements they deliver in the standard house types.

[6] Description of the change from heat loss prevention to fabric energy efficiency standards

Table 12: Specification of the three main fabric improvement packages

Fabric Specifications		Basic	Good	Advanced
Wall U-value (W/m^2K)		0.23	0.18	0.15
Floor U-value (W/m^2K)		0.18	0.15	0.1
Roof U-value (W/m^2K)		0.15	0.13	0.1
Window U-value (W/m^2K)		1.5	1.4	1.1
Door U-value (W/m^2K)		1.5	1.4	1.1
Air permeability ($m^3/m^2/hr$)		5	3	1
Thermal Bridging (W/m^2K)		0.08	0.06	0.04
Mode of ventilation		Natural	Natural	MVHR
dwelling emission rate/target emission rate improvement achieved	Flat	23%*	28%	38%
	Terrace	16%	24%	40%
	Semi	17%	26%	42%
	Detached	17%	26%	44%

* Note that in the case of apartments, a small improvement on the Basic fabric specification (e.g. external wall U-value to 0.2 W/m2K) would be sufficient to achieve a 25 per cent improvement of dwelling emission rate/target emission rate (i.e. compliant with Code level 3 mandatory requirement).

The fabric efficiency packages can be summarised as follows:

- **Basic** – This is representative of a fabric improvement package typically employed at Code level 3. These fabric improvements alone do not quite reach the 25 per cent dwelling emission rate improvement and so a certain capacity of low carbon generation technology would be applied. Note that a slight variant on this fabric package would be sufficient to achieve Code level 3 in a flat without low carbon generation.

- **Good** – A further enhanced fabric standard that would achieve the requirement of Code level 3 in each of the standard house types. This may be more typical of a level of fabric improvement employed at Code level 4.

- **Advanced** – A very tight level of fabric efficiency combining low U-values for each building element with very low air permeability and thermal bridging. A great deal of attention in construction and detailing would be required to achieve this level of air-tightness and avoidance of thermal bridges. A mechanical ventilation system will be necessary at such low air permeability level in order to maintain a comfortable environment.

The extra-over costs of achieving each of these fabric packages has been assessed, where the extra-over cost is the cost associated with improving the specification from a typical Part L 2006 compliant specification (i.e. the specification assumed in the standard house type). The extra-over costs of the fabric improvement packages are tabulated below:

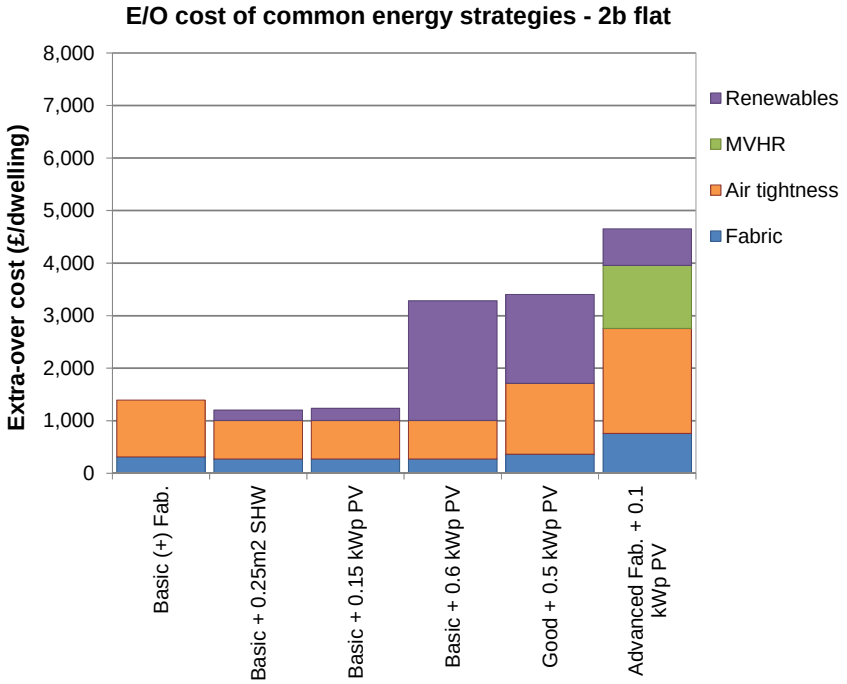
Table 13: Extra-over costs of the fabric improvement packages in each of the dwelling types (note these are the costs associated with improving the fabric standard over the base build specification). (Baseline: Part L 2006 compliant dwelling.)

Package	Two-bed flat	Two-bed terrace	Three-bed semi	Four-bed detached
Basic	£1,006	£1,070	£1,245	£1,460
Good	£1,710	£2,125	£2,650	£3,165
Advanced	£3,956	£5,440	£6,965	£8,080

4.1.2 COSTS OF TYPICAL ENERGY STRATEGIES

The fabric packages introduced above have been modelled in SAP 2009, to determine the capacity of low carbon generating technologies that would be required to comply with the mandatory dwelling emission rate reductions of each level of the Code.

The consultation with house-builders revealed that the most common approach to Code Level 3 is either to achieve the required dwelling emission rate reduction through fabric alone or to combine a more modest fabric improvement with solar thermal systems. At Code level 4, solar thermal does not tend to be used, with most house-builders with experience of building to this level combining fabric improvement with photovoltaic to reach the required energy standard. Extra-over costs for Code Level 3 and 4 compliant energy strategies are shown in the plots below, based on the three fabric packages in combination with photovoltaic or solar hot water systems.



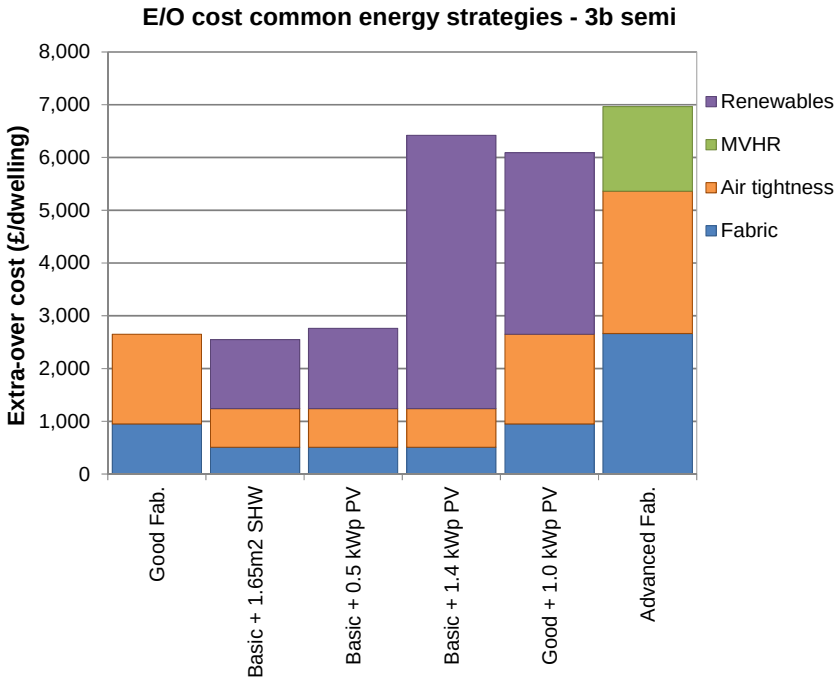


Figure 5: Extra-over costs of typical Code Level 3 and 4 energy strategies, in the two-bed flat and three-bed semi dwelling type (Baseline: Part L 2006.)

The cost analysis found there to be very little difference between the extra-over costs of the three typical Code Level 3 energy strategies. The combination of Basic Fabric with a solar hot water system is very marginally the lowest cost solution in both the flat and semi-detached house types. This is in accordance with the findings of the consultation.

Several developers consulted cited simplicity as a desirable feature in any approach to meeting the Code energy strategy, preferring to avoid installing low carbon technologies until necessary. The analysis suggests that the choice between a fabric-only approach to meeting Code Level 3 and a low carbon technology based approach is practically cost neutral. This may suggest that a fabric-only approach is likely to become standard now that the 25 per cent improvement of dwelling emission rate has become mandatory through Part L 2010 of the Building Regulations.

The Code Level 4 energy standard is difficult to achieve through fabric alone (in the case of the flat, the Advanced Fabric package requires a small capacity of photovoltaic). Based on the cost analysis the Advanced Fabric package is a more expensive approach to achieving Code Level 4 than combination of a less challenging fabric standard with photovoltaics. The typical approaches to Code Level 4 are either to maintain the Code Level 3 fabric standard and add greater low carbon generation capacity or to improve the fabric standard so as to reduce the requirement for further low carbon generation. The cost analysis suggested the latter approach is more cost-effective in houses, but that in flats there is little difference between the two approaches.

Although based on current costs a fabric-only approach to Code Level 4 is more expensive than an approach that includes low carbon generation, there are those in the house-building industry that believe a fabric-only approach will eventually be the most affordable route to Code Level 4. The AimC4 project, led by a consortium of house-builders, research institutions and building materials providers, is pioneering the use of innovative materials and processes to develop homes that meet the Code Level 4 dwelling emission rate standard through fabric solutions alone. The consortium aims to demonstrate a route to volume production of affordable Code Level 4 homes based on a 'fabric first' construction method[7].

4.1.3 ALTERNATIVE ENERGY STRATEGIES

Currently there is limited experience of building Code Level 5 and 6 homes and certainly too little to identify common approaches to meeting the mandatory dwelling emission rate reductions at these Code levels. One approach to the higher standards would be to increase the capacity of photovoltaics installed, potentially with an improvement to the fabric standard. In many cases, however, the practical applicability of this approach is likely to be limited by lack of available roof space, particularly in the case of Code level 6. To reduce the requirement for low carbon electricity generation, approaches to Code Level 5 and 6 may involve the use of a low carbon heating technology as the primary heating source.

The costs of energy strategies involving low carbon heating technologies have been analysed at Code Levels 4 to 6 (there is little evidence through the consultation of low carbon heating technologies being employed at Code Level 3). The analysis has focused on biomass boilers and air source heat pumps, which were assumed to have more widespread applicability than ground source heat pumps. In the case of flats, it is assumed that biomass boilers would be communal, but that air source heat pumps are installed individually in each flat (communal heat pumps are also a potential alternative).

In Figure 6 below, the extra-over costs of energy strategies involving air source heat pumps and biomass boilers are compared with packages based on fabric improvement and photovoltaic, for Code levels 4, 5, and 6. The cost analysis is shown for each of the four standard house types. A list of the central energy strategies assessed in this study is given in the appendices (Section 0).

[7] More information on the work of the AimC4 consortium can be found on their website www.aimc4.com/index.jsp

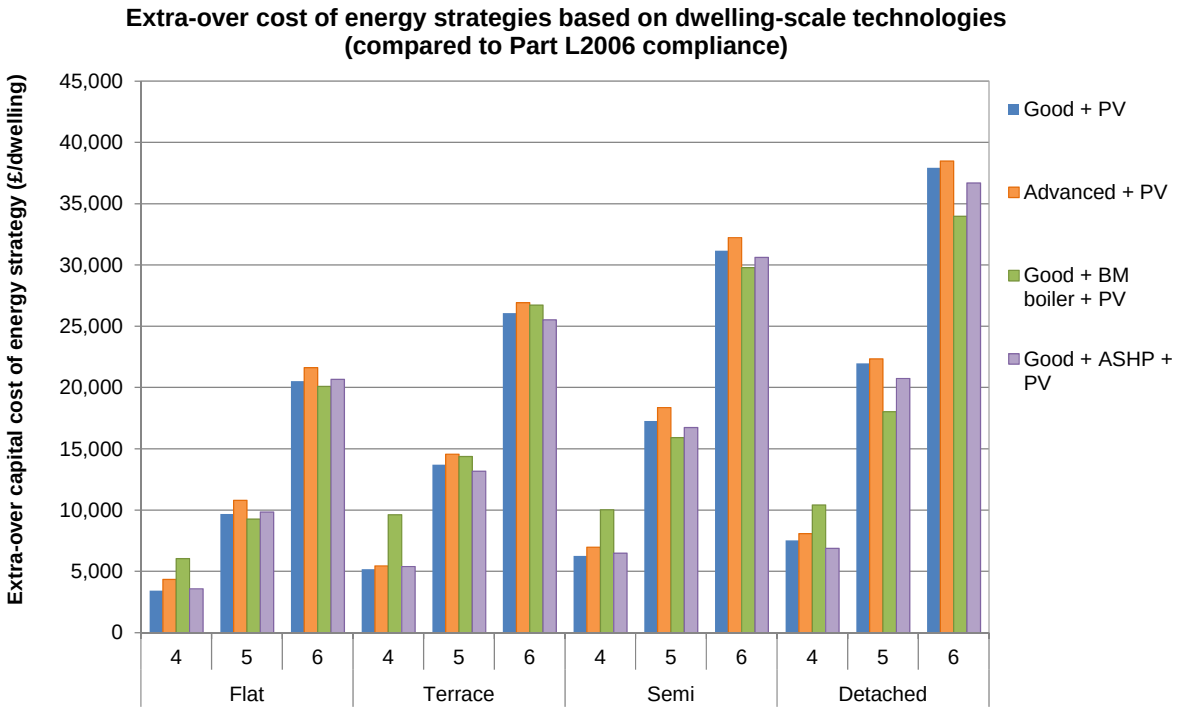


Figure 6: Extra-over cost of achieving the mandatory dwelling emission rate standards at higher Code levels (4 to 6) using dwelling-scale technologies (note that in the case of the biomass boiler strategy (BM boiler) in flats, the boiler is assumed to be a communal boiler serving the block). (Baseline: Part L 2006.)

At Code Level 4, the cost of the air source heat pump-based energy strategy is very similar to that of the lower cost photovoltaic strategy (i.e. Good fabric and photovoltaic). Given that a small capacity of photovoltaic is also needed in the air source heat pump-based strategy to meet the Code Level 4 standard, house-builders may prefer to install a larger photovoltaic array and avoid installation of the heat pump. Most house-builders consulted believe that air source heat pumps still need to be proven, both in terms of reliability and also to demonstrate that the seasonable performance factors claimed by manufacturers are achievable in practice. If this is the case as experience of using heat pumps grows, then they may become popular as an alternative to gas boilers, enabling costs of gas connections and infrastructure to be avoided.

Biomass boilers provide a reduction of dwelling emission rate that significantly exceeds the requirement of Code Level 4 and as such. Additional credits will be gained for the achieving a higher dwelling emission rate reduction, however these are less cost-effective than achieving credits under a number of other Code issues (see Section 5), hence biomass boilers do not represent a cost-effective approach to Code Level 4.

At Code Levels 5 and 6, biomass boilers (in combination with photovoltaics) do appear to present a lower cost solution compared to air source heat pump or photovoltaic-based strategies. The inclusion of a biomass-fuelled heating system significantly reduces the capacity of photovoltaic required to meet the Code Level 5

or 6 standard, which may make the highest Code standards more achievable in developments where there is limited area for installing photovoltaic.

Community-based energy infrastructure

The cost analysis has shown that biomass boilers provide a lower cost approach to Code Levels 5 and 6. If a biomass-fuelled heating system is employed, then a centralised boiler plant with community heating infrastructure may be more practical and potentially more cost-effective than individual, dwelling-scale biomass boilers. The central boiler plant allows better control of emissions from use of biomass fuel (particulates and NOx), which may allay the concerns over air quality often associated with use of biomass. The larger centralised plant, particularly on larger developments, may also enable the use of wood chip, rather than the more expensive pelletised fuel used in small-scale boiler technology.

Centralised heating plant is likely to be more cost-effective, in terms of cost per kW of heating capacity installed, than dwelling-scale technologies. This is offset by the requirement for community heating infrastructure, which is a significant additional cost. The costs of community-based energy systems have been assessed for each of the standard development scenarios (see Table 10) and are compared to the least cost dwelling-scale energy strategies in Figure 7 below.

The community energy systems assessed are gas combined heat and power, biomass heat-only boilers and biomass combined heat and power. Biomass combined heat and power has only been assessed in the case of the largest two development scenarios, as only in these scenarios does the capacity of combined heat and power system required reach the range of current availability of biomass combined heat and power systems (note it is assumed that combined heat and power systems are operated in a heat-load following mode, without significant heat rejection). The community energy systems have only been assessed in the case of Code levels 4 to 6, as a community-scale system is unlikely to be commonly applied at Code Level 3.

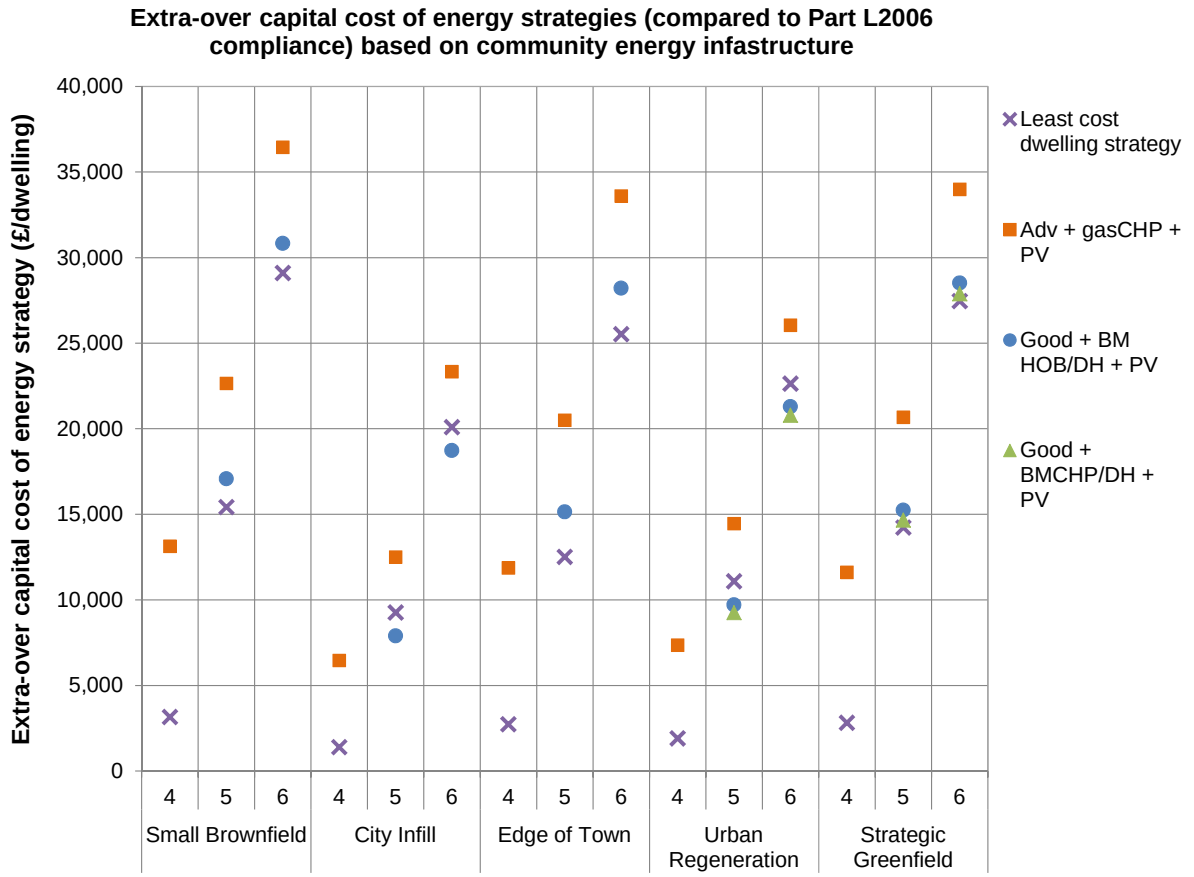


Figure 7: Extra-over costs of community-based energy infrastructure at Code levels 4 to 6 compared to the least cost dwelling-scale approach for each of the development scenarios (note that the extra-over costs shown are for averaged over the total dwellings in the development scenario). (Baseline: Part L 2006.)

The gas combined heat and power based energy strategy is a relatively expensive means of meeting the higher Code levels and is in all cases, significantly more expensive than the least cost dwelling-scale solution. The biomass-based community energy systems are the least cost approach to meeting Code Level 5 and 6 in the higher density developments – the City Infill and Urban Regeneration scenarios. In the case of the large-scale, modest density Strategic Greenfield development, the extra-over costs of the biomass-based community systems are closely comparable with the dwelling-scale solution, which at Code Level 5 and 6 is based on individual biomass boilers.

The analysis suggests that the cost comparison between dwelling-scale and community solutions is dependent on the development density – the cost of community heating infrastructure per dwelling tending to be lower on higher density developments, due to lower pipe lengths per dwelling connected.

There are a number of issues associated with provision of a community-based heating infrastructure that may be unfamiliar to many house-builders. An organisation will be needed to manage the community heating infrastructure, involving metering and billing heat customers, managing fuel supply contracts and deliveries (in the case of biomass), as well as maintenance of the system. Larger developers may have property management departments to provide these services,

but many house-builders will not want to remain responsible for maintaining the assets and managing heat supply contracts.

4.1.4 BIOMASS ISSUES

The analysis of potential energy strategies has highlighted the role that biomass-fuelled systems might play, particularly as developers seek to achieve Code levels 5 and 6. There are a number of barriers to the widespread use of biomass however, as summarised in the diagram below.

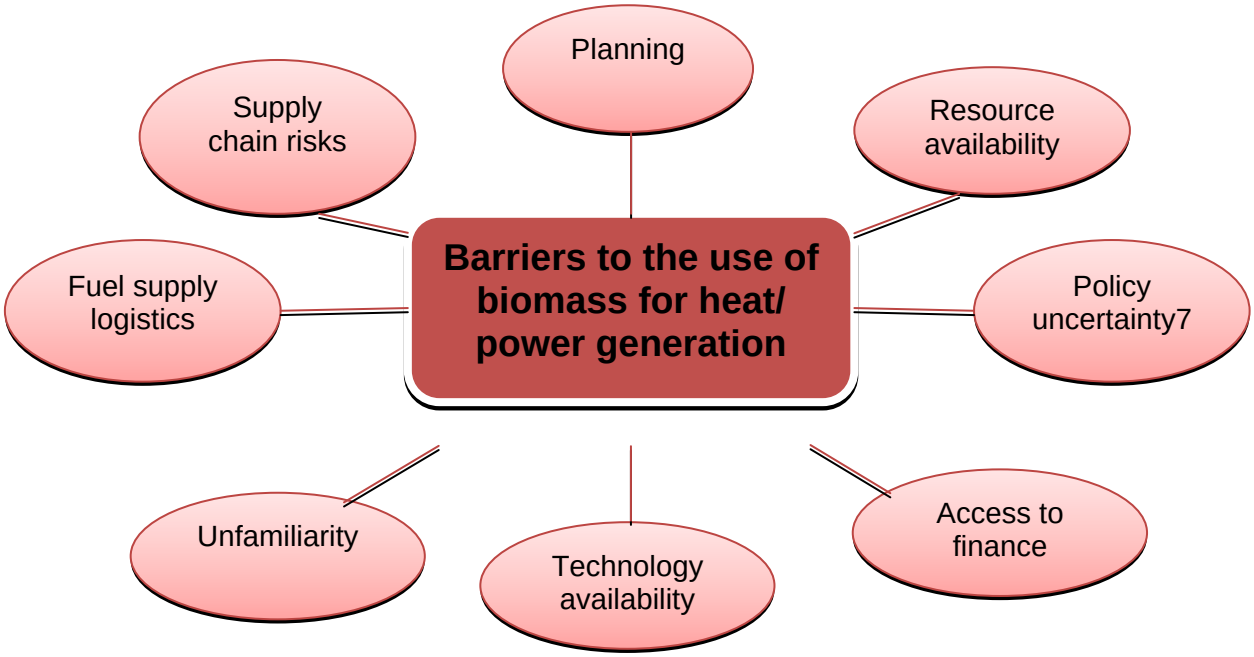


Figure 8: Barriers to the widespread use of biomass for heat and power generation

Resource availability – The most relevant biomass fuels for residential energy systems are likely to be wood fuel – virgin wood from forestry and tree surgery and waste wood, e.g. from sawmills, furniture making, paper industry etc – and energy crops, such as short rotation coppice, miscanthus and willow.

The existing virgin wood resource is around one million oven dried tonnes per year (odt/yr). The UK biomass strategy (2007)[8] predicts that this could be doubled by bringing currently unmanaged woodland into management Very approximately, this resource could provide heat to one million homes, if used in heat-only boilers (less if used in combined heat and power systems, although the carbon saving may be increased). The Strategy also predicts that the energy crop resource could be a third larger and the waste wood resource double that of virgin wood (note these are the technical potential of the energy sources, not considering economics of supply and use).

The biomass resource is substantial, although currently largely untapped.

Agricultural residue, such as animal slurry and poultry litter, and food wastes have not been considered here. These can be used to generate a biogas through

[8]http://www.biomassenergycentre.org.uk/pls/portal/docs/PAGE/RESOURCES/REF_LIB_RES/PUBLICATIONS/UKBIOMASSSTRATEGY.PDF

anaerobic digestion, which can then be used for heating, in combined heat and power engines or injected into the gas grid. There may be some potential for anaerobic digestion as part of a community energy infrastructure on large developments, particularly as electricity generated from biogas is supported under the feed-in tariff. Planning for anaerobic digestion plants in close proximity to residential developments may be a significant barrier however.

Supply chain risks – The supply chain for wood fuels is currently highly fragmented and for energy crops in early stages of development. This can present problems for developers of biomass projects in securing sufficient volumes of supply, particularly if looking to source fuel from the local area. The current early stage of the supply chain, price variability and uncertainty over future price trends is also a significant risk for biomass project developers.

Planning – Local planning authorities' concerns regarding use of biomass tend to focus on air quality impacts and, for larger-scale projects, traffic impacts related to the supply of fuel.

To achieve national air quality objectives local authorities are obligated to measure air quality and attempt to predict how it might change in their region. Air quality management areas are declared in areas where any objectives are not likely to be achieved. A Local Air Quality Action Plan is then developed to combat the issue. In addition the Clean Air Act (1993) allows local authorities to declare the whole or parts of their district to be a smoke control area. Designated smoke control areas and air quality management areas can significantly constrain the areas where biomass fuel is acceptable on planning grounds (as discussed above, exhaust gas treatment to remove NOx and particulates can mitigate these concerns in some cases, although these technologies are only economic on large-scale plant).

Technology availability – While biomass heat-only boilers are available across a wide variety of sizes, there is a lack of biomass combined heat and power systems at scales relevant to most residential development. Those technologies that are available at small-scale, e.g. organic rankine cycles systems are available down to around 200 kW electrical capacity, tend to be high capital cost. There is also a lack of experience with these systems in the UK.

Policy uncertainty – There is currently little subsidy for generation of low carbon heat. This is set to change with introduction of the renewable heat incentive, but while the details (e.g. tariff levels) and funding for this scheme are uncertain, project developers cannot business plan biomass projects. Solid biomass combined heat and power systems were also excluded from the feed-in tariff, although support for electricity generated by biomass is still available under the Renewables Obligation.

Access to finance– There is currently a lack of availability of finance for systems at a community-scale, due to unproven technology, policy uncertainty and fuel supply chain risks.

Unfamiliarity – Unfamiliarity with biomass technology and biomass fuel is a barrier at all levels, from the home-buyers, many of whom will not be used to a solid fuel heating system or receiving heat over a district system, to the house-builders who have little experience of planning biomass projects or installing plant and to finance-providers who view small-scale biomass as risky.

4.1.5 WIND-BASED ENERGY SYSTEMS

All the energy strategies discussed above assume that photovoltaics are used in combination with the various thermal plant options in order to achieve the necessary reduction of dwelling emission rate. Site-scale wind turbines could be considered as an alternative to photovoltaics in certain developments.

On-site wind has not been considered as a central technology in this assessment. None of the house-builders consulted identified sites where they have installed wind turbines as a means of achieving a Code rating. Wind resource constraints, space constraints and planning, along with a number of other geographical and regulatory constraints, will rule out the option of wind turbines in a substantial proportion of housing developments. In those cases where there is a good wind resource, space on site at adequate separation from buildings and other physical hazards and no other particular constraints on wind development, then wind turbines could provide a lower cost means of achieving dwelling emission rate targets.

It is unlikely that wind turbines would be considered as a solution at Code Level 3, given that the standard can be met by fabric improvement alone or by combining fabric improvement with a limited amount of low carbon energy generation. The extra-over capital cost of strategies aimed at meeting Code levels 4 to 6 are shown in the figure below for a range of development scenarios. Costs for wind turbine strategies have not been shown in the case of the City Infill development scenario, as it is unlikely that on-site wind would be applicable in these types of development. For comparison, the extra-over costs of the lowest cost photovoltaic based strategies are plotted on the same graph.

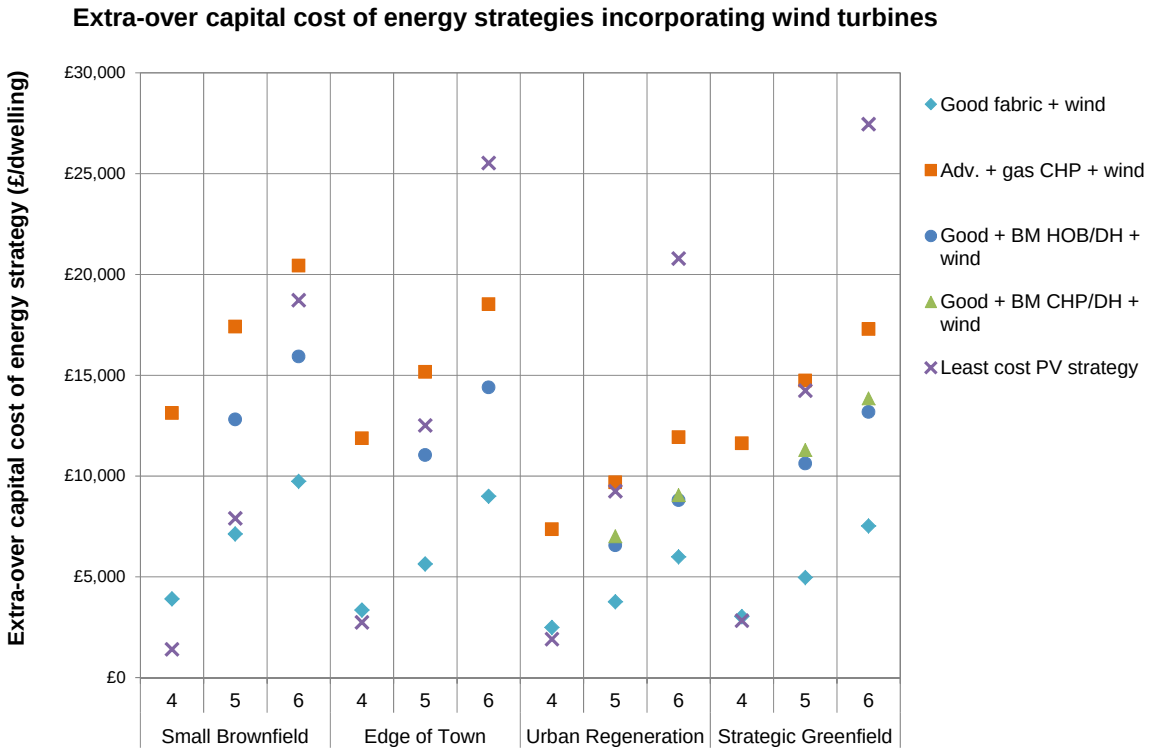


Figure 9: Extra-over capital costs of energy strategies incorporating wind turbines compared to the lowest cost photovoltaics-based strategy (Baseline: Part L 2006.)

At Code level 4, the extra-over costs of wind and photovoltaics-based strategies are fairly similar. At this Code level, the capacity of wind turbines required is relatively small and the capital costs of turbines high on a £/kW basis. At Code level 5 and 6, however, the extra-over costs of wind-based strategies are generally significantly lower than the lowest cost photovoltaic strategy relying on photovoltaic. The greater requirement for low carbon electricity to meet Code level 5 and 6 mandatory carbon standards justifies a switch to larger scale wind turbines, which provide more cost-effective low carbon electricity generation.

The analysis suggests that where wind turbines can be deployed, the lowest cost means of achieving the carbon reduction targets is to rely heavily on wind for low carbon generation, rather than combining wind turbines with low carbon heating. The total wind turbine capacity required in combination with fabric improvement alone is shown in the table below for each development scenario.

Table 14: Wind turbine capacity to achieve mandatory dwelling emission rate targets at each Code level, assuming fabric improvement but no low carbon heating source

Development	Wind turbine capacity (kW)		
	Code level 4	Code level 5	Code level 6
Small Brownfield	9	28	64
Edge of Town	40	130	298
Urban Regeneration	283	1,020	2,508
Strategic Greenfield	822	2,671	6,082

As a very approximate guide, the power density of wind turbines in terms of required land area varies from around 80m^2/kW for a 15 kW turbine to around 15 m^2/kW for a 2MW turbine. So, for example, the land area required for wind turbine installation on the Strategic Greenfield site would be around 90,000 m^2 (note that buildings would be excluded from this area, but it could provide amenity space).

4.1.6 FINANCING ENERGY STRATEGIES

As discussed, the development of a community-based energy infrastructure offers the opportunity to defray the investment cost through the sale of heat and power. The developer may operate the community system themselves or, perhaps more likely, a third-party organisation will invest in the development of the system on the basis of the projected revenues. Further opportunities to generate a return on investment in low carbon energy systems have become available through the financial incentive regime, notably the feed-in tariff and the anticipated renewable heat incentive.

Where the low carbon heat or electricity is generated by centralised plant, the organisation that owns that plant will clearly capitalise on the feed-in tariff or renewable heat incentive revenues. In the case that the low carbon technology is installed in a home, such as a roof-mounted photovoltaic array, the home-buyer may want to benefit from the feed-in tariff revenues. There are, however, a number of organisations that finance photovoltaic installations in existing homes, whereby the home-owner benefits from use of the electricity generated by the system and the financing organisation takes the feed-in tariff revenues. This arrangement could equally apply to new build housing, in which case the cost of the photovoltaic installation to the developer is greatly reduced.

At the time of writing, the feed-in tariff has been in operation a relatively short time and the renewable heat incentive has not yet been introduced. Hence the impact of these incentives on developers' technology choices is yet been seen, although some of the developers consulted have experienced that housing associations are increasingly specifying that photovoltaics should be installed as part of the energy solution. The opportunities to generate revenue from energy systems and to attract financing from third-parties may however influence developers' selection of energy solution in the future. To assess the impact of ongoing revenue opportunities on the

selection of energy strategy, the dwelling-scale and community-based energy solutions have been compared on the basis of net present value of the investment.

The net present value is the difference between the capital cost and the present value of operating costs and revenues over a 20-year period (operating profits are discounted at a rate of 8 per cent). In this analysis the net present value represents the cost to the developer, for example assuming that a third party provides a capital contribution on the basis of the present value of operating profits.

In the case of dwelling scale technologies, it is assumed that revenues from the feed-in tariff and export of electricity to the grid can be capitalised on by the developer or third-party. Electricity used within the home is a benefit to the occupier. In the case of renewable heating technologies installed within the home, however, it has not been assumed that the developer or a third-party are able to capitalise on the renewable heat incentive for consumption of renewable heat.

In the figure below the comparison between most economic dwelling-scale technologies and community-scale energy infrastructure is shown, on the basis of the net-present value of the investment.

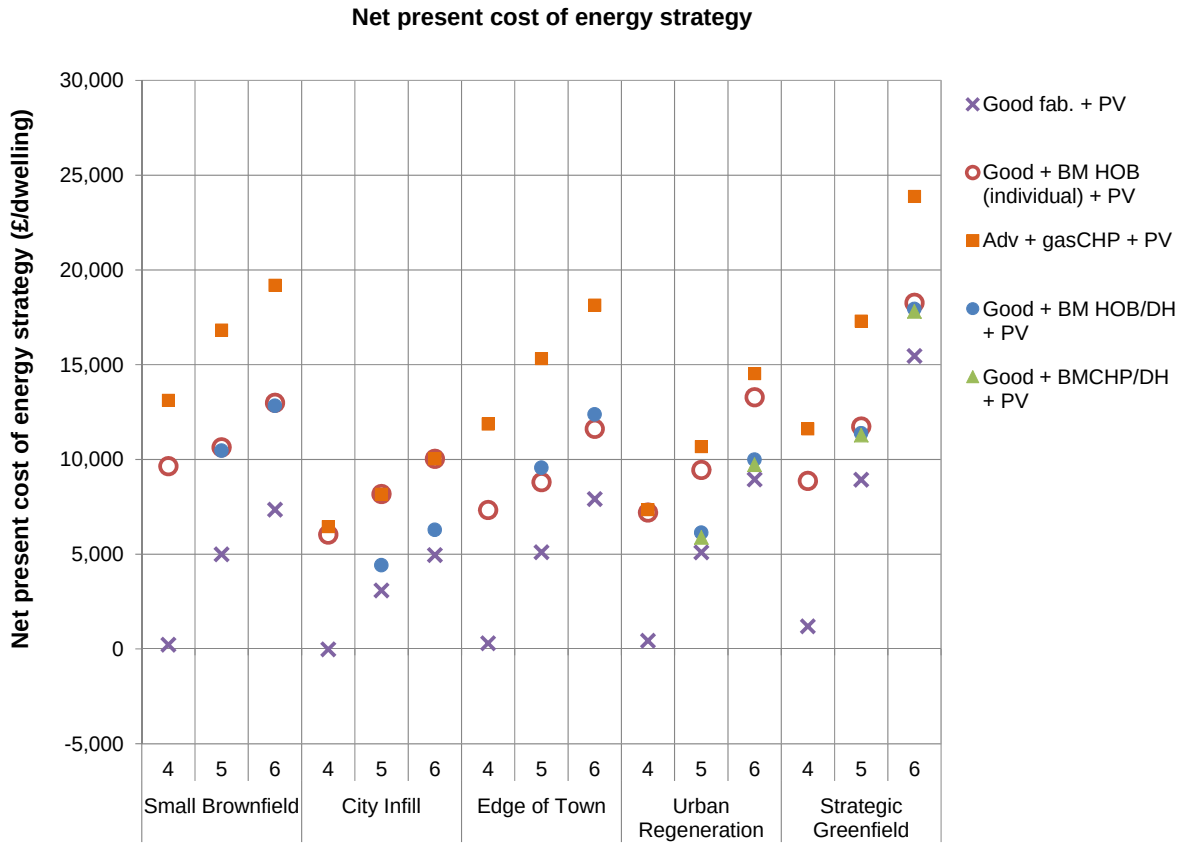


Figure 10: Net present cost of energy strategies devised to meet the Code level 4 to 6 mandatory emissions standards, for each development scenario (Baseline: Part L2006.)

On the basis of net present value of the investment, the 'Good fabric' and photovoltaics energy strategy is the most economic, thanks to the relatively generous feed-in tariff support for photovoltaic. However, this is unlikely to be practical at Code levels 5 and 6 in a large proportion of developments, due to the constraints on space availability for installation of panels. If it is assumed that Good fabric improvement and photovoltaic is not feasible at Code levels 5 and 6, then in the higher density development scenarios, i.e. the City Infill and Urban Regeneration, the community-based infrastructures provide the most economic energy solutions. In the case of the lower density developments, the economics of dwelling-scale solutions and community-based systems are closely matched at Code levels 5 and 6.

In all cases, fabric improvement and photovoltaics is likely to be the most economic solution at Code level 4 under the current incentive regime. Note that the net present value of this energy solution is close to zero for systems compliant with the requirements of Code level 4, i.e. potentially cost neutral to developers. The potential to finance investment in energy systems on the basis of future revenue could considerably reduce the capital cost to developers at higher Code levels. The net present value of Code level 5 energy solutions are in the range of £5,000 to £10,000 and between £10,000 to £15,000 at Code Level 6 (in each case the costs are slightly higher for the Strategic Greenfield development).

4.2 Water

The mandatory requirement of *Wat 1: Indoor water use* stipulates that consumption must not exceed 120, 105 and 80 litres per person per day at Code levels 1 and 2, 3 and 4 and 5 and 6 respectively. The consultation discussions were focused on the specifications required to meet the 105 l/p/d requirement at Code levels 3 and 4 and the associated costs. There is less experience of meeting the Code Level 5 and 6 mandatory standards, however the Code Water Calculator Tool can be used to identify the water saving features that would be required to achieve the 80 l/p/d standard.

Typical water feature specifications at Code level 3 and 4 and a potentially appropriate solution for Code level 5 and 6 is tabulated below.

Table 15: Packages of water measures appropriate to the Code level 3 & 4 (105 l/p/d) and Code level 5 & 6 (80 l/p/day) mandatory Wat 1 standards.

Water saving feature	Code Level 3 and 4	Code Level 5 and 6
Water consumption (l/p/d)	105	80
Low flush WCs	4/2.6 l	4/2.6 l
Low flow wash basin taps	2 l/min	2 l/min
Low flow shower	6 l/min	4.5 l/min
Bath capacity	150l	100 l
Kitchen tap flow rate	4 l/min	4 l/min
Rainwater harvesting	No	No

Greywater recycling	No	Yes
Water efficient washing machine	No	Yes

The extra-over costs associated with the water feature specifications described above have been estimated based on discussions with house-builders, supplemented with Davis Langdon's cost databases where necessary. The Wat 1 extra-over costs are tabulated below:

Table 16: Extra-over costs of water feature specifications suitable to achieving the mandatory Wat 1 consumption standards at Code levels 3 and 4 and 5 and 6.

Water specification extra-over cost	Two-bed flat	Two-bed terrace	Three-bed semi	Four-bed semi
Code level 3 & 4 (105 l/p/d)	£150	£150	£200	£200
Code level 5 & 6 (80 l/p/d)	£6,150	£4,650	£4,700	£4,700

4.3 Other mandatory issues

In addition to the mandatory requirements under the Energy and CO_2 and Water categories, there are four further mandatory issues. These issues, which are under the Materials, Surface Water and Waste categories, are mandatory at all Code levels without any differentiated requirements between the Code levels. A brief description of these mandatory issues and associated extra-over costs is given below:

Mat 1: Environmental Impact of Materials

The mandatory element of this issue involves achieving a Green Guide rating of A+ to D for at least three of the following building envelope elements: roof, external walls, internal walls, upper and ground floors, windows. Previous work on costs of building to the Code assumed that meeting this requirement would not represent an extra-over cost as most developers' base build specifications would comply. Feedback from developers during the consultation undertaken for this study suggests that this is the case.

Sur 1: Management of Surface Water Run-off from developments

The uncredited mandatory element of this issue consists of meeting two requirements[9]:

1. Peak rate of run-off – peak run-off rate into watercourses must not increase as a result of development of the site.

2. Volume of run-off – additional predicted volume of rainwater discharge due to a 1 in 100 year event of six hour duration must be entirely reduced using infiltration and/or made available for use in the dwelling for non-potable applications.

[9] For full details see the Code Technical Guide, p.139–140.

The costs of complying with these requirements will be highly site specific and in some cases may be substantial. There was a general consensus amongst developers consulted, however, that meeting this mandatory aspect of Sur 1 is not an extra over cost due to the Code. In most cases the Environment Agency enforces policies to ensure that new development does not increase the chance of flooding. Drainage systems for new development must therefore be designed to in such a way that the mandatory requirement of Sur 1 is met by default.

Developers have raised concerns over the stipulation under Sur 1 that rainwater discharge must be made available for use in dwellings if it cannot be entirely reduced using infiltration. This implies a requirement for rainwater harvesting systems to be used in sites where ground conditions are not compatible with infiltration. A requirement for rainwater harvesting does impose a significant cost. A cost of £3,500/unit has been assigned on the basis of consultation responses and internal cost data, which includes the tank, filters, pumping, pipework and controls. This cost is also likely to be somewhat site specific, depending, for example, on ground conditions.

An amendment to the technical requirements of the mandatory element of Sur 1 has been made following the 2010 Code consultation, which is intended to alleviate the high associated costs on sites with limited scope for infiltration. The new requirements provide greater flexibility in the approach to managing volume rate of discharge and broaden the range of SuDs techniques that are acceptable[10]. The revision to the technical requirement has added an additional requirement to the mandatory element 'Design for System Failure', requiring the dwellings to be protected from flooding in the event of a failure of the local drainage system. No indication of the likely costs of complying with this new requirement was available through the consultation.

Was 1: Storage of non-recyclable waste and recyclable household waste

All Code homes must include adequate internal and external space for waste storage. Container volumes must meet or exceed those recommended by British Standards 5906 and all containers must be accessible to disabled people.

Developers provide waste storage space that meets these requirements to satisfy client expectations, which means that this aspect of the Code is not perceived to be overly onerous.

Was 2: Construction Site Waste Management

To date a site waste management plan has been required on all sites where a Code rating is sought. Many developers reported that a site waste management plan is generally required anyway, so this element of the Code represents duplication[11]. In recognition of this feedback, this mandatory requirement has been removed from the Code in the October 2010 revision.

[10] Consult the technical guide for a full description of the revised mandatory element of Sur 1 http://www.planningportal.gov.uk/uploads/code_for_sustainable_homes_techguide.pdf.

[11] A site waste management plan has been required on all sites with an estimated cost of £300,000 or above (excluding VAT) since the introduction of the Site Waste Management Plan Regulations 2008. The regulations can be enforced through fixed penalty notices issued by local authorities or the Environment Agency.

5 Overall approaches to Code compliance

Once the mandatory issues at a particular Code level have been addressed, the house builder has flexibility to choose which other issues to address in order to accumulate sufficient credits and therefore sufficient Code points to achieve the targeted Code level.

The house builder is likely to seek to achieve the least cost approach to achieving any given Code level. On this basis, a model has been developed to predict which issues a house builder is likely to tackle in achieving each Code level. The model assumes that issues will be addressed sequentially, in order of their cost-effectiveness on a £/point basis. The model allows prediction of the overall extra-over cost of each Code level to be predicted, i.e. the cumulative cost of all issues adopted in achieving the necessary points score for a particular Code level.

On the basis of the consultation with a range of house-builders we have attempted to assign a typical cost to each credit available under the Code. The complete table of extra-over costs at the issue level is shown in the appendices (see Appendix C).

It is clearly difficult to assign a single cost to each of the Code's issues as, in reality, these costs will be dependent on a multitude of factors, many of which will be specific to a particular site (the cost of Surface Water and Ecology credits, for example, will be highly site specific). The extra-over cost to a particular house-builder will also be dependent on their typical build specification and capabilities of their existing supply chains. It is not possible to account for these sensitivities in an analysis of the Code extra-over costs that seeks to be broadly relevant. The potential variability in costs and the factors that will drive these variations are discussed in Section 5.2.

The approach to achieving a particular Code level and the associated extra-over cost will also depend on whether the home is being built for the private market or as social housing. In the case of social housing, the housing association may specify that certain features that attract Code credits, for example lifetime homes or secured by design, must be included as a condition of public funding. The differences in approach and Code costs between private and social housing are explored in Section 5.2.4.

5.1 Low and zero cost measures

Certain Code credits tend to be gained at very low cost by the majority of house builders consulted, either by continuing to follow their standard practices or by minor alterations that do not attract a significant cost penalty. There are also certain Code issues that house builders will typically be required to address irrespective of whether a Code level is being sought, for example as a result of planning policy or Environment Agency requirements. Although the measures adopted to meet these requirements may have an associated cost, they are not attributable to the extra-over cost of the Code.

The issues that were frequently identified as zero or nominal cost are summarised in the table below. In some cases a particular issue was identified as providing zero-cost credits, but the number of credits believed to be awarded at no cost differed between the house builders. The range in the number of credits thought to be available at zero cost is also shown.

Table 17: Summary of the Code issues that the majority of house-builders identified as being addressable at low or zero cost and the number of credits available at minimal cost

Issue	Total credits available	Proportion of developers reporting zero extra-over cost	Credits gained at zero extra-over cost		
			Low	High	Mean
Mat 1: Environmental Impact	15	89%	6	14	9.9
Mat 2: Sourcing - Basic Elements	6	78%	1	5	3.3
Mat 3: Sourcing - Finishing Elements	3	67%	1	3	1.7
Sur 2: Flood Risk	2	67%	2	2	2.0
Was 2: Construction Waste Management	2	89%	2	2	2.0
Pol 1: Insulant GWP	1	89%	1	1	1.0
Pol 2: NOx Emissions	3	67%	1	3	2.3
Hea 3: Private Space	1	67%	1	1	1.0
Man 2: Considerate Constructors Scheme	2	56%	2	2	2.0
Eco 1: Ecological Value of Site	1	56%	1	1	1.0
Eco 3: Protection of Ecological Features	1	89%	1	1	1.0

All house builders spoken to agreed that zero cost credits were available in the Materials category, although there was a wide discrepancy in the numbers of credits achieved at no cost. Where credits were not attained through standard practices there was only limited evidence of changes to specifications and supply chains to increase the number of credits achieved. Administrative burden and onerous requirements for documentation were cited as barriers to achieving higher numbers of credits.

Two credits are available under Sur 2 'Flood Risk' if the site is situated in an area of low annual probability of flooding and where the site specific flood risk assessment indicates a low risk of flooding from all sources. For developments sited in compliant locations and assuming a flood risk assessment would be required in any event (i.e. is not a Code specific requirement), then this is a zero extra-over cost issue. For sites that are located in a medium or high flooding risk area, then credits under this issue are likely to be highly costly to achieve.

The majority of house-builders agreed that achieving two credits under Was 2 'Construction Waste Management' was zero extra-over cost, as site waste management plan including procedures for waste minimisation and diversion from landfill would be executed as standard.

Under the Pollution category, there was a general consensus that the credit under Pol 1 for ensuring that blowing agents used in manufacture or installation of insulation materials have a GWP within required limits were achieved at zero cost. There were divergent views on how many credits could be achieved under Pol 2 at zero cost. This would depend on the NOx emissions levels of boilers installed as part of standard specifications.

Most builders agreed that credits under Hea 3 for provision of private space tended to be available at no additional cost in houses. In the case of flats it was noted that this could be a costly issue address if balconies were not included as part of the standard design.

It is difficult to generalise on the costs associated with credits under the Ecology category, as they are likely to be highly site specific. Development of sites of low ecological value is rewarded with a low cost credit under Eco1. Where a site has been confirmed as being of inherently low ecological value, a further credit is awarded under Eco 3 for protection of ecological features (i.e. where no features of ecological value have been identified).

5.2 Predicted approach to achieving Code levels

Based on the issue level analysis of Code costs shown in Appendix C, projections have been made of the least cost approaches to each Code Level and their associated extra-over costs.

Examples of the sequential adoption of Code issues on the basis of their cost-effectiveness are shown in Table 20. In these examples, it is assumed that the dwellings are built for the private market in the Small Brownfield development scenario. Based on the route to each Code level shown in Figure 11, the breakdown of expenditure in each category at each of the Code levels is shown in Table 19.

5.2.1 LEAST COST APPROACH

The modelling predicts that the least cost approach to meeting Code level 3 will involve targeting the zero and low cost credits in the Materials, Waste, Pollution and Management (Man 1 – 3) categories along with relatively low cost credits in the Energy category, e.g. energy efficient lighting credits, and in the Health category, e.g. the easier to achieve day-lighting and sound insulation credits. In the case of the three-bed semi, the private space credits (Hea 3) are assumed to be low cost, whereas in the flat these credits may be expensive to achieve (this assumes that balconies are not included as part of the standard specification. Balconies may be required as standard in social housing and, in practice, the market may demand balconies in private homes). In the example development it is also assumed that a large proportion of the Ecology credits are available at low cost. Ecology is potentially a key driver of overall Code costs and is discussed in more detail below.

The increased mandatory Energy and CO_2 standard at Code level 4 is the major contributor to the increase in overall Code extra-over cost. In order to achieve the overall points score required at Code Level 4, the modelling predicts that there are further relatively low cost credits that can be achieved in the Energy category, for example provision of home office capabilities. The cost modelling predicts that Lifetime Homes may be adopted at Code Level 4 in the case of flats, as this represents relatively cost-effective credits. Due to the higher cost of meeting Lifetime Homes in houses, it is not expected that this issue will be addressed until

Code Level 5. Note that in the social housing sector, Lifetime Homes is often a requirement of the social housing landlord, irrespective of the Code level requirement.

There is a substantial increase in mandatory dwelling emission rate requirement from Code Level 4 to 5, which will again account for a substantial proportion of the increase in extra-over cost. The change in the mandatory water consumption limit under Wat 1, which is likely to require greywater recycling, is also a significant cost increase. At Code level 5, higher cost issues such as Lifetime Homes (Hea 4) and Secured by Design (Man 4) are expected to be addressed in both flats and houses. Other harder to achieve credits under the Heath and Well-being category, in terms of achieving daylight factors and sound insulation, will also need to be addressed. It is assumed in this example that a biomass heating system is used to achieve the mandatory dwelling emission rate improvement. This results in a loss of credits under Pol 2 (NOx emissions) than would be the case if a gas condensing boiler were used as the primary heating source.

To achieve Code level 6 the majority of Code issues need to be addressed. The additional high cost issues that are expected to be adopted include achieving two credits for cycle storage and the second credit under Ene 5 for supply of energy efficient white goods (a substantial extra-over cost under the assumption that these are not supplied as part of a standard specification). Again it is assumed that a biomass-based energy system is employed to meet the dwelling emission rate requirement, resulting in a loss of credits under Pol 2. As a result, in order to achieve the minimum points requirement for Code level 6 it has been assumed that further credits will be achieved under the Materials section. The only other credits that are not adopted are those available under Sur 1 for treatment of rain-water run-off from hard surfaces and the credits awarded under Eco 4 for achieving major economic enhancement (in the case of homes it is further assumed that Eco 5 credits for efficient land use are not achieved, although a single credit is achieved in the case of developments with a high proportion of flats in the dwelling mix). The costs for the Surface Water and Ecology credits will be very site specific, however, it is assumed that these remaining credits would be highly costly to achieve in a majority of cases.

5.2.2 DEVELOPMENT SCALE AND DENSITY

The extra-over cost results shown in Table 19 are based on the City Infill (flat) and Small Brownfield development (three-bed semi) types. In each case, these are relatively small development scenarios (<50 dwellings) of varying density (high density in the case of the flatted City Infill development) and on previously developed land.

In terms of the extra-over costs of the Code, the scale and density of the development is likely to have the largest influence on the costs associated with the energy strategy. Developments of larger scale and higher density tend to be better suited to community infrastructure, due to economies of scale related to the centralised plant and lower district heating infrastructure costs (in terms of cost per connection). The variations in energy strategy costs are explored in detail in Section 4.1.

There are a number of other Code extra-over costs that exhibit a dependency on development scale, although these tend to be less significant than the energy strategy costs. Issues that are addressed at a site level rather than at the individual dwelling level will tend to benefit from economies of scale (i.e. such that the per dwelling cost is lower), these include issues under the Management category (Home User guides, Considerate Constructors, Construction Site Impacts), Construction Site Waste Management and also professional fees (e.g. Code assessors, ecologists, energy consultant, daylighting assessor etc.).

5.2.3 ECOLOGY

The analysis of least cost approach to achieving required Code scores at each Code level above is predicated on the assumption that a significant number of low cost credits are available in the Ecology category. This is a result of the particular development scenario under consideration, i.e. a brownfield development on a site of low inherent ecological value. Under this assumption the following credits are assumed to be available:

Table 18: Assumptions on the number of credits that can be achieved under the Ecology category for a brownfield site of low inherent ecological value

Eco 1	**1 credit is awarded for development of a site of low ecological value**	**£0**
Eco 2	1 credit awarded for appointing an ecologist and following all key recommendations and 30% of additional recommendations.	£300
Eco 3	1 credit awarded by default for protection of features of ecological value, as it is assumed that no such features are present.	£0
Eco 4	3 credits for achieving a minor positive ecological enhancement are assumed to be relatively easily achieved, given the low ecological value of the pre-developed site.	£100
Eco 5	In the case of heavily flatted developments, it is assumed that 1 credit is awarded for efficient use of land. This credit is not achieved where houses dominate the dwelling mix.	£0

* Note extra-over costs in the table above are based on the three-bed semi house type.

On this basis, 6 to 7 credits are gained in the relatively heavily weighted Ecology category at fairly low extra-over cost.

In the case that the development is planned for a greenfield site, with significant existing ecologically valuable features, certain of the credits tabulated above would either not be achievable (i.e. Eco 1) or would be significantly more expensive. Providing a positive ecological enhancement under Eco 4, for example, may be difficult to achieve and protection of ecological features, under Eco 3, could be costly.

It is reasonable that development of brownfield, low ecological value sites is encouraged through the Code and that where greenfield land is being developed, the developers should take potentially onerous steps to protect ecological value if a good sustainability rating is to be achieved. The ecological value of the existing site,

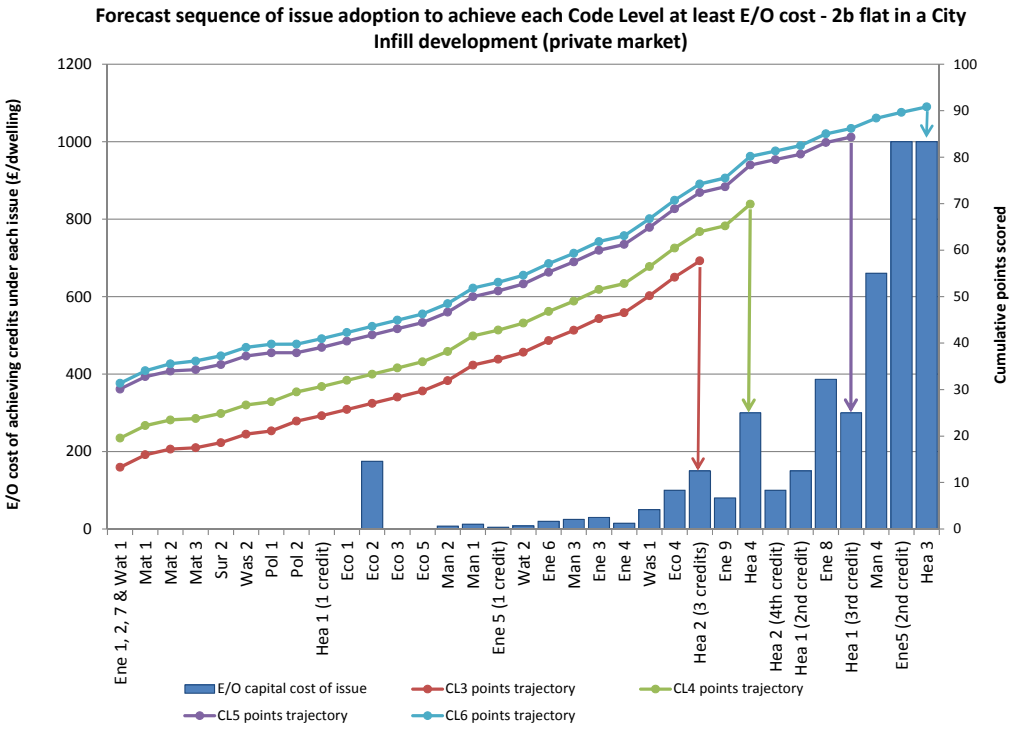
however, may well have significant implications for the approach, particularly at lower Code levels (3 and 4) where developers have more flexibility in the issues they choose to address.

The modelling suggests that on a greenfield site, where Eco 3 and 4 credits are difficult to achieve (and no credit can be gained under Eco 1), developers of Code level 3 homes are likely to focus efforts on lower cost credits in the Energy category (such as Ene 9) and Health category, e.g. daylighting, to recoup credits. On these sites, developers of Code 4 homes may build to Lifetime Homes standards rather than trying to achieve Eco 3 and 4 credits. Developers of Code level 5 and 6 homes may still need to address these Ecology credits, even at high costs, in order to meet the necessary points total.

Table 19: Extra-over cost by Code category for the two-bed flat in the City Infill development and the three-bed semi in the Small Brownfield development (Baseline: Part L 2006.)

Two-bed flat	CL3		CL4		CL5		CL6	
	Credits	extra-overcost	Credits	extra-overcost	Credits	extra-overcost	Credits	extra-overcost
Ene1, 2 & 7	7	£1,395	12	£3,421	18	£9,266	19	£20,096
Other Energy issues	6	£70	7	£150	9	£537	10	£1,537
Water	4	£158	4	£158	6	£6,158	6	£6,158
Materials	14	£0	14	£0	14	£0	16	£0
Surface water	2	£0	2	£0	2	£0	2	£0
Waste	6	£50	6	£50	6	£50	6	£50
Pollution	4	£0	4	£0	1	£0	1	£0
Health	4	£150	10	£700	11	£1,000	12	£2,000
Management	7	£45	7	£45	9	£705	9	£705
Ecology	7	£275	7	£275	7	£275	7	£275
Total	**61**	**£2,143**	**73**	**£4,799**	**83**	**£17,991**	**88**	**£30,821**

Three-bed semi	CL3		CL4		CL5		CL6	
	Credits	extra-over cost	Credits	extra-over cost	Credits	extra-over cost	Credits	extra-over cost
Ene1, 2 & 7	8	£3,143	12	£6,261	18	£15,541	19	£29,411
Other Energy issues	5	£120	7	£275	7	£275	10	£2,125
Water	4	£250	4	£250	6	£4,750	6	£4,750
Materials	14	£0	14	£0	14	£0	16	£0
Surface water	2	£0	2	£0	2	£0	2	£0
Waste	7	£100	7	£100	7	£100	7	£100
Pollution	4	£0	4	£0	1	£0	2	£0
Health	6	£200	7	£350	12	£1,455	12	£1,455
Management	7	£90	7	£90	9	£620	9	£620
Ecology	6	£400	6	£400	6	£400	6	£400
Total	**63**	**£4,303**	**70**	**£7,726**	**82**	**£23,141**	**89**	**£38,861**



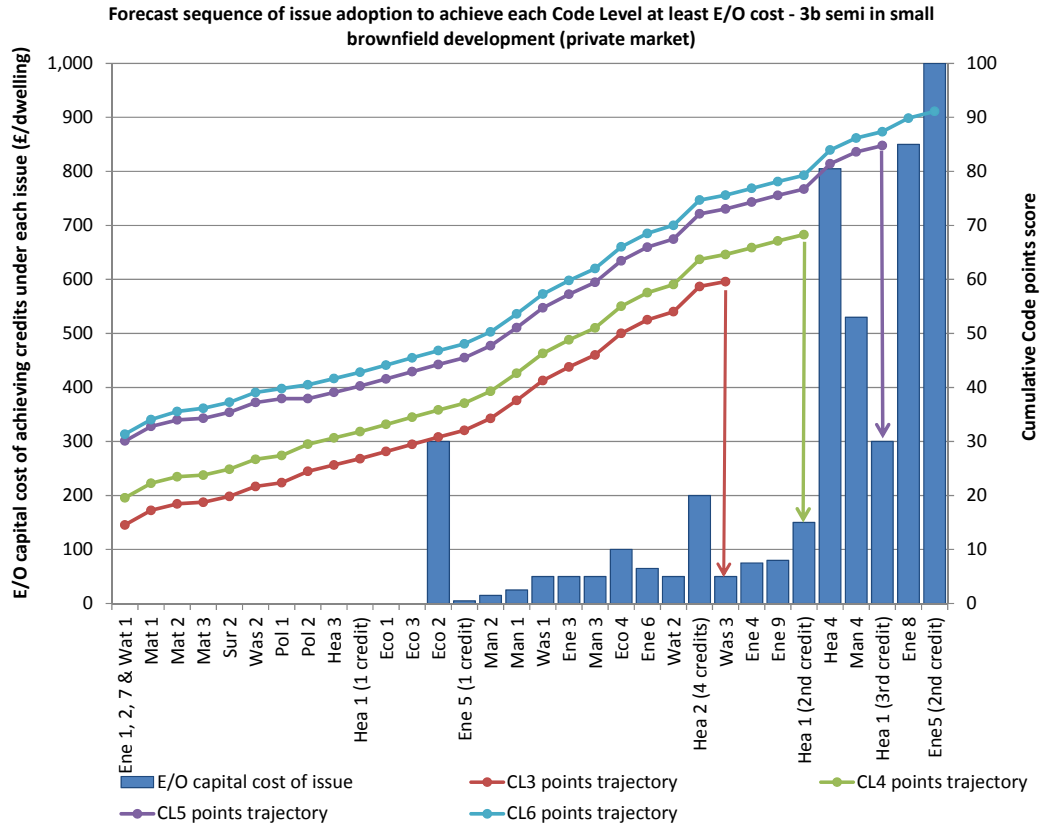


Figure 11: Code issues addressed in order to achieve the minimum points scores needed at each Code level in the two-bed flat (City Infill) and three-bed semi (small brownfield). (Baseline: Part L 2006.)

Table 20: Mandatory issues addressed and associated extra-over costs and points achieved at each Code level (Baseline: Part L 2006.)

Mandatory Issues	Action	Cumulative cost				Cumulative points			
		CL3	CL4	CL5	CL6	CL3	CL4	CL5	CL6
Ene 1	Installation of an energy system that complies with the mandatory DER reduction required by the target Code Level.	£3,143	£6,261	£15,541	£29,411	6.28	10.04	17.57	18.83
Ene 2	Credits are awarded for the Heat Loss Parameter achieved. The E/O cost for this is included in the cost for Ene 1.	Incl. in Ene1				8.79	12.55	20.08	21.34
Ene 7	Credits are awarded for CO2 reduction through onsite renewable energy generated. Costs are included in the energy system E/O cost under Ene 1	Incl. in Ene1				10.04	15.06	22.59	23.85
Wat 1	Installation of water saving measures in order to achieve the mandatory water consumption limits stipulated at each Code level	£200	£200	£4,700	£4,700	14.54	19.56	30.09	31.35
Mat 1	At least 3 of the following five elements achieve a Green Guide rating of A+ to D - (i) Roof (ii) External walls (iii) Internal walls (iv) Upper and ground floors (v) Windows	£0	£0	£0	£0	14.54	19.56	30.09	31.35
Sur 1	Attenuation of surface water run-off (flow rate and volume) to that of the undeveloped site. Assumed to be a planning / EA requirement so not an E/O cost of the Code.	£0	£0	£0	£0	14.54	19.56	30.09	31.35
Was 1	Provide space for waste storage at least in line with the minimum requirements of BS5906	£0	£0	£0	£0	14.54	19.56	30.09	31.35
Was 2	Develop and implement a site wide management plan.	£0	£0	£0	£0	14.54	19.56	30.09	31.35
Mandatory Issue Sub-total		**£3,343**	**£6,461**	**£20,241**	**£34,111**	**14.54**	**19.56**	**30.09**	**31.35**

Table 21: Tradable issues addressed and associated extra-over costs in order to accumulate sufficient points for each Code level (three-bed semi in a small brownfield development)

Issue	Action	Cost of issue	Cumulative cost	Cumulative points
Mat 1	Use of materials with low lifecycle environmental impacts. Code points assessed using Mat1 calculator tool - assume 9 credits are awarded.	£0	£0	2.70
Mat 2	Responsible sourcing of 80% of materials in key building elements - assume 4 credits available	£0	£0	4.20
Mat 3	Responsible sourcing of 80% of materials in finishing elements - assume 1 credit available	£0	£0	4.80
Sur 2	Development location is in an area with low annual probability of flooding.	£0	£0	5.90
Was 2	Commitment to reduce construction waste, sort and divert from landfill.	£0	£0	7.73
Pol 1	Insulant materials used with low GWP blowing agents	£0	£0	8.43
Pol 2	Use a heating system with low NOx emissions - 3 credits available for low emissions condensing boilers. Note if biomass heating system is used, credits will be lost under this issue.	£0	£0	9.13
Hea 3	Provision of adequate outdoor private space	£0	£0	10.30
Hea 1 (1 credit)	Kitchen achieves a minimum average daylight factor of 2%	£0	£0	11.46
Eco 1	Development on a site of low ecological value	£0	£0	12.80
Eco 3	Default credit for protection of ecological features - assumption that no features exist	£0	£0	14.13
Eco 2	Fees for an ecologist to confirm site of low ecological value and recommend enhancements	£300	£300	15.46
Ene 5 (1 credit)	Provide an information leaflet on the EU energy efficiency labelling of white goods	£5	£305	16.72
Man 2	Register under considerate constructors scheme and commit to go beyond best practice.	£15	£320	18.94
Man 1	Provide a home user guide with information on site and surroundings.	£25	£345	22.27
Was 1	Supply and fit adequate internal recyling bins. Assumed that a local authority collection scheme is in place.	£50	£395	25.93
Ene 3	Provide energy efficient fittings for >75% internal light fittings.	£50	£445	28.44
Man 3	Manage construction site to minimise construction impacts (4 items covered)	£50	£495	30.66
Eco 4	Achieve a minor positive change in ecological value. Based on a site of initial low ecological value with an ecologist employed under Eco 2.	£100	£595	34.66
Ene 6	Install energy efficient space and security lighting with PIR sensors and day-ight cut-off.	£65	£660	37.17
Wat 2	Provide a system to collect rainwater for internal / external irrigation.	£50	£710	38.67
Hea 2 (4 credits)	Achieve sound insulation standards that are a 5 dB improvement on those required by Approved document E of the Building Regulations	£200	£910	43.34
Was 3	Provide a composter bin	£50	£960	44.25
Sub-total			***£960***	***44.25***
CODE LEVEL 3 TOTAL			**£4,303**	**58.80**

Ene 4	Install a drying line (e.g. rotary line)	£75	£1,035	45.51
Ene 9	Provide an adequate space and telephone and data connection points to enable set-up of a home office	£80	£1,115	46.76
Hea 1 (2nd credit)	Ensure a daylight factor of 1.5% is achieved in living rooms, dining rooms, studies and home office space.l	£150	£1,265	47.93
Sub-total			***£1,265***	***47.93***
CODE LEVEL 4 TOTAL			**£7,726**	**67.49**
Hea 4	Ensure that the dwelling complies with all principles of Lifetime Homes	£805	£2,070	52.60
Man 4	Employ an ALO or CPDA (and follow advice) and comply with Part 2 Physical Security aspects of 'Secured by Design'	£530	£2,600	54.82
Hea 1 (3rd credit)	Ensure 80% of working planes in kitchens, dining rooms, living rooms, studies and home offices receive direct light from the sky.	£300	£2,900	55.99
Sub-total			***£2,900***	***55.99***
CODE LEVEL 5 TOTAL			**£23,141**	**85.38**
Ene 8	Provide space for storage of 2 bicycles.	£850	£3,750	58.50
Ene5 (2nd credit)	Provide fridges and freezers or fridge freezers that have an A+ rating under the EU energy efficiency labelling scheme	£1,000	£4,750	59.75
Sub-total			***£4,750***	***59.75***
CODE LEVEL 6 TOTAL			**£38,861**	**89.77**

5.2.4 SOCIAL HOUSING

The approaches to the Code and associated extra-over costs shown in Figure 11 and **Table 21**, have been based on private market housing. It is assumed in this case that outside of the Code's mandatory issues, the developer has a free-hand in deciding which tradable issues to address and is therefore likely to select the least cost approach. This may not be so in the case of social housing, where conditions of public funding stipulated by the Homes and Communities Agency or specification of a particular housing association may require certain issues to be addressed.

Where the social housing specification requires that a certain Code issue is addressed (in addition to the Homes and Communities Agency requirement that all social housing should achieve Code level 3), then the cost of meeting this issue should be considered as part of the base build cost rather than as a Code extra-over cost. By addressing the issue, however, credits under the Code will be achieved, which may then have a knock-on effect on the overall approach to meeting the particular Code level.

The issues that housing associations are perhaps most likely to require as part of their base build specifications are Lifetime Homes (Hea 4) and Secured by Design (Man 4). These are among the more costly issues to address and would not generally be incorporated at Code level 3 (i.e. the level at which most social housing is currently built) if it were not a requirement of the housing association. Our cost modelling and discussion with the house builders suggests that some developers may address these issues at Code level 4, for example on a greenfield site where Ecology credits are difficult to achieve, but that in many cases these issues would not be addressed until Code level 5 and 6.

The cost of building to Code levels 3 and 4 have been compared in the case that the developer has freedom over which non-mandatory issues to address (i.e. private market) and in the case where Lifetime Homes and Secured by Design are mandated (common in the social housing sector). This comparison is shown in the figure below for the two-bed flat and three-bed semi house types, in the City Infill and Small Brownfield development scenarios respectively. The overall cost of the code issues addressed is high in the case social homes scenario, however if it is assumed that Lifetime Homes and Secured by Design are part of the base build, then the extra-over cost of achieving the Code standard is lower than in the case of private market homes.

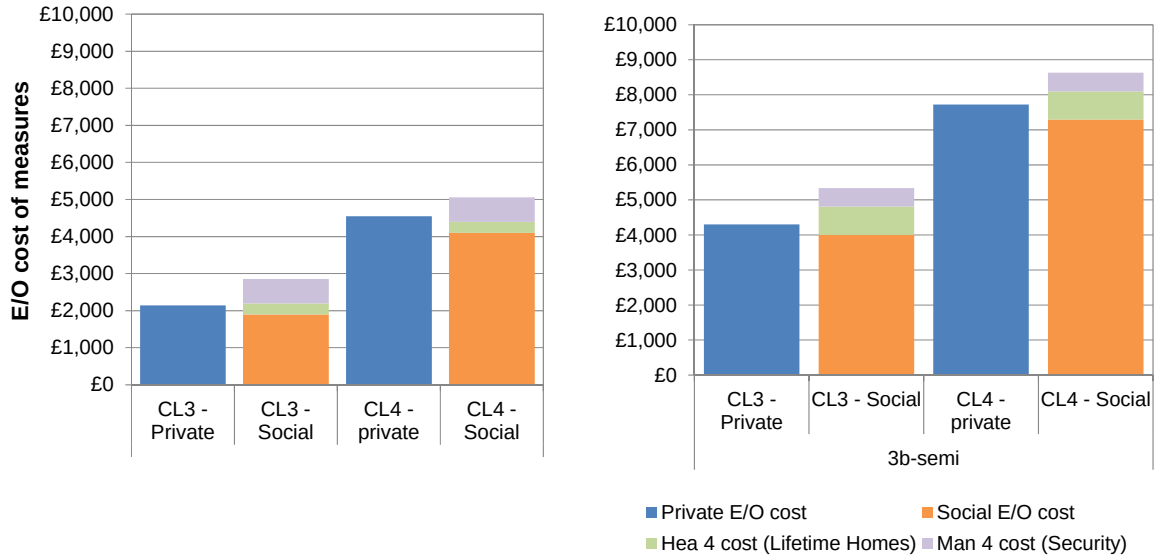


Figure 12: Variation in Code extra-over cost at Code levels 3 and 4 as a result of a social housing specification stipulating that Lifetime Homes and Secured by Design standards must be incorporated as part of the base build specification (Baseline: Part L 2006.)

6 Overall Code costs

Based on the assessment of cost by issue and analysis of likely approaches to building to the Code, the overall Code extra-over costs have been modelled for each dwelling type and each development scenario.

In each case, it is assumed that the least cost approach to achieving the Code is taken. This includes selecting the lowest cost energy strategy, which tends to be the largest component of the extra-over cost. The lowest cost energy strategies at each Code level and for each development scenarios are tabulated below (note that it is assumed that the same strategy is applied to all dwellings in a particular development scenario).

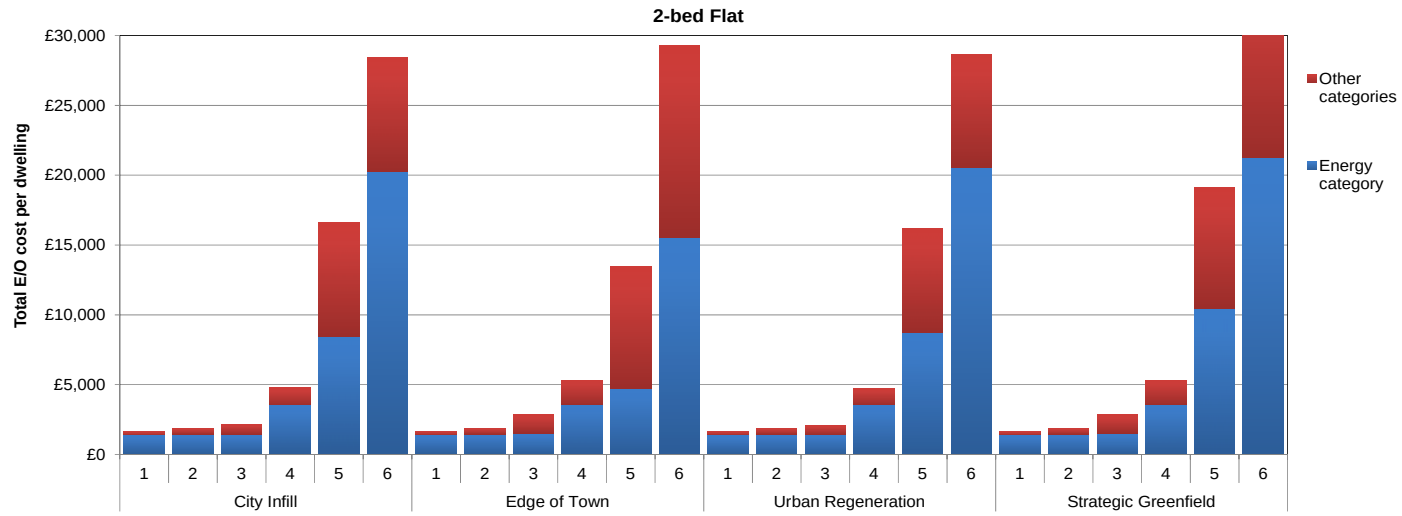
Table 22: Lowest cost energy strategies selected in overall modelling of Code costs

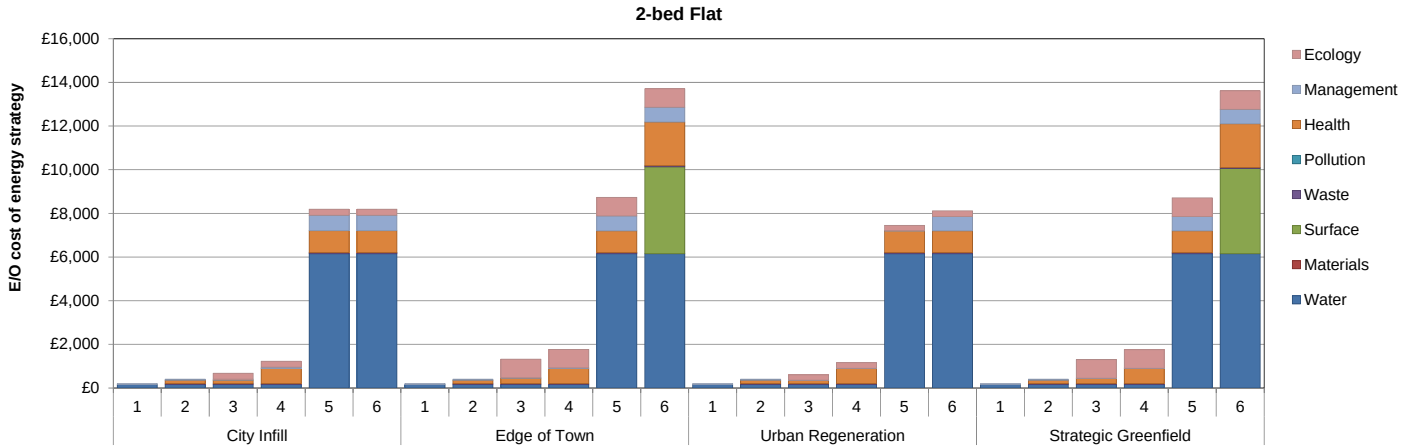
Development	Code Level					
	1	2	3	4	5	6
Small Brownfield	Good fabric + PV				Good + BM HOB & PV	
City Infill					Good + BM HOB/DH & PV	
Edge of town					Good + BM HOB & PV	
Urban Regeneration					Good + BM CHP/DH & PV	
Strategic Greenfield					Good + BM HOB & PV	

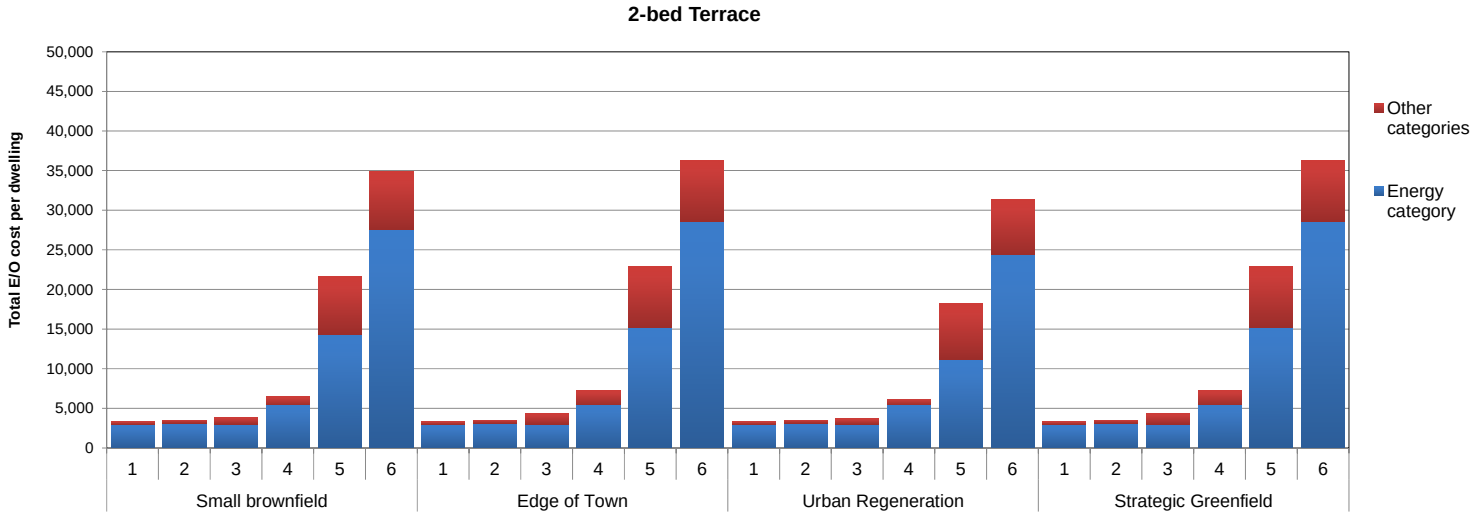
The extra-over costs by Code level for each dwelling type and development scenario are tabulated in below. The variation in Code costs between development scenario and breakdown of Code costs by Code category is highlighted in the bar charts in Figure 13.

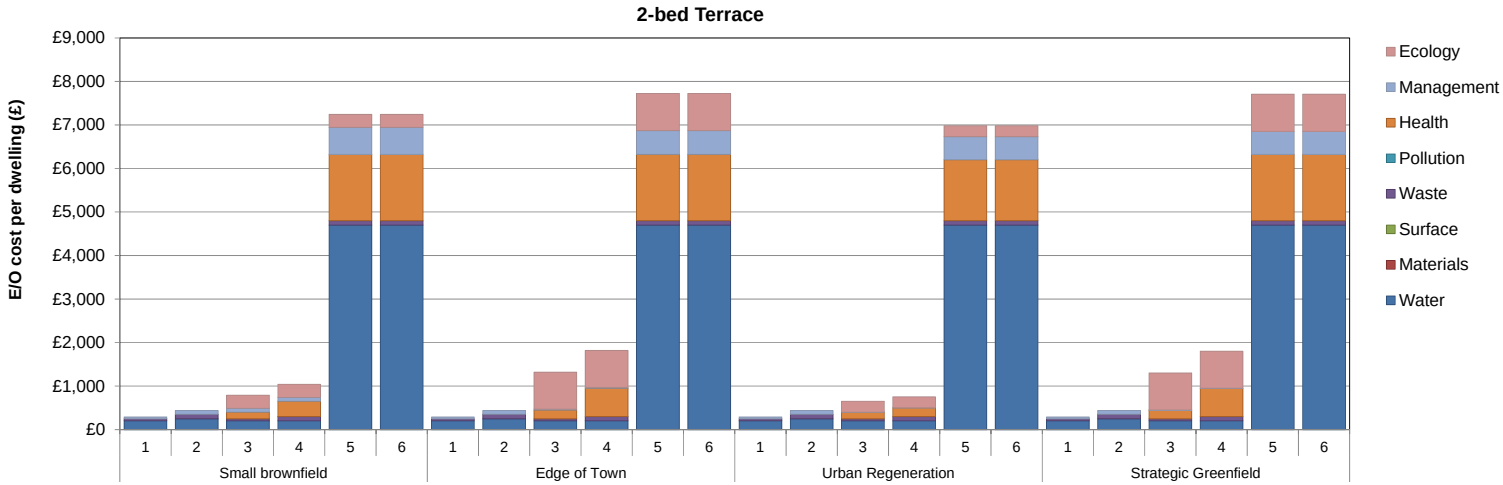
Table 23: Code extra-over cost and percentage increase on base build cost for each dwelling type and each development scenario (Baseline: Part L2006.)

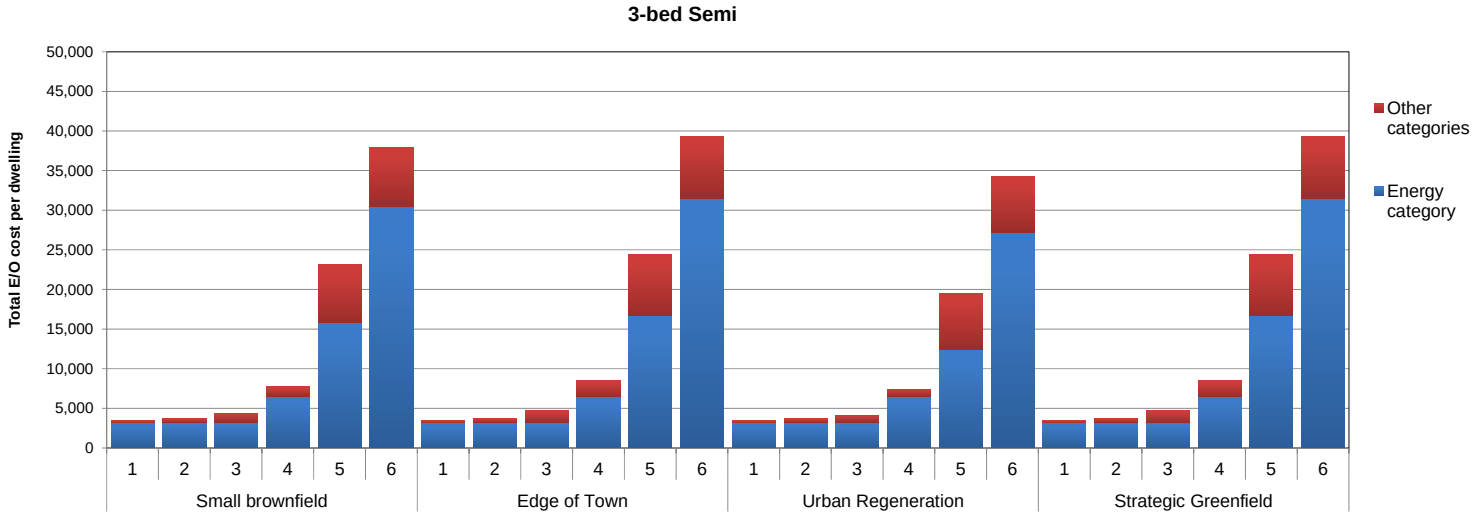
Code Level	2b-Flat		2b-Terrace		3b-Semi		4b-Detached		Average dwelling	
	E/O cost	%	E/O cost	%	E/O cost	%	E/O cost	%	E/O cost	%
Small brownfield (20 dwellings at 40 dph)										
1	-	-	£3,290	4.3%	£3,460	4.2%	£3,860	4.3%	£3,472	4.2%
2	-	-	£3,530	4.6%	£3,700	4.4%	£4,110	4.6%	£3,714	4.5%
3	-	-	£3,810	4.9%	£4,300	5.2%	£4,550	5.1%	£4,154	5.1%
4	-	-	£6,470	8.4%	£7,730	9.3%	£8,690	9.8%	£7,418	9.1%
5	-	-	£21,640	28.1%	£23,140	27.8%	£24,910	28.0%	£22,894	28.0%
6	-	-	£34,840	45.2%	£37,860	45.5%	£41,720	46.8%	£37,424	45.7%
City Infill (40 dwellings at 160 dph)										
1	£1,620	3.0%	-	-	-	-	-	-	£1,620	3.0%
2	£1,870	3.5%	-	-	-	-	-	-	£1,870	3.5%
3	£2,140	4.0%	-	-	-	-	-	-	£2,140	4.0%
4	£4,800	9.0%	-	-	-	-	-	-	£4,800	9.0%
5	£16,620	31.2%	-	-	-	-	-	-	£16,620	31.2%
6	£28,440	53.4%	-	-	-	-	-	-	£28,440	53.4%
Edge of town (100 dwellings at 40 dph)										
1	£1,620	3.0%	£3,290	4.3%	£3,460	4.2%	£3,860	4.3%	£3,031	4.0%
2	£1,870	3.5%	£3,530	4.6%	£3,700	4.4%	£4,110	4.6%	£3,275	4.4%
3	£2,870	5.4%	£4,330	5.6%	£4,730	5.7%	£4,920	5.5%	£4,194	5.6%
4	£5,340	10.0%	£7,250	9.4%	£8,500	10.2%	£9,470	10.6%	£7,522	10.0%
5	£13,450	25.3%	£22,960	29.8%	£24,470	29.4%	£26,240	29.5%	£21,655	28.8%
6	£29,260	55.0%	£36,310	47.1%	£39,330	47.3%	£43,200	48.5%	£36,626	48.8%
Urban Regeneration (1000 dwellings at 160 dph)										
1	£1,620	3.0%	£3,290	4.3%	£3,460	4.2%	£3,860	4.3%	£2,158	3.5%
2	£1,870	3.5%	£3,530	4.6%	£3,700	4.4%	£4,110	4.6%	£2,406	3.9%
3	£2,070	3.9%	£3,670	4.8%	£4,050	4.9%	£4,300	4.8%	£2,601	4.2%
4	£4,730	8.9%	£6,180	8.0%	£7,440	8.9%	£8,470	9.5%	£5,343	8.7%
5	£16,180	30.4%	£18,180	23.6%	£19,550	23.5%	£21,290	23.9%	£17,004	27.7%
6	£28,670	53.9%	£31,380	40.7%	£34,270	41.2%	£38,100	42.8%	£29,964	48.9%
Strategic Greenfield (2000 dwellings at 40 dph)										
1	£1,620	3.0%	£3,290	4.3%	£3,460	4.2%	£3,860	4.3%	£3,121	4.1%
2	£1,870	3.5%	£3,530	4.6%	£3,700	4.4%	£4,110	4.6%	£3,365	4.4%
3	£2,850	5.4%	£4,320	5.6%	£4,710	5.7%	£4,900	5.5%	£4,259	5.6%
4	£5,330	10.0%	£7,230	9.4%	£8,490	10.2%	£9,450	10.6%	£7,672	10.0%
5	£19,140	36.0%	£22,950	29.8%	£24,450	29.4%	£26,220	29.4%	£23,292	30.4%
6	£34,870	65.5%	£36,290	47.1%	£39,320	47.3%	£43,180	48.5%	£38,293	50.0%
Large edge of town (3,300 dwellings at 40 dph)										
1	£1,620	3.0%	£3,290	4.3%	£3,460	4.2%	£3,860	4.3%	£2,937	4.0%
2	£1,870	3.5%	£3,530	4.6%	£3,700	4.4%	£4,110	4.6%	£3,182	4.3%
3	£2,850	5.4%	£4,320	5.6%	£4,710	5.7%	£4,900	5.5%	£4,073	5.5%
4	£5,330	10.0%	£7,230	9.4%	£8,490	10.2%	£9,450	10.6%	£7,356	10.0%
5	£19,140	36.0%	£22,820	29.6%	£24,340	29.3%	£26,140	29.3%	£22,684	30.8%
6	£35,070	65.9%	£36,170	46.9%	£39,210	47.1%	£43,090	48.4%	£37,832	51.4%

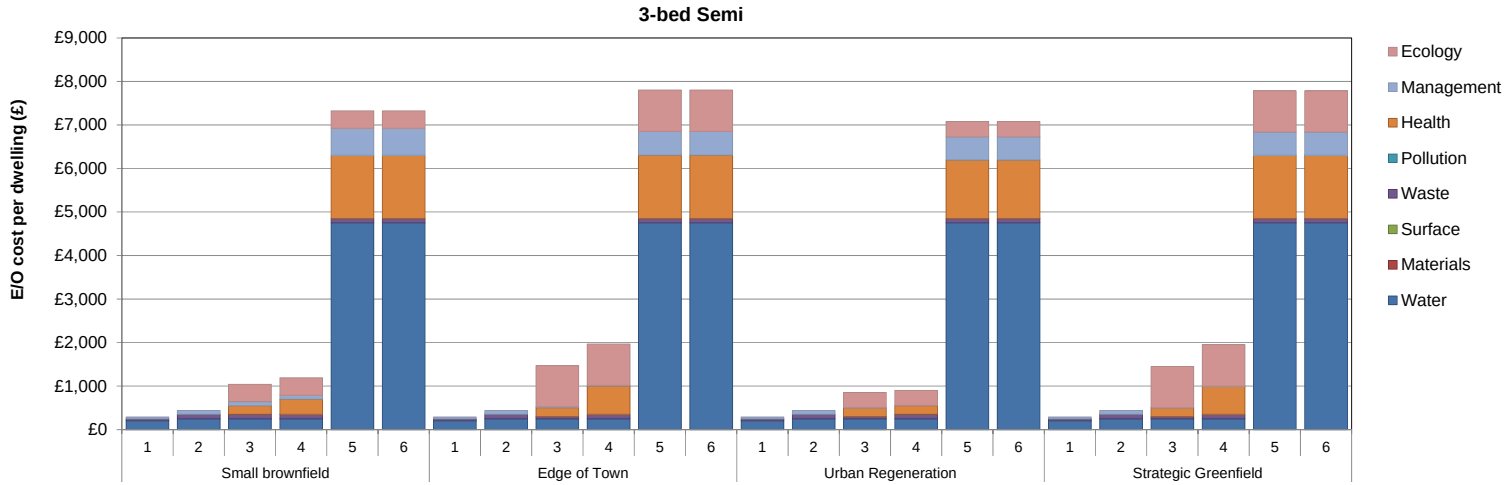

2-bed Flat
Total E/O cost per dwelling
£30,000
£25,000
£20,000
£15,000
£10,000
£5,000
£0
1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6
City Infill
Edge of Town
Urban Regeneration
Strategic Greenfield
Other categories
Energy category

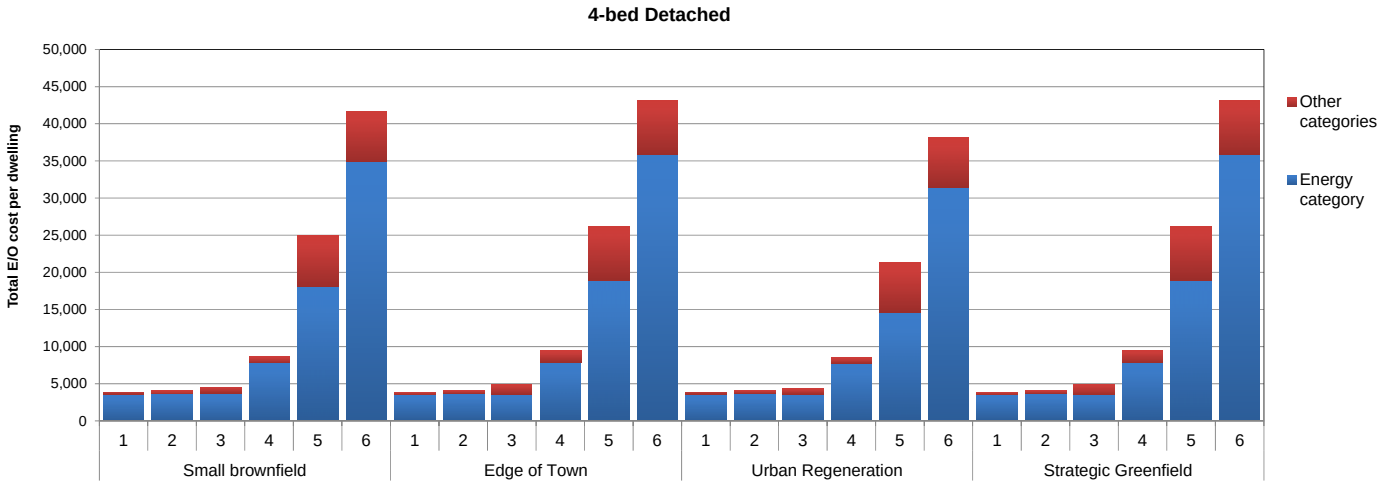

2-bed Flat
E/O cost of energy strategy
£16,000
£14,000
£12,000
£10,000
£8,000
£6,000
£4,000
£2,000
£0
1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6
City Infill
Edge of Town
Urban Regeneration
Strategic Greenfield
Ecology
Management
Health
Pollution
Waste
Surface
Materials
Water


2-bed Terrace
Total E/O cost per dwelling
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6
Small brownfield
Edge of Town
Urban Regeneration
Strategic Greenfield
Other categories
Energy category


2-bed Terrace
E/O cost per dwelling (£)
£9,000
£8,000
£7,000
£6,000
£5,000
£4,000
£3,000
£2,000
£1,000
£0
1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6
Small brownfield
Edge of Town
Urban Regeneration
Strategic Greenfield
Ecology
Management
Health
Pollution
Waste
Surface
Materials
Water


3-bed Semi
Total E/O cost per dwelling
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6
Small brownfield
Edge of Town
Urban Regeneration
Strategic Greenfield
Other categories
Energy category


3-bed Semi
E/O cost per dwelling (£)
£9,000
£8,000
£7,000
£6,000
£5,000
£4,000
£3,000
£2,000
£1,000
£0
1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6
Small brownfield
Edge of Town
Urban Regeneration
Strategic Greenfield
Ecology
Management
Health
Pollution
Waste
Surface
Materials
Water


4-bed Detached
Total E/O cost per dwelling
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6
Small brownfield
Edge of Town
Urban Regeneration
Strategic Greenfield
Other categories
Energy category

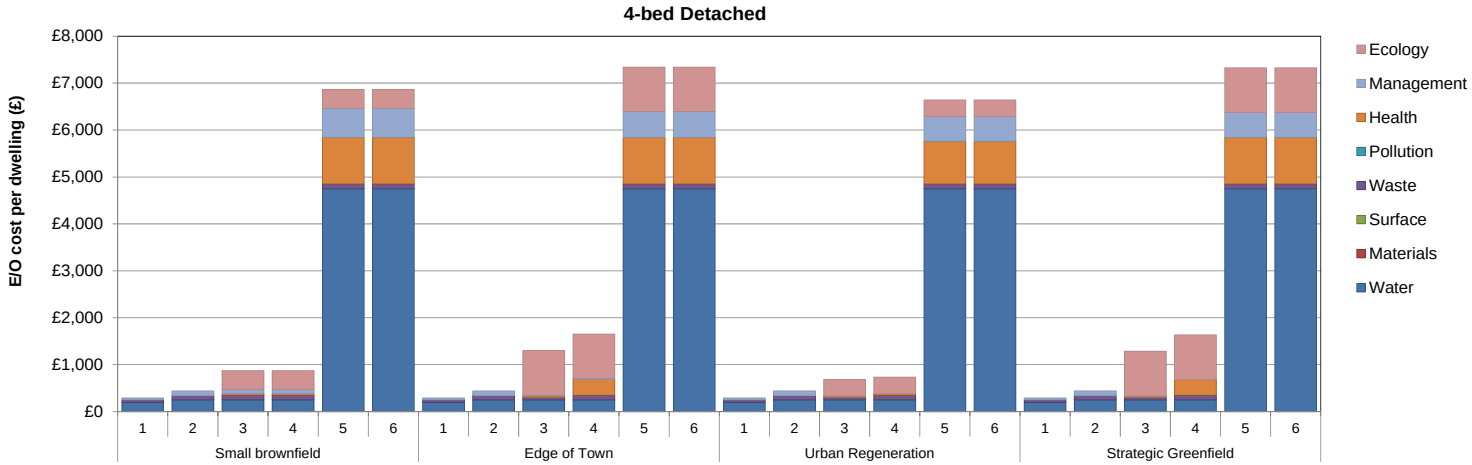


Figure 13: Variation in Code extra-over costs between the development scenarios. Code extra-over costs are broken down into Energy Category and Other costs (top charts) and distribution of Other costs between non-energy categories is shown in the lower charts (Baseline: Part L 2006.)

6.1 Impact of changes to the Building Regulations on Code extra-over costs

One of the key reasons for introduction of the Code for Sustainable Homes was to provide guidance to the house-building industry on the intended direction of change of the Building Regulations, i.e. the standards of construction that currently attract credits under the Code will gradually be introduced as minimum standards through Building Regulations.

The area where this gradual adoption of Code standards by the regulations has been most clearly defined is in the energy category. A trajectory for revisions to Part L (Conservation of fuel and power) toward introduction of the Zero Carbon policy has been set-out that involves the mandatory dwelling emissions rate at Code Levels 3 and 4 becoming minimum regulatory standards under Part L 2010 (already in force) and Part L 2013, respectively. A further example of this is the 2010 revision to Part G of the Regulations – Sanitation, hot-water safety and water efficiency – which has adopted the Code Level 1 and 2 minimum standard for internal water consumption (125 l/p/d including a fixed allowance of 5 l/p/d for external water consumption).

The extra-over cost of the Code is defined as the additional cost incurred in achieving a Code level, over the cost of constructing a dwelling to the minimum regulatory standard. As parts of the Code are adopted by the Regulations, the extra-over cost of achieving a particular Code level drops (and the cost of building the baseline dwelling increases by an equivalent amount).

All cost data presented in this report so far are extra-over costs relative to a baseline of Part L 2006 (and Part G – Hygiene (1992), the precursor to Part G 2010). This is an appropriate baseline for this report, as it reflects the extra-over cost of building to the Code incurred by house-builders to-date. Looking forward, however, it is necessary to consider the extra-over cost relative to a baseline of the revised Building Regulations, as this will be the additional cost burden of achieving a Code rating over and above compliance with regulations.

The impact of factoring the Part L 2010 revision into the baseline dwelling costs on the Code extra-over costs is shown in the figure below, for the case of a three-bed semi dwelling type.

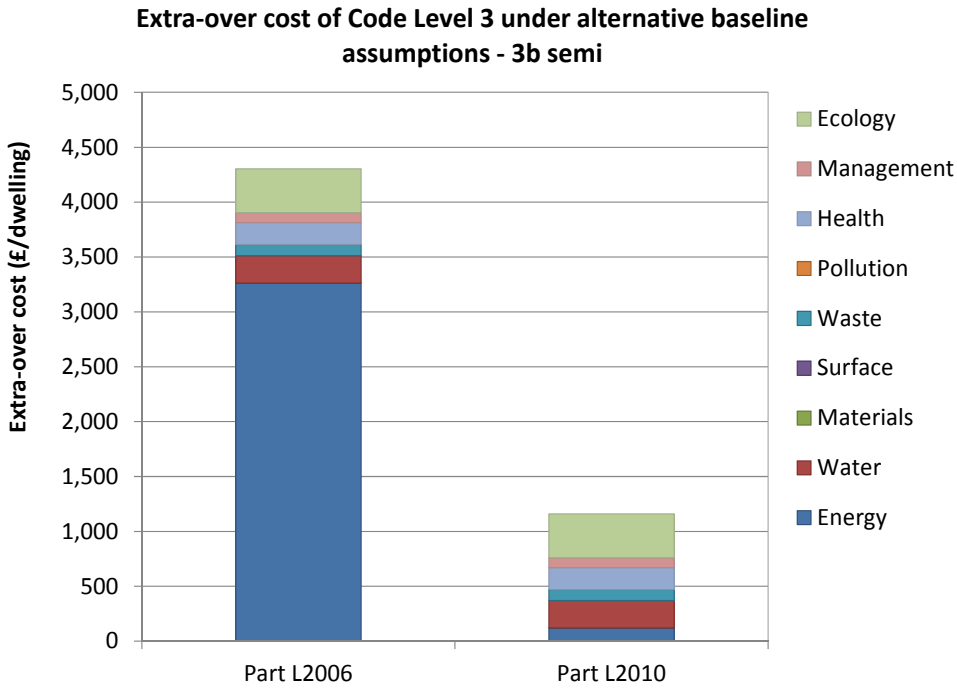


Figure 14: Impact of incorporating 2010 revisions to Part L into the base build cost on Code extra-over costs

As shown in the chart above, a large fraction of the extra-over cost of building to Code Level 3 relative to building a Part L 2006 compliant home is associated with the Energy and CO_2 category and particularly with meeting the minimum dwelling emission rate standard. Now that the this dwelling emission rate standard is required by the Building Regulations, the extra-over cost associated with achieving Code Level 3 compared to meeting minimum regulatory standards is reduced considerably (although the overall cost of constructing the Code Level 3 dwelling is unchanged). The impact of changes to Part G on the Code extra-over cost are marginal, as the extra-over cost of achieving the 120 l/p/d standard is assumed to be limited.

The extra-over costs of building to each Code level relative to a revised baseline, i.e. a base build cost that includes Part L 2010, are tabulated on the following page for each dwelling type. The extra-over cost of achieving Code Level 3 relative to the revised base build cost is around 1 per cent to 2 per cent, compared to the cost increment of 5 per cent to 6 per cent that has been incurred over building to a Part L 2006 minimum standard. Although the overall cost of building the dwelling has not changed, this may encourage more house-builder to build to Code Level 3, given that they are required by regulation to adopt the most costly part of the standard.

Table 24: Extra-over costs of building to the Code relative to a baseline that includes 2010 changes to Part L (Baseline: Part L2010)

Code Level	2b-Flat		2b-Terrace		3b-Semi		4b-Detached		Average dwelling	
	E/O cost	%	E/O cost	%	E/O cost	%	E/O cost	%	E/O cost	%
Small brownfield (20 dwellings at 40 dph)										
1	-	-	£320	0.4%	£320	0.4%	£320	0.3%	£320	0.4%
2	-	-	£560	0.7%	£560	0.6%	£560	0.6%	£560	0.7%
3	-	-	£840	1.0%	£1,160	1.3%	£1,000	1.1%	£1,000	1.2%
4	-	-	£3,500	4.4%	£4,580	5.3%	£5,140	5.5%	£4,260	5.0%
5	-	-	£18,670	23.3%	£20,000	23.2%	£21,360	23.1%	£19,740	23.2%
6	-	-	£31,870	39.8%	£34,720	40.2%	£38,170	41.2%	£34,270	40.3%
City Infill (40 dwellings at 160 dph)										
1	£230	0.4%	-	-	-	-	-	-	£230	0.4%
2	£470	0.9%	-	-	-	-	-	-	£470	0.9%
3	£750	1.4%	-	-	-	-	-	-	£750	1.4%
4	£3,400	6.2%	-	-	-	-	-	-	£3,400	6.2%
5	£15,220	27.9%	-	-	-	-	-	-	£15,220	27.9%
6	£27,050	49.5%	-	-	-	-	-	-	£27,050	49.5%
Edge of town (100 dwellings at 40 dph)										
1	£230	0.4%	£320	0.4%	£320	0.4%	£320	0.3%	£298	0.4%
2	£470	0.9%	£560	0.7%	£560	0.6%	£560	0.6%	£538	0.7%
3	£1,470	2.7%	£1,360	1.7%	£1,590	1.8%	£1,370	1.5%	£1,457	1.9%
4	£3,950	7.2%	£4,280	5.3%	£5,360	6.2%	£5,920	6.4%	£4,787	6.2%
5	£12,060	22.1%	£19,990	25.0%	£21,330	24.7%	£22,690	24.5%	£18,921	24.3%
6	£27,870	51.0%	£33,340	41.7%	£36,190	41.9%	£39,650	42.8%	£33,892	43.5%
Urban Regeneration (1000 dwellings at 160 dph)										
1	£230	0.4%	£320	0.4%	£320	0.4%	£320	0.3%	£257	0.4%
2	£470	0.9%	£560	0.7%	£560	0.6%	£560	0.6%	£497	0.8%
3	£680	1.2%	£700	0.9%	£910	1.1%	£750	0.8%	£699	1.1%
4	£3,330	6.1%	£3,210	4.0%	£4,300	5.0%	£4,930	5.3%	£3,435	5.4%
5	£14,790	27.1%	£15,210	19.0%	£16,410	19.0%	£17,740	19.2%	£15,103	23.9%
6	£27,270	49.9%	£28,410	35.5%	£31,130	36.1%	£34,550	37.3%	£28,055	44.4%
Strategic Greenfield (2000 dwellings at 40 dph)										
1	£230	0.4%	£320	0.4%	£320	0.4%	£320	0.3%	£302	0.4%
2	£470	0.9%	£560	0.7%	£560	0.6%	£560	0.6%	£542	0.7%
3	£1,450	2.7%	£1,350	1.7%	£1,570	1.8%	£1,350	1.5%	£1,436	1.8%
4	£3,930	7.2%	£4,260	5.3%	£5,340	6.2%	£5,900	6.4%	£4,846	6.1%
5	£17,740	32.5%	£19,980	25.0%	£21,310	24.7%	£22,670	24.5%	£20,469	25.8%
6	£33,470	61.3%	£33,320	41.6%	£36,170	41.9%	£39,630	42.8%	£35,467	44.7%
Large edge of town (3,300 dwellings at 40 dph)										
1	£230	0.4%	£320	0.4%	£320	0.4%	£320	0.3%	£293	0.4%
2	£470	0.9%	£560	0.7%	£560	0.6%	£560	0.6%	£533	0.7%
3	£1,450	2.7%	£1,350	1.7%	£1,570	1.8%	£1,350	1.5%	£1,424	1.9%
4	£3,930	7.2%	£4,260	5.3%	£5,340	6.2%	£5,900	6.4%	£4,705	6.2%
5	£17,740	32.5%	£19,850	24.8%	£21,200	24.6%	£22,590	24.4%	£20,035	26.3%
6	£33,670	61.6%	£33,200	41.5%	£36,060	41.8%	£39,540	42.7%	£35,181	46.2%

7 Cost changes over time

The qualitative understanding developed through consultation with home builders suggests that Code costs have not changed significantly over the last two years. An exception here is the cost of renewable technologies, which have decreased due to higher volume of procurement and supply chains. Any decrease in costs is attributable to market pressures rather than greater experience in building to the Code.

Home builders are experienced in developing optimal solutions that suit their building methodology, however, it is questionable as to how much of this is standardised. The methodology of one of the most experienced Code home builders was to focus on the fabric first then to focus on renewables. Their methodology was to have a standard fabric specification for all Code level houses and then to have the required renewables to achieve each level of the Code. This strategy was used in order that there was standardisation with the fabric which would obviously yield greater efficiencies in construction.

Developers have found their freedom to choose between a fabric first and a low carbon technology approach is dependent on geographical location. Some planning authorities, for example the Greater London Authority, have renewable energy targets, which impose a constraint on home builders focusing on the fabric first, as they are required to meet renewable energy targets in any case[12].

A further driver for home builders to focus on fabric rather than renewables is that even though the cost of renewable technologies are decreasing due to large volume of supply, there is a still a skills gap for installing specialised technologies. Therefore, reducing supply costs need to be balanced against potentially high labour rates. There is also the requirement for all installers and products to be certified through the Microgeneration Certification Scheme (supported by the Department of Energy and Climate Change).

7.1 Overall price trends across the building industry

Forecasting overall price trends across the building industry is a complex area given the significant level of uncertainty in both technical solutions and market changes.

Multiple competing factors can influence these costs. For example, present day costs can be estimated with a high level of accuracy, but projecting these costs forward, say six years (in the context of a ‘depressed’ market) introduces uncertainty. To help articulate these costs and level of certainty in a clear way we have identified that there are two types of costs, both of which would potentially impact on outturn costs:

- Carbon sensitive variances; and
- Non-carbon sensitive variances.

[12] Note that the Draft Replacement of the London Plan proposes a revision to this policy that will impose a carbon reduction target, rather than a renewable energy generation target.

Carbon sensitive variances

These changes in cost reflect a changing market, which adapts to a growing need to deliver low carbon solutions. These were categorised as following:

- Labour – reflecting changes in skill sets and professional services to deliver new services.
- Material/design solutions – reflecting changes in the supply chain as new products are introduced to deliver improved performance at a lower cost.
- Renewable technologies – as above but with an emphasis on solutions like photovoltaic and SHW.

Our view is that these costs will decrease in real terms over time as the industry finds more efficient (i.e. low cost) ways to meet the low carbon challenge.

Adapting the current skill levels are likely to improve the speed and quality of installation of new technologies, however, it is not clear how quickly this can be developed. With greater provision of labour in these areas, more of these technologies can be installed resulting in greater take-up by homebuilders and hence potentially greater economies of scale.

Innovative materials/design solutions can often provide the same or better performance/function and potentially often at lower costs if produced in large volumes. However, these potential lower costs cannot be capitalised on if the use by homebuilders does not justify large volumes of production.

The average unit cost of renewable technologies is reducing as the take up increases. However, we suspect that there will be different rates of change in the price for these technologies as they each have discreet supply chains. In addition, the supply chains for the homebuilders were variable and were dependant on their preferred technologies for use in developments. Our view is that these costs will decrease over time as the industry finds more efficient (i.e. low cost) ways to meet the low carbon challenge.

Non-carbon sensitive variances

These include regional variations in pricing and market conditions (inflation/deflation).

There is considerable variation in the cost of construction across the UK, principally a function of labour costs.

At present we are in a deflationary market, however, this is likely to change in the future in line with the boom/bust property cycles.

The following is a summary of what we believe to be the likely impact on costs over time.

CARBON SENSITIVE COSTS	
Key issue	**Likely impact on costs over time**
Labour Costs	Uncertain how cost of labour will evolve. Currently there is a shortage of skills to deliver the volume of technical work required, but likely to see this skills base expand to meet demand. Likely negligible impact on cost.
Material costs	Alternative materials exist which can deliver higher performance qualities more efficiently, but because they are not mainstream they will tend to be more costly. As the industry adapts to lower U-values we are likely to see material costs fall through efficiency gains in bulk procurement of these new materials.
Technology costs	The market for renewables is now reasonably mature on a European and global level, albeit UK supply chains are still growing to meet demand. Also, the technology is also reasonably mature but advances are still being made which should reduce the unit cost. Therefore it is expected that the cost of renewables will decrease slightly through volume procurement and technology advances.

NON CARBON SENSITIVE COSTS		
Key issue	**Impact on cost**	**Comment**
Regional variations	Range varies from -41% (Northern Ireland) to 9% (Inner London)	Based on Spons 2010 Published Indices.
Regional variations (material improvements)	Range varies from -34% (Northern Ireland) to 7% (Inner London)	This based on an assessment taking into account the fact that material costs are less sensitive to regional variations than labour costs. Hence, if we assume 1.0 to be the regional relative price sensitivity, we assume the material sensitivity factor to be 0.80, which is fairly significant. This indicates that materials are less likely to follow regional variations trends.

Regional variations (renewable technologies)	Range varies from -12% (Northern Ireland) to 3% (Inner London)	This accounts for the fact that renewable technologies are nominally sensitive to regional variations. Hence, we have assumed the renewable technology sensitivity factor to be 0.20. This indicates that renewable technologies are only marginally sensitive to regional variations.
Market conditions	-3% to 4% (These are annual variances)	Tender prices throughout 2010 are expected to be fairly flat before improving conditions in 2011. For the year 2011 tender prices are expected to move between -3% and +2%. For the year 2012 prices are forecast to rise by 3%-4%. This will depend on private sector work recovering sufficiently to take up slack caused by public sector cutbacks. Tender Prices for the year 2013 and 2014 are forecast to rise by 3% and 3.5% respectively. We do not forecast beyond 2014 - however, with current trends from 2014, this could 3.5% per annum for 2015 and 2016.

(Ref: unpublished report to Zero Carbon Hub – Review of Cost Volatility and Certainty through to 2016)

7.2 Learning

A cost reconciliation was undertaken comparing costs from the March 2010 report to the current study. Generally it was found that some costs were nominally reduced by approximately 8 per cent (primarily energy and water issues). However, this needs to be weighed against the market conditions. Tender price indices indicate that costs have fallen approximately 11 per cent in the last two years, therefore, the nominal reduction in the energy and water issues may have been attributable to market conditions rather than learning and hence in actual fact, costs may not have changed much. However, there was the general view that costs of low and zero carbon technologies had dropped due to larger volume of procurement.

The general consensus from the consultation was that costs had not dropped significantly and programme times were not shorter (hence, preliminaries costs remained unchanged). However, in terms of learning, the homebuilders did state that processes were smoother and construction methodologies becoming more standardised. Since, it has taken them two years to achieve this level of comfort in building to Code homes, it may be that the next two years will see greater levels of change in learning.

However, we do believe that housebuilders are learning and are targeting credits that will achieve Code levels for **minimum** costs. Designs are being rationalised and where possible zero cost credits are targeted.

Currently Code Level 6 homes (Zero Carbon homes) are not common and housebuilders are mainly focusing on building to the Code where it is a mandatory requirement or a requirement of planning or a client requirement (through joint ventures). Therefore, currently, Code Level 3 Homes are most common as it is mandatory requirement for social housing. Therefore, housebuilders still have much learning to do with building to Code Level 6 and the benefits of 'learning' are still yet to be realised.

Appendices

A: Energy Strategy summary

Code Level	Fabric package	Primary heating tech.	Low carbon tech.	Capacity of low carbon tech (kWp)				dwelling emission rate Improvement			
				2bF	2bT	3bS	4bD	2bF	2bT	3bS	4bD
3	Basic	Gas boiler	None	-	-	-	-	23%	16%	17%	17%
	Basic (+)	Gas boiler	None	-	-	-	-	25%	19%	21%	21%
	Basic	Gas boiler	SHW	0.2	1.0	1.2	1.5	25%	25%	25%	25%
	Basic	Gas boiler	PV	0	0.5	0.5	0.55	25%	29%	27%	26%
4	Good	Gas boiler	PV	0.45	0.80	0.95	1.15	44%	45%	45%	44%
	Advanced	Gas boiler	PV	0.20	0.50	0.50	0.00	45%	53%	52%	44%
	Good	ASHP	PV	0.10	0.50	0.50	0.50	44%	49%	48%	46%
	Good	Biomass HOB (block-scale in flats)	None	-	-	-	-	70%	69%	70%	71%
	Advanced	Gas CHP & DH	None	-	-	-	-	49%	46%	48%	48%
5	Good	Gas boiler	PV	1.75	2.55	3.20	4.15	102%	102%	102%	102%
	Advanced	Gas boiler	PV	0.85	1.25	1.55	2.00	101%	102%	102%	101%
	Good	ASHP	PV	0.80	1.40	1.70	2.10	102%	102%	101%	101%
	Good	Biomass HOB (block-scale in flats)	PV	0.65	1.00	1.20	1.55	100%	101%	101%	101%
	Good	Biomass HOB & DH	PV	1.40	1.70	2.10	2.60	100%	100%	101%	101%
	Good	Biomass CHP & DH	PV	2.10	3.05	3.85	4.95	101%	100%	100%	101%
	Advanced	Gas CHP & DH	PV	1.80	2.40	3.00	3.75	102%	100%	101%	101%
6	Good	Gas boiler	PV	4.95	6.30	7.50	9.15	203%	185%	174%	165%
	Advanced	Gas boiler	PV	4.65	5.65	6.65	8.00	201%	185%	174%	165%
	Good	ASHP	PV	4.60	5.80	6.85	8.35	202%	185%	173%	165%
	Good	Biomass HOB (block-scale in flats)	PV	3.70	4.50	5.20	6.20	200%	184%	173%	165%
	Good	Biomass HOB & DH	PV	3.65	4.70	5.35	6.30	200%	185%	173%	164%
	Good	Biomass CHP & DH	PV	3.50	4.25	4.85	5.75	201%	183%	173%	165%
	Advanced	Gas CHP & DH	PV	4.25	5.00	5.75	6.85	202%	185%	173%	165%

B: Total Code costs by house type and development scenario

All costs reported in the tables below are relative to a Part L 2006 compliant baseline.

Two-bed flat

Code Level	1		2		3		4		5		6	
	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost
City Infill												
Energy	10	£1,420	13	£1,465	13	£1,465	17	£3,571	25	£8,429	28	£20,254
Water	4	£158	4	£158	4	£158	4	£158	6	£6,158	6	£6,158
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	2	£0	6	£50	6	£50	7	£50	7	£50	7	£50
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	1	£0	4	£150	8	£150	8	£700	12	£1,000	12	£1,000
Management	7	£45	7	£45	7	£45	7	£45	9	£705	9	£705
Ecology	0	£0	0	£0	7	£275	7	£275	7	£275	7	£275
Total	**44**	**£1,623**	**54**	**£1,868**	**65**	**£2,143**	**70**	**£4,799**	**83**	**£16,617**	**90**	**£28,442**
Edge of Town												
Energy	10	£1,420	13	£1,465	12	£1,545	19	£3,571	27	£4,723	29	£15,553
Water	4	£158	4	£158	4	£154	4	£154	6	£6,154	6	£6,154
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£3,980
Waste	2	£0	6	£50	6	£50	7	£50	7	£50	7	£50
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	1	£0	4	£150	8	£250	8	£700	12	£1,000	12	£2,000
Management	7	£45	7	£45	7	£18	7	£18	9	£678	9	£678
Ecology	0	£0	0	£0	5	£850	5	£850	5	£850	5	£850
Total	**44**	**£1,623**	**54**	**£1,868**	**62**	**£2,867**	**70**	**£5,343**	**83**	**£13,455**	**89**	**£29,265**
Urban Regeneration												
Energy	10	£1,420	13	£1,465	12	£1,465	17	£3,571	25	£8,726	28	£20,551
Water	4	£158	4	£158	4	£154	4	£154	6	£6,154	6	£6,154
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	2	£0	6	£50	6	£50	7	£50	7	£50	7	£50
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	1	£0	4	£150	8	£150	8	£700	12	£1,000	12	£1,000
Management	7	£45	7	£45	7	£2	7	£2	9	£2	9	£662
Ecology	0	£0	0	£0	7	£250	7	£250	7	£250	7	£250
Total	**44**	**£1,623**	**54**	**£1,868**	**64**	**£2,071**	**70**	**£4,727**	**83**	**£16,182**	**90**	**£28,667**
Strategic Greenfield												
Energy	10	£1,420	13	£1,465	12	£1,545	19	£3,571	27	£10,423	29	£21,253
Water	4	£158	4	£158	4	£154	4	£154	6	£6,154	6	£6,154
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£3,900
Waste	2	£0	6	£50	6	£50	7	£50	7	£50	7	£50
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	1	£0	4	£150	8	£250	8	£700	12	£1,000	12	£2,000
Management	7	£45	7	£45	7	£1	7	£1	9	£661	9	£661
Ecology	0	£0	0	£0	5	£850	5	£850	5	£850	5	£850
Total	**44**	**£1,623**	**54**	**£1,868**	**62**	**£2,850**	**70**	**£5,326**	**83**	**£19,138**	**89**	**£34,868**

Two-bed terrace

Code Level	1		2		3		4		5		6	
	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost
Small Brownfield												
Energy	9	£2,995	13	£3,090	13	£3,015	18	£5,431	25	£14,391	28	£27,591
Water	3	£200	4	£250	4	£200	4	£200	6	£4,700	6	£4,700
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	6	£50	7	£100	6	£50	7	£100	7	£100	7	£100
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	2	£0	2	£0	5	£150	8	£350	12	£1,525	12	£1,525
Management	5	£40	7	£90	7	£90	7	£90	9	£620	9	£620
Ecology	0	£0	0	£0	6	£300	6	£300	6	£300	6	£300
Total	**45**	**£3,285**	**53**	**£3,530**	**61**	**£3,805**	**70**	**£6,471**	**82**	**£21,636**	**89**	**£34,836**
Edge of Town												
Energy	9	£2,995	13	£3,090	13	£3,015	19	£5,431	27	£15,241	29	£28,586
Water	3	£200	4	£250	4	£200	4	£200	6	£4,700	6	£4,700
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	6	£50	7	£100	6	£50	7	£100	7	£100	7	£100
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	2	£0	2	£0	7	£200	8	£650	12	£1,525	12	£1,525
Management	5	£40	7	£90	7	£18	7	£18	9	£548	9	£548
Ecology	0	£0	0	£0	5	£850	5	£850	5	£850	5	£850
Total	**45**	**£3,285**	**53**	**£3,530**	**62**	**£4,333**	**70**	**£7,249**	**83**	**£22,964**	**89**	**£36,309**
Urban Regeneration												
Energy	9	£2,995	13	£3,090	13	£3,015	17	£5,431	25	£11,194	28	£24,394
Water	3	£200	4	£250	3	£200	4	£200	6	£4,700	6	£4,700
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	6	£50	7	£100	6	£50	7	£100	7	£100	7	£100
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	2	£0	2	£0	5	£150	8	£200	12	£1,400	12	£1,400
Management	5	£40	7	£90	7	£2	7	£2	9	£532	9	£532
Ecology	0	£0	0	£0	7	£250	7	£250	7	£250	7	£250
Total	**45**	**£3,285**	**53**	**£3,530**	**61**	**£3,667**	**70**	**£6,183**	**83**	**£18,176**	**90**	**£31,376**
Strategic Greenfield												
Energy	9	£2,995	13	£3,090	13	£3,015	19	£5,431	27	£15,241	29	£28,586
Water	3	£200	4	£250	4	£200	4	£200	6	£4,700	6	£4,700
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	6	£50	7	£100	6	£50	7	£100	7	£100	7	£100
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	2	£0	2	£0	7	£200	8	£650	12	£1,525	12	£1,525
Management	5	£40	7	£90	7	£1	7	£1	9	£531	9	£531
Ecology	0	£0	0	£0	5	£850	5	£850	5	£850	5	£850
Total	**45**	**£3,285**	**53**	**£3,530**	**62**	**£4,316**	**70**	**£7,232**	**83**	**£22,947**	**89**	**£36,292**

Three-bed semi-detached

Code Level	1		2		3		4		5		6	
	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost
Small Brownfield												
Energy	9	£3,168	13	£3,263	13	£3,263	18	£6,536	25	£15,816	28	£30,536
Water	3	£200	4	£250	4	£250	4	£250	6	£4,750	6	£4,750
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	6	£50	7	£100	7	£100	7	£100	7	£100	7	£100
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	2	£0	2	£0	8	£200	8	£350	12	£1,455	12	£1,455
Management	5	£40	7	£90	7	£90	7	£90	9	£620	9	£620
Ecology	0	£0	0	£0	6	£400	6	£400	6	£400	6	£400
Total	**45**	**£3,458**	**53**	**£3,703**	**65**	**£4,303**	**70**	**£7,726**	**82**	**£23,141**	**89**	**£37,861**
Edge of Town												
Energy	9	£3,168	13	£3,263	12	£3,263	19	£6,536	27	£16,666	29	£31,531
Water	3	£200	4	£250	4	£250	4	£250	6	£4,750	6	£4,750
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	6	£50	7	£100	6	£50	7	£100	7	£100	7	£100
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	2	£0	2	£0	8	£200	8	£650	12	£1,455	12	£1,455
Management	5	£40	7	£90	7	£18	7	£18	9	£548	9	£548
Ecology	0	£0	0	£0	5	£950	5	£950	5	£950	5	£950
Total	**45**	**£3,458**	**53**	**£3,703**	**62**	**£4,731**	**70**	**£8,504**	**83**	**£24,469**	**89**	**£39,334**
Urban Regeneration												
Energy	9	£3,168	13	£3,263	12	£3,198	17	£6,536	25	£12,473	28	£27,193
Water	3	£200	4	£250	4	£250	4	£250	6	£4,750	6	£4,750
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	6	£50	7	£100	6	£50	7	£100	7	£100	7	£100
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	2	£0	2	£0	8	£200	8	£200	12	£1,345	12	£1,345
Management	5	£40	7	£90	7	£2	7	£2	9	£532	9	£532
Ecology	0	£0	0	£0	7	£350	7	£350	7	£350	7	£350
Total	**45**	**£3,458**	**53**	**£3,703**	**64**	**£4,050**	**70**	**£7,438**	**83**	**£19,550**	**90**	**£34,270**
Strategic Greenfield												
Energy	9	£3,168	13	£3,263	12	£3,263	19	£6,536	27	£16,666	29	£31,531
Water	3	£200	4	£250	4	£250	4	£250	6	£4,750	6	£4,750
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	6	£50	7	£100	6	£50	7	£100	7	£100	7	£100
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	2	£0	2	£0	8	£200	8	£650	12	£1,455	12	£1,455
Management	5	£40	7	£90	7	£1	7	£1	9	£531	9	£531
Ecology	0	£0	0	£0	5	£950	5	£950	5	£950	5	£950
Total	**45**	**£3,458**	**53**	**£3,703**	**62**	**£4,714**	**70**	**£8,487**	**83**	**£24,452**	**89**	**£39,317**

Four-bed detached

Code Level	1		2		3		4		5		6	
	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost	Credits	E/O cost
Small Brownfield												
Energy	9	£3,574	13	£3,669	13	£3,679	18	£7,819	25	£18,049	28	£34,859
Water	3	£200	4	£250	4	£250	4	£250	6	£4,750	6	£4,750
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	6	£50	7	£100	7	£100	7	£100	7	£100	7	£100
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	2	£0	2	£0	8	£34	8	£34	12	£994	12	£994
Management	5	£40	7	£90	7	£90	7	£90	9	£620	9	£620
Ecology	0	£0	0	£0	6	£400	6	£400	6	£400	6	£400
Total	**45**	**£3,864**	**53**	**£4,109**	**65**	**£4,553**	**70**	**£8,693**	**82**	**£24,913**	**89**	**£41,723**
Edge of Town												
Energy	9	£3,574	13	£3,669	12	£3,614	19	£7,819	27	£18,899	29	£35,854
Water	3	£200	4	£250	4	£250	4	£250	6	£4,750	6	£4,750
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	6	£50	7	£100	6	£50	7	£100	7	£100	7	£100
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	2	£0	2	£0	8	£34	8	£334	12	£994	12	£994
Management	5	£40	7	£90	7	£18	7	£18	9	£548	9	£548
Ecology	0	£0	0	£0	5	£950	5	£950	5	£950	5	£950
Total	**45**	**£3,864**	**53**	**£4,109**	**62**	**£4,916**	**70**	**£9,471**	**83**	**£26,241**	**89**	**£43,196**
Urban Regeneration												
Energy	9	£3,574	13	£3,669	12	£3,614	17	£7,739	25	£14,645	28	£31,455
Water	3	£200	4	£250	4	£250	4	£250	6	£4,750	6	£4,750
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	6	£50	7	£100	6	£50	7	£100	7	£100	7	£100
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	2	£0	2	£0	8	£34	8	£34	12	£909	12	£909
Management	5	£40	7	£90	7	£2	7	£2	9	£532	9	£532
Ecology	0	£0	0	£0	7	£350	7	£350	7	£350	7	£350
Total	**45**	**£3,864**	**53**	**£4,109**	**64**	**£4,300**	**70**	**£8,475**	**83**	**£21,285**	**90**	**£38,095**
Strategic Greenfield												
Energy	9	£3,574	13	£3,669	12	£3,614	19	£7,819	27	£18,899	29	£35,854
Water	3	£200	4	£250	4	£250	4	£250	6	£4,750	6	£4,750
Materials	14	£0	14	£0	14	£0	14	£0	14	£0	16	£0
Surface	2	£0	2	£0	2	£0	2	£0	2	£0	2	£0
Waste	6	£50	7	£100	6	£50	7	£100	7	£100	7	£100
Pollution	4	£0	4	£0	4	£0	4	£0	1	£0	3	£0
Health	2	£0	2	£0	8	£34	8	£334	12	£994	12	£994
Management	5	£40	7	£90	7	£1	7	£1	9	£531	9	£531
Ecology	0	£0	0	£0	5	£950	5	£950	5	£950	5	£950
Total	**45**	**£3,864**	**53**	**£4,109**	**62**	**£4,899**	**70**	**£9,454**	**83**	**£26,224**	**89**	**£43,179**

C: Costs by issue

Category	Issue	Name	Requirement	Credits	Points	Flat	House	Description of measures
ENERGY	Ene 3	Internal Lighting	>75% dedicated ee light fittings (2 credits)	2	2.51	£30	£50	Cost of additional low energy light fittings (most developers consulted would typically target 2 credits under this issue)
	Ene 4	Drying Space	Provide adequate internal drying space (1 credit)	1	1.26	£15	£75	Allowance for provision of an internal tidy-dry in flats and installing a rotary drying line in houses
	Ene 5	Eco-labelled White Goods	Provide an information leaflet on the EU energy efficiency labelling of white goods	1	1.26	£5	£5	Nominal cost for provision of an information leaflet
			Provide fridges and freezers or fridge freezers that have an A+ rating under the EU energy efficiency labelling scheme	1	1.26	£1,000	£1,000	Most developers consulted do not provide white goods as standard, hence the extra-over cost of achieving these credits are assumed to relate to the full cost of providing compliant appliances.
	Ene 6	External Lighting	External space lighting is provided by dedicated energy efficient fittings	1	1.26	£0	£0	Low energy external lighting fittings would usually form part of a standard specification (zero extra-over cost).
			All external security lighting is designed for energy efficiency and adequately controlled (e.g. movement detection sensors and day-light cut-off or timers)	1	1.26	£20	£65	Allowance for provision of PIR sensors to external lighting controls
	Ene 8	Cycle Storage	1 cycle store for every two studios or 1 bed dwellings / 1 cycle per dwelling (2 or 3 bed) / 2 cycle stores per 4+ bed dwelling	1	1.26	£183	£600	Costs will be dependent on whether a dedicated enclosure is provided or whether cycle storage is provided in an existing secure area, such as a garage or basement of flats (and in the latter case, whether an allowance is made for the space required). Costs assume a shed and concrete pad is provided (based on 2 to 3-bed dwelling).
			1 cycle store for every studio or 1 bed dwellings / 2 cycles per 2 or 3 bed dwellings / 4 cycle stores per 4 bed dwelling	2	2.51	£387	£850	Additional costs are based on an costs of enlarged enclosure and additional cycle storage rack.
	Ene 9	Home Office	Sufficient space and services to allow occupant to set-up a home office	1	1.26	£80	£80	Cost for provision of telephone / data connection points
WATER	Wat 1	Internal Water Consumption	Measures to achieve below 120 litres/person/day (1 credit)	1	1.5	No data		No developers gave costs for achieving fewer than 3 credits (mandatory at Code Level 3) under Wat1
			Measures to achieve below 110 litres/person/day (2 credits)	2	3			
			Measures to achieve below 105 litres/person/day (3 credits)	3	4.5	£150	£200	Typical specification is low flush toilet likely to be 2.6l, washbasins taps at 4l/min, bath of 150l capacity and kitchen taps at 4l/min.
			Measures to achieve below 90 litres/person/day (4 credits)			No data		
			Measures to achieve below 80 litres/person/day (5 credits)	5	7.5	£6,150	£4,700	Rainwater or greywater recycling system required.
	Wat 2	External Water Consumption	Provision of a system to collect rainwater for internal / external irrigation.	1	1.5	£10	£50	Allowance for installation of water butts. Cost for flats assumes 2 communal water butts per block of flats (based on an 8-flat block)

MATERIALS	Mat 1	Environmental Impact of materials	At least 3 of the following five elements achieve a Green Guide rating of A+ to D - (i) Roof (ii) External walls (iii) Internal walls (iv) Upper and ground floors (v) Windows	0	0	£0	£0	
			The number of credits awarded for the 5 key elements described above is calculated using the Code Mat1 Calculator Tool - maximum of 15 credits available	9	2.7	£0	£0	Consultation revealed that house-builders achieve between 6 to 9 credits under this issue at no extra-over cost (i.e. through existing supply chains)
	Mat 2	Sourcing - Basic Elements	Responsible sourcing of 80% of the assessed materials in the following building elements - (i) Frame (ii) Ground Floor (iii) Upper floors (iv) Roof (v) External walls (vi) Internal walls (vii) Foundations / sub-structure (viii) Staircase (100% of timber in these elements must be legally sourced) - maximum of 6 credits available	4	1.2	£0	£0	Up to 4 credits can be achieved at no extra-over cost. Credits are more easily achieved for timber frame products.
	Mat 3	Sourcing - Finishing Elements	80% of a range of finishing elements is responsibly sourced - up to 3 credits available	1	0.3	£0	£0	1 credit typically achieved through normal practices. Few developers targeted more than 1 credit due to the high administrative burden.
SURFACE WATER	Sur 1	SW Run-Off Management	Flood risk assessment to ensure mandatory requirement is met (0 credits)	0	0	£0	£0	Attenuation of surface water run-off is usually a planning / Environment Agency requirement so the mandatory element is not considered a mandatory element. If ground conditions do not allow attenuation by infiltration, then significant costs for rainwater harvesting systems can be incurred to meet the Code's requirement for use of rainwater within developments.
			Improved quality of discharged rainwater via SUDS (2 credits)	2	1.1	£3,500	£2,000	Costs of SUDS systems typically high - £500 to £1000/unit. Not generally targetted for Code purposes
	Sur 2	Flood Risk	Raised access routes and ground floors (for developments in med/high flood risk) (1 credit)	2	1.1	£0	£0	Zero cost if development is situated in a low flood-risk area. Costs to achieve these credits for developments situated in a med/high flood risk area would be substantial, such that these crediits would be unlikely to be targeted.

WASTE	Was 1	Waste Storage	Internal storage space for recyclable waste (2 credits)	2	1.83	£50	£50	Costs for supply and fit of recycling bins
			Combination of internal storage space and adequate external storage capacity.	2	1.83	£0	£0	Zero additional cost to achieve a further 2 credits assuming that the Local Authority provides a collection scheme. In cases where there is no local authority collection scheme, a further cost may be incurred in providing adequate external bins and suitable access.
			Internal storage + Local Authority collection scheme for recyclable waste (4 credits)					
	Was 2	Construction Waste Management	Site waste management plan (0 credits - mandatory)	0	0	£0	£0	The majority of developers consulted reported that 2 credits can be achieved as part of normal practice
			Commitments to reduce waste generated on site (1 credit)	1	0.91	£0	£0	
			Sorting construction site waste and diverting from landfill (1 credit)	1	0.91	£0	£0	
	Was 3	Composting Facilities	Provide home or community composting (1 credit)	1	0.91	£0	£50	Allowance for provision of a composter in houses. This credit is unlikely to be targetted in an apartment scheme.
POLLUTION	Pol 1	Insulant GWP	GWP of materials in key elements <5 (1 credit)	1	0.7	£0	£0	No extra-over cost to comply
		NOx Emissions	Reduce dry NOx emissions below 100mg/kWh (1 credit)	2	1.4	£0	£0	2 of a maximum of 3 availabe credits are likely to be achieved as part of the standard specification (i.e. good quality condensing boiler). Credits may not be achievable if a biomass boiler or heat pump is installed.
			Reduce dry NOx emissions below 70mg/kWh (2 credits)					
			Reduce dry NOx emissions below 40mg/kWh (3 credits)					
HEALTH & WELL-BEING	Hea 1	Daylight	Kitchens achieve a minmum average daylight factor of 2%	1	1.17	£0	£0	Costs reported in the consultation ranged from approx £50 for a single credit (costs related to testing) up to £300 to achieve all 3 credits. It was commented that these credits are difficult to achieve in flats that are single aspect.
			Living rooms, dining rooms, studies and any home office to achieve a minimum average daylight factor of 1.5%	1	1.17	£150	£150	
			80% of the working plane in each of the rooms described above must receive direct light from the sky	1	1.17	£300	£300	
	Hea 2	Sound Insulation	Achieve sound insulation standards that are higher than those given in Approved Document E of the Building Regulations (demonstrted by sound-testing or use of robust details) - 3dB improvement	1	1.17			A wide range of costs were reported during the consultation. The highest occurrence of responses stated that 3 credits could be achieved, at extra-over costs varying from £30 to £200/unit. Note that all credits can be achieved in detached homes at no extra-over cost.
			5dB improvement	3	3.5	£150	£150	
			8dB improvement	4	4.67	£250	£250	
	Hea 3	Private Space	Provide adequate private outdoor space	1	1.17	£0	£0	No extra-over costs and balconies assumed to be provided as standard in flats (often a requirement in social housing).
	Hea 4	Lifetime Homes	Comply with all principles of lifetime homes applicable to the dwelling	4	4.67	£300	£700	Costs for meeting accessibility, supports / reinforcement and bathroom modifications. Note that often a requirement of housing associations in social housing, so not considered and extra-over cost.

MANAGEMENT	Man 1	Home User Guide	Home user guide (1 credit)	1	1.11	£0	£0	Minor cost for production and printing of guide.
			Home user guide including info related to site and surroundings (2 credits)	2	2.22	£25	£25	
	Man 2	Considerate Constructors Scheme	Commitment to meet best practice under a nationally or locally recognised certification scheme , such as Considerate Constructors	1	1.11	£0	£0	Minor unit cost related to registration of site. Many developers consulted complied with Considerate Constructors as standard.
			Commitment to go beyond best practice (2 credits)	2	2.22	£15	£15	
	Man 3	Construction Site Impacts	Procedures to cover 2 items (1 credit)	1	1.11	£0	£0	2 credits likely to be achieved as standard.
			Procedures to cover 4+ items (2 credits)	2	2.22	£0	£0	
	Man 4	Security	Employ an ALO or CPDA (and follow advice) to comply with 'Secured by Design' (2 credits)	2	2.22	£660	£530	Common measures implemented are as follows: • PAS 24 doors and windows • Laminated glass • Secure letterboxes • Additional lighting The CDPA is usually consulted (no costs are incurred in consulting with him/her).
ECOLOGY	Eco 1	Ecological Value of Site	Confirm site is of low ecological value (1 credit)	1	1.33	£0	£0	Zero cost for brownfield development
	Eco 2	Ecological Enhancement	Appoint a suitably qualified ecologist to recommend enhancements. Adopt all key recommendations and 30% of additional recommendations.	1	1.33	£150	£250	Allowance for employing an ecologist and following sufficient recommendations. These costs will be highly site specific.
	Eco 3	Protection of Ecological Features	Protect all existing features of ecological value during construction	1	1.33	Dependent on site		Cost is highly site specific. Likely to be easier to achieve on a brownfield site of low ecological value.
	Eco 4	Change in Ecological Value	Ecological value before and after development is measured and overall change in species per hectare is:			Dependent on site		Assume that at least 2 credits can be achieved if an ecologist is employed. Again this is highly variable depending on the site, although credits should be more easily achieved on a brownfield site. 4 credits likely to be very difficult to achieve.
			Neutral	2	2.66			
			Minor +ve change (3 credits)	3	4			
			Major +ve change (4 credits)	4	5.33			
	Eco 5	Building Footprint	Achieve net internal floor area:net internal ground floor area ratio equal to or greater than 2.5:1 (or 3:1 for a block of flats).	1	1.33	£0	£0	Credits dependent on site layout.
			Achieve net internal floor area:net internal ground floor area ratio equal to or greater than 3:1 (or 4:1 for a block of flats).	2	2.66	£0	£0	

D: Overview of the Code for Sustainable Homes

D.1 INTRODUCTION TO THE CODE

As the national standard for the sustainable design and construction of new homes, the Code is designed to reduce carbon emissions and create homes that are more sustainable.

The extensive framework provided by the Code sets challenging targets in various categories; from energy use and CO_2 emissions, to water consumption, to site ecology. The Code includes nine categories of sustainable design and ratings are based on a six star system[13]. Each category is further sub-divided into a number of discrete issues, with a total of 34 issues across all nine design categories. Credits are scored against issues, with higher performance being rewarded with more credits, up to the maximum number of credits available for the issue.

Although building to the Code is voluntary, the number of Code homes is expected to increase significantly in the coming years. The 2010 changes to Part L of the Building Regulations correspond to the mandatory CO_2 reduction requirement of Code level 3. Since meeting the emission performance targets is one of the more costly aspects of the Code, the extra over spend to build to Code 3 will decline. Furthermore, many local authorities now require some level of Code compliance in new developments, and Code level 3 is mandatory for social housing if a Government grant is sought.

D.2 PREVIOUS STUDIES INTO THE COST OF BUILDING TO THE CODE

There have been a number of studies into the costs of building to the Code since its initial launch in December 2006, as summarised below[14].

A cost review of the Code for Sustainable Homes (February 2007)

The original study into the costs of building Code homes was undertaken by Cyril Sweett for English Partnerships and the Housing Corporation. This work was based on summary Code guidance from December 2006 and was completed before the finalised version of the Code technical guide was published. The results of this study at the highest Code levels (5 and 6) are now out dated since the assumptions made on the level of emission reduction required do not match what was subsequently adopted.

The results for the end of terrace house in this study show extra over costs in the region £3,500–£5,500 to build to Code level 3. For Code level 4 the costs for this dwelling type are given as £4,700–£14,700.[15]

[13] The nine sustainable design categories are: Energy/CO_2, Water, Materials, Surface Water Run-off, Waste, Pollution, Health and Well-being, Management, and Ecology.
[14] The Code was officially launched by DCLG in December 2006 and ratings became possible following the publication of the Technical Guide in April 2007.
[15] *A cost review of the Code for Sustainable Homes*, Cyril Sweett, Table 6.3, p.47 (February 2007).

Since this study was completed before it was possible to gain a Code rating (the technical guide was still being finalised), the results were based largely on a desk-based study of costs rather than empirical cost data.

Cost Analysis of The Code for Sustainable Homes (July 2008)

An update to the original study into the costs of building to the Code was published in mid-2008. This work aimed to refine the analysis, taking into account the finalised technical guidance and other supporting information such as calculation tools, a revised Green Guide specification and a definition of zero carbon. The work included four dwelling types and four distinct development scenarios and a range of costs were derived to take account of variable such as original ecological value of the site and flood risk.

Results of the cost analysis (in 2008 prices) for the end of terrace house showed extra over costs of £4,930–£5,800 for Code for Sustainable Homes level 3 and £8,400–£9,500 for Code for Sustainable Homes level 4. The ranges for Code for Sustainable Homes level 5 were £17,500–£20,200 and £31,200–£37,700 for Code for Sustainable Homes level 6.[16]

This study was undertaken at a time when the Code was still relatively novel, the house building industry was in the early stages of understanding the Code and its wider implications, and experience of building Code homes was very limited. Another cost study was commissioned in late 2008 to gather data to inform an impact assessment of changes to the Code (see below).

Code for Sustainable Homes: A Cost Review (March 2010)

This report presents cost data based on a consultation that took place in late 2008 and early 2009. An update to the costs of building Code homes was required by DCLG in order to quantitatively assess the impacts of proposed future changes to the Code. The final impact assessment was published alongside a public consultation on changes to the Code in December 2009 and the associated cost report followed in March 2010.

The study considered four basic dwelling types, in line with those used in the studies discussed above. Twelve development scenarios were created, differentiated by scale (total number of dwellings), dwelling mix, density, and site type (greenfield/ brownfield).

The cost results from this study show a wider range compared to the previous (July 2008) work. This is a reflection of the wider range of development scenarios and energy strategies considered in this study. The cost ranges for the semi-detached house at Code for Sustainable Homes level 3 were £2,650–£9,400, and £6,600–£17,900 at Code for Sustainable Homes level 4[17]. The equivalent ranges at Code for Sustainable Homes levels 5 and 6 were £25,600–£31,600 and £28,400–£43,500.

This cost review also explored the key sensitivities and cost drivers, and considered how extra over costs may change over time in the context of changes to Building Regulations (and therefore base build costs).

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[16] *Cost Analysis of The Code for Sustainable Homes*, DCLG, Table 4.2, p.32 (July 2008).

[17] Note that the semi-detached house is equivalent to the end of terrace dwelling modelled in the previous studies.

D.3 SUMMARY OF CHANGES TO THE CODE

Periodic updates to the Code are necessary to keep it up-to-date and aligned with related legislation such as Part L of the Building Regulations. A consultation on proposed technical and policy changes to the Code was undertaken between December 2009 and March 2010[18]. After considering all responses to the consultation, DCLG published a final impact assessment on the preferred changes to the Code, which are summarised below.

Table 25: Summary of changes to the Code, October 2010

Category / Issue Affected	Change
Energy & CO_2: Ene1 and Ene2	**Reallocation of credits from Ene 1 to Ene 2 and metric change from heat loss parameter to kWh/m^2.yr** Total number of credits in Ene 1 reduced from 15 to 10, such that zero credits are awarded for meeting the dwelling emission rate improvement required by Part L 2010.Ten credits available for achieving net zero carbon standard with respect to all regulated and unregulated emissions. The 5 credits from Ene 1 are reallocated to the Building Fabric issue (Ene 2) and the metric used to measure fabric improvement is changed from heat loss parameter to kWh/m^2/yr (space heating and cooling), which is in line with the Fabric Energy Efficiency Standard proposed as part of the zero carbon homes definition. A further change is the introduction of awarding credits against Ene1 and Ene2 on a sliding scale such that fractions of credits can be achieved (to a resolution of 0.1 credits).
Energy & CO_2: Ene3	**Remove internal lighting credits and replace with Energy Display Devices** Ene3: Internal Lighting credits removed. New issue – Energy Display Devices – added, also with two credits available. One credit for providing an energy display device showing electricity consumption data. Two credits for providing an energy display device showing electricity and primary heating fuel consumption data.

[18] *Sustainable New Homes – The Road to Zero Carbon: Consultation on the Code for Sustainable Homes and the Energy Efficiency standard for Zero Carbon Homes*, DCLG, (December 2009).

Waste (Was1. Was3) and Health & Well-being (Hea3)	**Updating accessibility requirements and changes to the Waste category** Terminology change for access requirements of Was 1, Was 3 and Hea 3 to centre on 'inclusive design' rather than 'wheelchair users'. Amend Was1 checklist to mirror approach of Lifetime Homes and generate a single approach towards inclusive design throughout the Code. Remove requirement for bins to be within 30 metres of an external door (compliance is covered by Part H of Building Regulations). Remove the mandatory element of Was 2: Construction Site Waste Management, which had stated that a site waste management plan must be produced. Provide 1 voluntary credit for a compliant site waste management plan (that meets the criteria set out on p.132 of consultation technical guide, published December 2009). Up to two further credits available for diverting waste from landfill (1 credit for diverting 50% of construction waste, 2 credits for diverting 85% from landfill).
Management (Man4)	**Security standards** Previously, 2 credits would be gained against Man4: Security for consulting an architectural liaison officer or a crime prevention and detection advisor and following advice to comply with 'Section 2 – Physical Security' of *Secured by Design – New Homes*. The revision involves splitting the two credits such that one is available for achieving certain minimum security standards (Box B of the consultation document: *Sustainable New Homes – The Road to Zero Carbon* (December 2009), p.54). Provided that the first credit is gained, the second credit is available for consulting the local police and following advice to comply with wider range of security requirements of 'Section 2 – Physical Security' from *Secured by Design New Homes*.
Surface Water (Sur1)	**Technical changes to Sur 1: Surface Water Run-Off Management** The technical change involves changes to the requirements for volume of run-off and peak rate run-off. Also an amendment to the criteria for water quality (one credit for ensuring that run-off at risk of pollution receives at least two levels of treatment and run-off not at risk of pollution receives at least one treatment before discharge from site).

Health & Well-being (Hea4)	**Lifetime Homes exemptions on steeply sloping sites** For dwellings on plots with sloping topography that predominantly exceeds 1:12, an exemption from the requirement to meet Design Criteria 2 (access from car parking) and 3 (approach gradients) of the Lifetime Homes standard will apply, as long as accessible steps are installed. For these dwellings, a maximum of 3 credits under Hea 4 will be available for complying with all other Lifetime Homes criteria.

D.4 EXPERIENCE OF BUILDING TO THE CODE

DCLG collect, collate and publish statistics on the number of Code certificates issued by Code level, sector and region. The following graph shows the number of certificates issued at the time of the consultation undertaken for this study. Note that a logarithmic scale has been used due to the large differences in totals between Code levels.

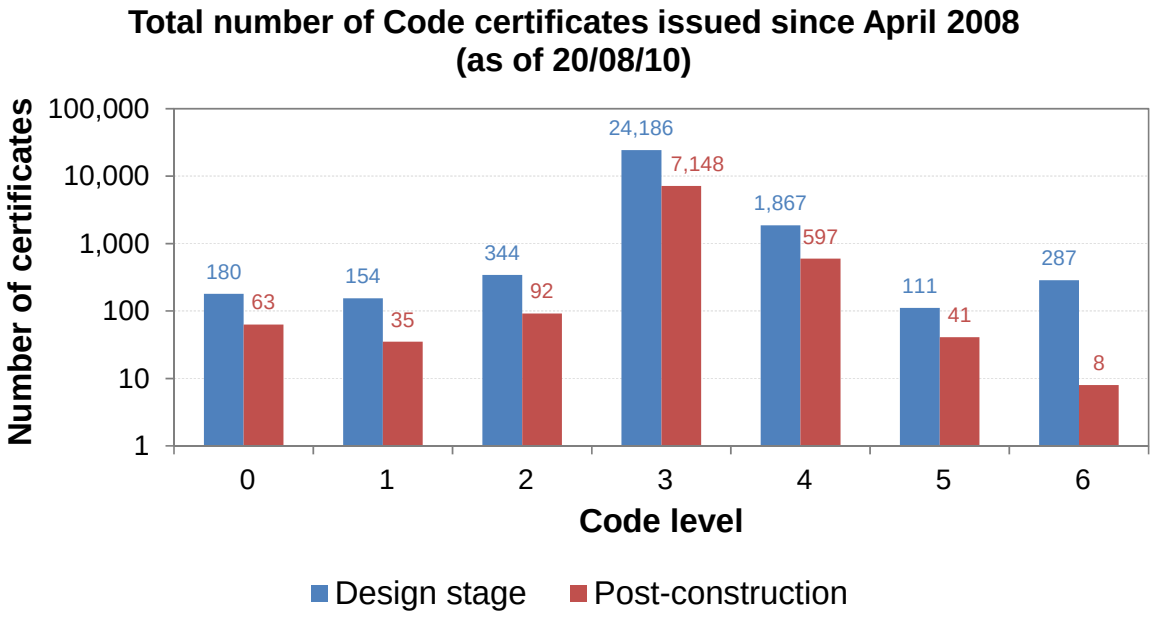

Figure 15: Number of Code certificates issued by Code level to summer 2010[19]

These data suggest that by summer 2010 over 27,000 design stage certificates and nearly 8,000 post-construction certificates had been issued across all Code levels. The vast majority of post-construction certificates have been for homes built to Code level 3 (c.90 per cent) and level 4 (7.5 per cent).

[19] Source: DCLG: www.communities.gov.uk/publications/corporate/statistics/codesustainablesapq22010.

E: List of consultees

The following organisations were consulted during the course of this study. The authors are grateful for their participation.

- Taylor Wimpey
- Bovis Homes
- KeepMoat
- Countryside Properties
- Kier Residential
- Galliford Try
- Fairview
- Cala Homes
- Anwyl Construction
- Durkan
- Southdale Homes

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