Communities and Local Government

Cost Analysis of The Code for Sustainable Homes

Final Report

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July 2008
Department for Communities and Local Government

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Contents

Chapter 1

Introduction

This report presents the findings of research to update and enhance existing cost benchmarks for achieving different performance levels under the Code for Sustainable Homes[1] (the Code). This work builds on an initial cost analysis that was completed prior to the publication of the Code technical guidance document (initially published in April 2007 and revised in September). As a result the initial cost estimates made assumptions about the method for achieving some performance standards based on the summary guidance published in December 2006 and pre-existing Ecohomes standards.

This study was commissioned to refine the cost analysis of the Code in light of the publication of the finalised technical guidance together with other supporting information (e.g. the partial Green Guide to Specification).

1.1 Limitations of previous work

The cost analysis of the Code performed early 2007 required updating because of the changes to the detail of credit requirements arising from the publication of the Code technical guidance (with associated calculation tools) and the release of a revised Green Guide to Specification[2]. The inclusion within the technical guidance of a formal definition of Zero Carbon housing also enables the costs associated with Code level 6 to be estimated.

In addition, the initial cost estimates to not fully take into account the potential variation in approaches to the Code and the associated costs in different forms of development location (e.g. in areas of high flood risk or with high, medium or low levels of ecological value).

1.2 Aims

This research seeks to:

- Update the cost analysis undertaken by Cyril Sweett for English Partnerships and the Housing Corporation in light of the finalised technical guidance on the Code.

[1] 'A cost review of the Code for Sustainable Homes', English Partnerships and the Housing Corporation, February 2007.

[2] Although some specification information, notably windows, is still outstanding.

- Provide greater confidence in the analysis of the cost implications of achieving the energy standards in Code levels 4, 5 and 6.
- Provide analysis of the overall cost implications of achieving Code level 6.
- Assess the potential for reductions in the cost of meeting different Code levels arising from increased uptake of the key technologies.
- Provide overarching cost information on achieving each level of the Code together with a semi-quantitative evaluation of likely trends in cost.

While a few technical matters are still to be resolved, sufficient data is now available to allow robust cost analysis of each Code level for four different house types under different development scenarios, thereby providing reasonable upper and lower bound estimates.

1.3 Structure of this report

The subsequent sections of this report set out:

- Revisions to Cyril Sweett's initial cost analysis for specific credits in light of the finalised technical guidance on the Code
- The range of development scenarios against which costs have been considered (because of the large number of potential development scenarios the analysis is based on a selected number of scenarios believed to illustrate upper and lower cost ranges).
- Estimated costs of compliance with each of the Code levels for each house type under the different development scenarios and the savings in terms of utility bills, carbon emissions and consumption of potable water.
- Analysis of the likely potential for future cost reductions arising from widespread uptake of the Code.

Whilst every effort has been made to develop accurate and representative cost analyses, it is important to remember that these are cost estimates and are not definitive. The actual costs incurred will depend on numerous factors including the developer, their supply chain and circumstances of any specific site (e.g. location, housing mix, etc).

In addition, it is important to remember that there is currently very little established technical or commercial information for some of the performance standards required for the higher Code levels.

1.4 Approach to cost estimation

The implications of meeting each Code level are presented in comparison to the costs of a baseline home (e.g. a Building Regulations compliant home). Costs are presented

on a per dwelling and per m2 basis for four different house types across four generic development scenarios. Baseline information on each housetype is shown in Table 1.1 and the four development scenarios are described in Table 1.2. The development scenarios represent a range of development sizes, housing mixes and densities, and are used to test the applicability of different strategies for achieving Code credits (particularly for energy). Other site variables are described in Section 3.

Table 1.1: Baseline information on the four house types considered

Parameter	Detached	End terrace/semi	Mid terrace	Flat
Internal floor area (m^2)	102	76	76	60
Roof area (m^2)	58	38	38	20
Construction cost (£ m^2)	£786	£745	£745	£1342
Assumed occupancy (persons)	4	3	3	2
Regulated carbon emissions (t per year)	2.34	1.70	1.51	1.35
Unregulated carbon emissions (t per year)	1.38	1.20	1.20	1.00
U Values ($W/m^2/K$)				
Floor	0.22			
Exposed walls	0.28			
Roof	0.14			
Windows	1.71			
Half glazed door	1.79			
Fully glazed doors	1.71			
Solid Doors	0.99			
Thermal bridging	0.08			
Ventilation	Natural ventilation – fans in kitchens and bathrooms			
Airtightness	8			
Heating				
System	Central heating with radiators			
Gas condensing boiler efficiency	90.2%			
Controls	Delayed start thermostat, cylinder stat, programmer, TRVs			
Hot water				
Hot water storage volume	160			
Hot water cylinder loss factor	0.015			
Lights	30% Low Energy			
Cooking and Appliances	Estimated using formulae used in Code for Sustainable Homes Technical Guide			

Table 1.2: Summary of development scenarios

Scenario	Approximate percentage of annual completions	Density (dwell/ha)	Site Area (ha)	Dwelling Types	Nos.	Dwelling Mix	Percentage of Social housing
Small scale	15%	30	0.3	Detached	4	45%	20%
				Terrace	3	33%	
				End-t/semi	2	22%	
				Flat	0	0%	
				Total	**9**	**100%**	
City infill	3%	180	0.1	Detached	0	0%	20%
				Terrace	0	0%	
				End-t/semi	0	0%	
				Flat	18	100%	
				Total	**18**	**100%**	
Market town	72%	50	2	Detached	25	25%	20%
				Terrace	27	27%	
				End-t/semi	21	21%	
				Flat	27	27%	
				Total	**100**	**100%**	
Urban Regeneration	10%	160	4.7	Detached	30	4%	20%
				Terrace	15	2%	
				End-t/semi	8	1%	
				Flat	697	93%	
				Total	**750**	**100%**	

The analysis represents an estimate of the total costs to a contractor, including materials, plant and labour, preliminaries, overheads, contingencies, profit, and design fees.

The models relate to the construction of the dwellings only. They therefore make no specific allowance for items which would by their nature be site specific, such as:

- Substructure (other than ground floor slab)
- Below ground and site drainage
- Site works
- Site and common infrastructure.

It should be noted that compliance with higher levels of the Code may require the introduction or re-specification of common infrastructure, such as use of Combined Heat and Power (CHP) systems and/or sustainable drainage. In these instances, the assessment identifies the estimated net increase in cost on a cost per dwelling basis. The base dwelling costs themselves, however, do not include allowance for infrastructure beyond the demise of the property.

The costings also exclude the following:

- Site acquisition costs
- Professional fees, other than design fees incurred by the contractor
- Party wall awards and any work in connection therewith
- Building Control and planning fees
- Any payments which may be required under Section 106 of the Town and Country Planning Act
- Remediation of site contamination
- Survey works
- Legal fees
- Finance costs
- Loose furniture and fittings, such as curtains, blinds, shelving, furniture and kitchen appliances
- Highways works
- Value Added Tax.

The costings are based on Q4 2007 price levels for homes built by a housing developer with a trading turnover of around 5,000 to 10,000 dwellings per annum. It is appreciated that individual building contracts may vary in size from developments of small sites (around 12 units) to much larger sites accommodating 100 units or more. The estimated costs in this report are assumed to apply equally to these different scenarios on the basis that the type of contractor used would be similar, as would the design and specification of the individual dwellings.

Wherever possible, the costs in this report have been based upon quotations received from contractors and suppliers, with an adjustment made to reflect bulk purchase arrangements that might be applicable for projects of the sizes described. The size and nature of bulk purchase discounts were estimated following discussions with contractors and suppliers.

Chapter 2

Revisions to previous cost estimates in light of finalised technical guidance

Cyril Sweett's initial cost analysis of each Code credit area is detailed in 'A cost review of the Code for Sustainable Homes'[3] and the basis of these costs is not repeated here in detail. Rather, key areas where the detail of published technical guidance document suggests that the initial costing is no longer appropriate are discussed together with proposed updated cost figures. This revised analysis is based on the guidance published in September 2007.

2.1 Areas of change in the new technical guidance

The finalised technical guidance on the Code includes several areas of change from the approaches proposed previously (or those inferred from EcoHomes where detailed information was not available). The most significant overall change between the Code and EcoHomes is that many of the standards in the Code are now applicable to each dwelling in isolation instead of being based on the minimum or average performance of the development as a whole. This impacts compliance costs both positively and negatively. In some instances it means that houses with higher performance standards (e.g. better daylight levels) are not disadvantaged by the poor performance of other homes on a development. However, it also requires each individual home to adopt a measure that if it is to achieve the associated credit. This prevents a developer from providing enhancements (e.g. cycle storage) only to those homes where it is easiest or most cost effective.

Some changes to the technical guidance have only minor cost impacts (or where these are difficult to quantify) which depend either on the site's housing mix (e.g. building foot print: floor area ratio) or the site's location (presence of a Local Authority kerbside recyclables collection scheme). The key changes in the updated technical guidance are detailed in Table 2.1, changes which are considered to have significant and quantifiable cost impact have been highlighted and are analysed in further detail in the remainder of this section.

[3] English Partnerships and the Housing Corporation, February 2007.

Table 2.1: Credit areas where the Code Technical Guide may have a cost impact (relative to previous estimates pre April 2007)

Area of change	Details of change	Potential impact on previous cost analysis?
Dwelling Emission Rate	Each individual dwelling must achieve the required improvement on 2006 building regulations Part L1a. A definition of the requirements for a Zero Carbon homes has been included in the technical guidance thereby enabling analysis of Code Level 6.	✔
Cycle storage	Change to the number of cycles to be stored. Credits are now allocated on the number of cycle storage spaces per dwelling	✔
Internal Water	New Water credit calculation tool with revised calculation method	✔
Flood risk	Technical Guidance has changed to allow the allocation of credits for flood resilient construction	✔
Environmental impact of materials	Changes to BRE Green Guide to Housing specification and BRE credit calculator tool	✔
Household waste	Credits are no longer allocated when a site is located within a local authority kerbside recycling area	✘
Sound	Recognition of the Robust Details scheme and increase in sound performance for higher credit score	✔
Lifetime homes	Updated cost information is being made available by the Housing Corporation	✔
Security	Credits are now allocated when advice is sough from an Architectural Liaison Officer or Crime Prevention Design Advisor. A Secure by Design Credit is no longer required and credits are not awarded for the use of LPS or PAS standard products	✘
Building footprint	Measurement of dwelling density has changed from total external building footprint to Net internal ground floor area	✘

In addition to changes to the technical standards shown in Table 2.1, the finalised technical guidance includes slightly different weighting factors for the credit categories, this may have some minor impact on the costs associated with meeting individual performance standards (because achieving the same performance standards results in a different weighted value being achieved), although this is not believed to be a significant influence on overall costs of achieving each Code level. The analysis presented in Section 4 of this report utilises the weighting factors published in the September 2007 technical guidance.

2.2 Dwelling emission rate

Cyril Sweett's initial cost analysis focused on the development of cost effective solutions to Code level 3 and (to a lesser extent Code level 4). Although options for achieving Code level 5 were identified these did not necessarily represent an optimal combination of measures (for example the analysis did not include the use of biomass CHP or other

emerging technologies). In addition, at the time of the initial analysis no definition of a Zero Carbon home was available and as a result it was not possible to assess the different approaches to achieving Code level 6 for energy.

Since completion of the initial cost analysis, further research and modelling of options for achieving the energy requirements of Code levels 3, 4, 5 and 6 has been undertaken based on the most current technical guidance and a broader range of carbon saving technologies. Full detail of the modelling process, data and analysis is contained within the separate publication[4] and only the key findings are presented here.

Analysis was carried out on the carbon savings achieved through application of different carbon saving technologies (Table 2.2) to four different dwelling types built in one of four development scenarios (see Section 3). For each dwelling type a suitable mix of technologies was selected to achieve the required reduction in carbon emissions on a Part L 2006 compliant baseline. The technology options and associated costs associated with Code levels 3, 4, 5 and 6 are shown in Table 2.3 for each of the four house types assessed in the study.

Table 2.2: Carbon Saving Technologies

Technology option	**Scale (if applicable)**	**£/unit (minimum)**	**£/unit (maximum)**	**Unit**
Solar Water Heating	Generally 2.8m² of flat panel collector per dwelling	£850	£850	m²
PV	Scaled from 0.25kWp to 4kWp per dwelling	£4,200	£4,800	kWe
Biomass Heating	Scaled on biomass boiler capacities from 25kW to 1,000kW	£200	£600	kWth
Ground Source Heat Pumps	Scaled on GSHP capacities from 250kW to 500kW	£800	£2,750	kWth
Biomass CHP	Scaled for biomass CHP capacities (large sites)	£3,500	£3,500	kWe
	Scaled for biomass CHP capacities (small City Infill sites)	£16,000	£16,000	kWe
Gas Fired CHP	Scaled on CHP capacities from 8kWe to 40kWe	£1,200	£3,400	kWe
	Scaled on CHP capacities over 400kWe	£650	£1,200	kWe
Micro Wind	Generally based on 1.5kW unit per dwelling	£2,500	£2,500	kWe
Medium Wind	Scaled on basis of units of size 150kW to 600kW	£1,250	£1,500	kWe
Large Wind	Scaled on basis of units of size 600kW to 1,200kW	£900	£1,250	kWe

[4] Communities and Local Government, 2007. Research to Assess the Costs and Benefits of the Government's Proposals to Reduce the Carbon Footprint of New Housing Development

Table 2.3: Achieving minimum energy requirements for Code levels 1 to 6 (assuming that no wind power can be used)

Code level	Carbon Saving (%)	Development scenario											
		Small			City Infill			Market town			Urban Regen		
		Technology	Cumm capital cost	Cumm code credits	Technology	Cumm capital cost	Cumm code credits	Technology	Cumm capital cost	Cumm code credits	Technology	Cumm capital cost	Cumm code credits
Detached House													
1	10	Improved controls	£275	1	N/A	N/A	N/A	Improved controls	£275	1	Improved controls	£275	1
2	18	Improved air tightness and insulation levels	£1,648	4	N/A	N/A	N/A	Improved air tightness and insulation levels	£1,648	4	Improved air tightness and insulation levels	£1,648	4
3	25	4m2 flat panel SHW	£3,916	7	N/A	N/A	N/A	4m2 flat panel SHW	£3,916	7	PV	£5,536	7
4	44	Best practice energy efficiency and PV	£10,914	11	N/A	N/A	N/A	Biomass heating	£9,868	10	Biomass heating	£8,223	10
5	100	Biomass heating and PV	£22,367	17	N/A	N/A	N/A	Biomass CHP	£17,132	16	Biomass CHP	£14,254	16
6	Zero Carbon	Advance practice energy efficiency, PV and biomass heating	£40,228	19	N/A	N/A	N/A	Advance practice energy efficiency, PV and biomass CHP	£32,752	19	Advance practice energy efficiency, PV and biomass CHP	£31,125	19
End Terraced													
1	10	Improved controls	£275	1	N/A	N/A	N/A	Improved controls	£275	1	Improved controls	£275	1
2	18	Improved air tightness and insulation levels	£1,648	4	N/A	N/A	N/A	Improved air tightness and insulation levels	£1,648	4	Improved air tightness and insulation levels	£1,778	4
3	25	4m2 flat panel SHW	£3,916	7	N/A	N/A	N/A	4m2 flat panel SHW	£3,692	7	PV	£4,020	7
4	44	Biomass heating	£5,880	11	N/A	N/A	N/A	Biomass heating	£7,115	10	Biomass heating	£5,930	10
5	100	Biomass heating and PV	£13,292	17	N/A	N/A	N/A	Biomass CHP	£12,353	16	Biomass CHP	£10,278	16
6	Zero Carbon	Advance practice energy efficiency, PV and biomass heating	£29,393	19	N/A	N/A	N/A	Advance practice energy efficiency, PV and biomass CHP	£24,822	19	Advance practice energy efficiency, PV and biomass CHP	£23,631	19

Table 2.3: Achieving minimum energy requirements for Code levels 1 to 6 (assuming that no wind power can be used)

Code level	Carbon Saving (%)	Development scenario											
		Small			City Infill			Market town			Urban Regen		
		Technology	Cumm capital cost	Cumm code credits	Technology	Cumm capital cost	Cumm code credits	Technology	Cumm capital cost	Cumm code credits	Technology	Cumm capital cost	Cumm code credits
Mid Terraced													
1	10	Improved controls	£275	1	N/A	N/A	N/A	Improved controls	£275	1	Improved controls	£275	1
2	18	Improved air tightness and insulation levels	£1,648	4	N/A	N/A	N/A	Improved air tightness and insulation levels	£1,648	4	Improved air tightness and insulation levels	£1,778	4
3	25	4m2 flat panel SHW	£3,916	7	N/A	N/A	N/A	4m2 flat panel SHW	£3,692	7	PV	£3,581	7
4	44	Biomass heating	£5,133	11	N/A	N/A	N/A	Biomass heating	£6,187	10	Biomass heating	£5,156	10
5	100	Biomass heating and PV	£11,933	17	N/A	N/A	N/A	Biomass CHP	£10,742	16	Biomass CHP	£8,938	16
6	Zero Carbon	Advance practice energy efficiency, PV and biomass heating	£29,172	19	N/A	N/A	N/A	Advance practice energy efficiency, PV and biomass CHP	£24,696	19	Advance practice energy efficiency, PV and biomass CHP	£23,569	19
Flat													
1	10	N/A	N/A	N/A	Improved controls	£460	1	Improved controls	£275	1	Improved controls	£460	1
2	18	N/A	N/A	N/A	Improved air tightness and insulation levels	£1,648	4	Improved air tightness and insulation levels	£1,648	4	Improved air tightness and insulation levels	£1,648	4
3	25	N/A	N/A	N/A	PV and Best Practice energy efficiency	£2,622	7	PV and Best Practice energy efficiency	£2,622	8	PV and Best Practice energy efficiency	£2,622	7
4	44	N/A	N/A	N/A	PV and Best Practice energy efficiency	£5,054	11	Biomass heating	£5,054	10	Biomass heating	£4,782	10
5	100	N/A	N/A	N/A	Best practice energy efficiency and Biomass	£12,055	17	Biomass CHP	£9,962	16	Biomass CHP	£8,289	16
6	Zero Carbon	N/A	N/A	N/A	Advance practice energy efficiency, PV and biomass CHP	£18,430	19	Advance practice energy efficiency, PV and biomass CHP	£18,996	19	Advance practice energy efficiency, PV and biomass CHP	£16,775	19

The costs associated with achieving the Zero Carbon standard are disproportionately higher than for Code 5 (100 per cent improvement on TER) because of the need to achieve a heat loss parameter of 0.8 W/m2 K or less. This has the impact of adding additional cost to achieve the improved thermal performance of the building envelope, while simultaneously reducing the scale of carbon savings that could be achieved through a CHP system (because of the reduced overall heat demand).

These costs assume that it is not possible to use wind turbines (micro, medium or large scale) on any of the developments. It is reasonable to assume that at least some of the houses on Small Scale rural developments would be able to utilise micro wind technology, and that on some of the Market Town developments it would be realistic to use medium or large scale wind turbines (either onsite or directly linked). Where wind technologies can be used effectively costs are reduced markedly, as shown in Table 2.4.

Table 2.4: Technology mix and costs for Small Scale and Market Town developments where wind energy can be utilised

		Development scenario					
		Small			**Market Town**		
Code level	**Carbon Saving (%)**	**Technology**	**Cumm capital cost**	**Cumm code credits**	**Technology**	**Cumm capital cost**	**Cumm code credits**
Detached House							
1	10	Improved controls	£275	1	Improved controls	£275	1
2	18	Improved air tightness and insulation levels	£1,648	4	Wind turbine	£1,127	4
3	25	Micro wind	£3,407	7	Wind turbine	£1,566	7
4	44	PV and micro wind	£7,458	11	Wind turbine	£2,600	10
5	100	PV, Biomass heating and micro wind	£18,722	17	Wind turbine	£3,053	16
6	Zero Carbon	Advanced practice energy efficiency, PV, biomass heating and micro wind	£36,583	19	Advanced practice energy efficiency and wind turbine	£13,065	19
End Terraced							
1	10	Improved controls	£275	1	Improved controls	£275	1
2	18	Improved air tightness and insulation levels	£1,778	4	Wind turbine	£818	4
3	25	Micro wind	£3,407	7	Wind turbine	£1,137	7
4	44	Best practice energy efficiency and micro wind	£5,586	10	Wind turbine	£2,001	10
5	100	Best Practice Energy Efficiency, Biomass heating and micro wind	£10,687	17	Wind turbine	£2,600	16
6	Zero Carbon	Advanced practice energy efficiency, PV, biomass heating and micro wind	£24,721	19	Advanced practice energy efficiency and wind turbine	£8,771	19

Table 2.4: Technology mix and costs for Small Scale and Market Town developments where wind energy can be utilised

Code level	Carbon Saving (%)	Development scenario					
		Small			Market Town		
		Technology	Cumm capital cost	Cumm code credits	Technology	Cumm capital cost	Cumm code credits
Mid Terraced							
1	10	Improved controls	£275	1	Improved controls	£275	1
2	18	Improved air tightness and insulation levels	£1,778	4	Wind turbine	£729	4
3	25	Micro wind	£3,407	7	Wind turbine	£1,013	7
4	44	Best practice energy efficiency and micro wind	£5,500	10	Wind turbine	£1,782	10
5	100	Biomass heating and micro wind	£8,539	17	Wind turbine	£2,600	16
6	Zero Carbon	Advanced practice energy efficiency, PV, biomass heating and micro wind	£24,756	19	Advanced practice energy efficiency and wind turbine	£8,950	19
Flat							
1	10	N/A	N/A	N/A	Improved controls	£275	1
2	18	N/A	N/A	N/A	Wind turbine	£720	4
3	25	N/A	N/A	N/A	Wind turbine	£1,000	7
4	44	N/A	N/A	N/A	Wind turbine	£1,593	10
5	100	N/A	N/A	N/A	Wind turbine	£2,600	16
6	Zero Carbon	N/A	N/A	N/A	Advanced practice energy efficiency and wind turbine	£8,685	19

In addition to assessing the current costs of each carbon saving technology, the potential change in these costs over time was also considered, using learning rates. Learning rates are a measure of the extent to which costs are likely to change in proportion to the amount of experience (measured by the growth in installed capacity of a technology) gained by producers and installers. Learning rates are typically presented as a percentage change in cost that occurs for each doubling of the market for a particular technology. Using industry predictions for the growth of each of the carbon savings technologies, globally and within the UK, the possible future costs of each technology (in today's prices) have been estimated. Notwithstanding the inevitable uncertainty associated with such analysis, Table 2.5 shows the potential change (reduction) in the costs of achieving Code levels 4, 5 and 6 over time for homes built in a Market Town development.

Table 2.5: Change in energy compliance costs over time for Market Town development

Year	Detached House	End Terrace	Mid Terrace	Flat	Percentage reduction on 2008 base
Code Level 4					
2008	£5,880	£5,133	£5,054	£2,600	–
2010	£5,551	£4,845	£4,371	£2,530	3%
2013	£5,392	£4,707	£3,761	£2,445	6%
2016	£4,883	£4,350	£3,355	£2,371	10%
2025	£3,533	£3,147	£2,670	£2,193	19%
Code Level 5					
2008	£17,132	£12,353	£10,742	£9,962	–
2010	£16,621	£11,985	£10,422	£9,665	3%
2013	£15,960	£11,508	£10,008	£9,202	8%
2016	£15,274	£11,083	£9,637	£8,530	14%
2025	£12,699	£9,973	£8,672	£7,271	27%
Code Level 6					
2008	£32,752	£24,850	£24,742	£18,996	–
2010	£27,701	£21,059	£20,900	£16,183	15%
2013	£25,284	£19,072	£18,920	£14,968	21%
2016	£23,560	£17,651	£17,509	£14,100	26%
2025	£20,223	£14,919	£14,807	£12,386	35%

Further more detailed information on the carbon savings model used to estimate the costs of meeting the carbon standards in the Code is presented in separate research[5].

2.3 Cycle storage

In the cost report produced for English Partnerships, the cycle storage requirement under the Code was assessed on the same criteria as the existing EcoHomes 2006 guidance. The requirement was based on the percentage of homes on a development that provided sufficient cycle storage; 1 credit where 50 per cent of homes on a site meet the requirement and 2 credits where 95 per cent of homes meet the requirement.

[5] Communities and Local Government, 2007. Research to Assess the Costs and Benefits of the Government's Proposals to Reduce the Carbon Footprint of New Housing Development

The credit allocation system in the Code technical guidance is subtly different in that credits are only awarded to those homes that meet the required standard (irrespective of the other homes in the development) and the number of credits awarded depends on the number of spaces provided. Where either individual or communal cycle storage is provided (inline with guidance) 1 or 2 credits are allocated depending on the number of cycle storage spaces per dwelling (see Table 2.6).

Table 2.6: Credits available for each house type for provision of cycle storage

	Number of Cycle storage spaces	
	1 credit	**2 credits**
Studio or 1 bedroom dwelling (only applicable to communal storage)	N/A	1 space
2 and 3 bedroom dwellings	1 space	2 spaces
4 bedrooms and above	2 spaces	4 spaces

Table 2.7 shows the change in cycle storage provision, and the cost change, that results from the new code guidance.

Table 2.7: Cost implications of Code approach to cycle storage

Dwelling type		**EcoHomes**			**Code**				**Change from previous estimate**	
					1 credit		2 credits			
	No. of bedrooms	Requirement	£ for 1 credit (50% of site)	£ for 2 credits (95% of site)	Requirement	£	Requirement	£	1 Code credit	2 Code credits
Detached house	4	4	500	1000	2	850	4	1000	350	0
Mid/End Terraced house	3	2	500	1000	1	850	2	850	350	–150
Flat	2	1	150	300	1	150	2	300	0	0

The most significant impact of the revised application of this credit is that it a large proportion of the fixed costs of cycle storage apply even if only one credit is sought. The marginal cost of the second credit is therefore relatively low at £150. Therefore, it would be expected that most developers would seek both credits for cycle storage at a cost of £1000 rather than just one at a cost of £850.

2.4 Internal potable water consumption

Previous analysis of the methods required to achieve the minimum water consumption standards in the Code was based on guidance provided by BRE (in the absence of a published Code water consumption calculator). The water consumption calculator is now available and it is possible to assess the different approaches to achieving each performance level.

The approach to achieving each water standard has therefore been refined in line with the format of the water consumption calculator. Testing of the specifications used previously indicates that with a few slight amendments (see Table 2.8) the Code requirements can be achieved using the same technologies as those previously specified and that as a result there is no change to previous cost estimates.

The September 2007 Code Technical Guide sets out the basis for calculating water consumption from homes.

Table 2.8: Revised specification and cost of water appliances

Code level	Estimated water usage (l/person/day)	Initial Specification	Revised specification		Code Credits	Cost	Change from previous estimate
1 and 2	120	2 x 6/4 litre flush toilets 4 x taps with flow regulators 1 x shower 6 to 9 litres/min 1 x standard bath (80 litres per use) 1 x standard washing machine* 1 x standard dishwasher*	2 x 6/4 litre flush toilets 4 x taps with flow regulators (2.5 l/m) 1 x shower 6 litres/min 1 x standard bath (90 litres per use) 1 x standard washing machine* 1 x standard dishwasher*		1.5	£0	£0
3 and 4	105	As above, except: 2x4/2.5 litre flush toilets 1x 8 l/min shower 1x smaller shaped bath	As above, except: 2x4/2.5 litre flush toilets 1x smaller shaped bath		4.5	£125	£0
5 and 6	80	**Houses** As above, except: add grey water recycling or rainwater harvesting system (30% reuse)	Houses either:	As level 3 and 4, except: Rainwater harvesting 2 x 6/4 litre flush toilets	7.5	£2,650	£0
		Apartments As above, except: add communal grey water recycling or rainwater harvesting system (30% reuse)	Apartments either:	As level 3 and 4, except: Rainwater harvesting 2 x 6/4 litre flush toilets	7.5	£800	£0

Notes: *Additional cost of washing machine and dishwasher is assumed to be zero as these fittings are 'standard' industry performance. Therefore, if they are typically installed by house builder there would be no additional cost over their current specifications.

2.5 Flood risk

2.5.1 Flood risk credit criteria

Previously the Code credits relating to flood risk were assessed on the same criteria as those within the existing EcoHomes 2006 guidance and with the assumption that most developments would be in areas at low risk from flooding.

This update considers the method set out in the Code technical guidance, and also assesses how Code credits would be achieved for sites where the flood risk is medium to high, on the basis that a substantial proportion of future development be in flood plains and subject to risk of flooding.

Under EcoHomes 2006 credits could only be awarded where either:

- a development is located in a zone defined as having a low annual probability of flooding
- the finished floor level and access routes are 600mm above the (medium risk) design flood level.

The Code technical guidance allows the allocation of two credits where:

- the development is located in a zone defined as having a low annual probability of flooding
- where the ground level of all dwellings and access routes are designed to be at least 600mm above the design flood level of the flood zone in which the development is located
- flood resilient construction methods have been implemented in a dwelling's design
- flood defences or other non-structural measures are used to control the flood risk to a development.

One-third of the Government's designated new development sites are located within an area of medium flood risk (as designated by the Code guidance and Environment Agency), further more it is estimated that around 10,000 planned new properties in growth areas may be built in areas of significant flood risk (a probability greater than 1.3 per cent or 1 in 75 years)[6].

[6] Association of British Insurers, Making Communities Sustainable: Managing flood risks in the Government's growth areas, Final technical report (Volume 2), February 2005.

The cost analysis for this credit has been revised in line with the new technical guidance to assess the implications for housing in medium and high flood risk zones, which could comprise a substantial proportion of overall development in some parts of England (costs and credits for developments in low risk zones are unchanged). The use of non structural measures to reduce a site's flood risk is too site specific to allocate a 'per dwelling cost'[7] therefore the approach taken has been to consider either design for a ground floor that would not be impacted by flooding (i.e. car parking) or the use of flood resilient materials at ground floor level.

A recent study for the Association of British Insurers provides useful benchmark costs for incorporating flood resilience into housing as shown in Table 2.9.

Table 2.9: Cost benchmarks for flood resilience measures

Resilience measure	Semi-detached	2 bed Mid –Terrace house Cost	2 bed flat in a 3-storey apartment block	2 bed flat in a 4-storey apartment block
Use of flood resilient materials on ground floor*		£16,635	£5,545**	£4,159***

*based on the use of treated timber floorboards, solid concrete floor, water resistant gypsum plaster, water resistant windows and doors, wall mounted boiler, washing machine installed on first floor, raised ovens, high level electrics and service meters and non-chipboard kitchen and bathroom units.
** estimated on the basis that one third of the costs would apply to an individual flat in a three storey block.
*** estimated on the basis that one quarter of the costs would apply to an individual flat in four storey block.

Source: Association of British Insurers, Making Communities Sustainable: Managing flood risks in the Government's growth areas, Final technical report (Volume 2), February 2005.

Given the estimated cost level, it is quite unlikely that this credit would be sought by developers building in high flood risk areas (unless part of a separate planning requirement).

2.6 Environmental impact of materials

Since the initial cost analysis was undertaken BRE have released a new set of interim Green Guide specifications (+A to E rather than A to C) and a new credit calculation method. Using this method it is possible to score between 0.25 and 3 credits per building element depending on whether the proposed specification achieves a D to A+ standard. Up to 3 credits are available for each of the following building elements:

[7] Although for strategic development areas it would be expected that flood defences would be designed to provide protection for new housing.

- External walls
- Internal walls
- Ground and upper floors
- Roof
- Windows.

A total of 15 credits are therefore available with each credit being valued at 0.3 per cent of the overall score.

A baseline analysis of the standard house type specifications against the new Green Guide to Specification[8] has been carried out as shown in Table 2.10.

The majority of the base specifications used for both houses and flats achieve either B or A ratings and it is not necessary to make amendments to these standard specifications to achieve the majority of the available credits. The only exception being windows, where it is assumed that timber rather than PVC windows would be required to achieve an A or A+ rating (although this is not formally stated in the guidance).

In some cases an A+ rating is not achievable without completely changing the structure of the building (e.g. by switching to a timber panel construction method). The revised ratings also result in the blockwork housetypes assessed in this study scoring slightly (around 4 credits or 1.2 per cent) less well than they would have done using an 'EcoHomes based' assessment method. However, the relatively small difference in overall credits achieved for a standard masonry specification and a timber/steel based specification means that this is unlikely to have a major influence on material selections until Code levels 5 and 6 are sought.

Table 2.10: Ratings of standard specifications under the Green Guide to Specification

Element	Specification	Rating	Upgrades for to improve rating	Rating
Masonry house specification				
Windows & Glazed Doors	Double glazed (6-12-6), argon filled cavity, low 'e' coating on inner pane U PVC	Unknown (assumed to be E rating)	Assumed that a softwood timber framed window would achieve the highest possible rating as previously	Unknown (A+ and 3 credits assumed)
Roof	Pitched roof, 100mm mineral wool laid between joists with further 200mm over joists Concrete tiles	A (2 credits)	Same structure but with interlocking concrete tiles or reclaimed slates/clay tiles	A+ (3 credits)
External Walls	Brick, cavity, 'Durox Supabloc', 45mm partial cavity fill, plasterboard	A (2 credits)	Rendered aircrete blockwork cavity wall	A+ (3 credits)
Party Wall	Aerated blockwork cavity wall, with 2 layers of plasterboard	B (1 credit)	Not possible to determine a higher rated blockwork based specification	N/A

[8] No information on the rating of windows specifications was available at the time of writing.

Table 2.10: Ratings of standard specifications under the Green Guide to Specification

Element	Specification	Rating	Upgrades for to improve rating	Rating
Internal (load bearing)	Aerated blockwork, plasterboard, paint	A (2 credits)	Not possible to determine a higher rated blockwork based specification	N/A
Internal (non-load bearing)	Timber/steel stud, plasterboard, paint	A (2 credits)	Fairfaced wood, plywood or glazing would achieve A+ ratings are unlikely to be widely adopted	N/A
Ground Floor	Beam and insulation floor with screed finish	B (1 credit)	Chipboard decking on timber battens with insulation on beam and aerated block flooring	A+ (3 credits)
			Chipboard decking on timber battens with insulation on beam and lightweight block flooring	
Upper Floors	Engineered I beam joists with Chip board decking and plaster board	A+ (3 credits)	No change required	No change required
Masonry apartment specification				
Windows & Glazed Doors	double glazed (6-12-6), argon filled cavity, low 'e' coating on inner pane U PVC (as in old Guide)	Unknown (assume D rating)	Assumed that a softwood timber framed window would achieve the highest possible rating as previously	Unknown (assume A+ and 3 credits)
Roof	Pitched roof, 100mm mineral wool laid between joists with further 200mm over joists Concrete tiles	A (2 credits)	Interlocking concrete tiles or reclaimed slates/clay tiles	A+ (3 credits)
External Walls	Brick, cavity, 'Durox Supabloc', 45mm partial cavity fill, plasterboard	A (2 credits)	Not possible to determine a higher rated blockwork based specification	N/A
Internal (load bearing)	Aerated blockwork, plasterboard, paint	A (2 credits)	Not possible to determine a higher rated blockwork based specification	N/A
Internal (non-load bearing)	Timber/steel stud, plasterboard, paint	A (2 credits)	N/A (either fairfaced wood, plywood or glazing)	N/A
Ground Floor	Beam and aerated block floor with screed finish	B (1 credit)	Chipboard decking on timber battens with insulation on beam and aerated block flooring	A+ (3 credits)
			Chipboard decking on timber battens with insulation on beam and lightweight block flooring	A+ (3 credits)
Upper Floors	Concrete planks125mm Mineral wool quilt, Jet Floor Super 2A	C (0.5 credit)	Chipboard decking on timber I joists and plasterboard ceiling	A+ (3 credits)
			Chipboard decking on timber joists and plasterboard ceiling	A+ (3 credits)
			OSB decking on timber I joists and plasterboard ceiling	A+ (3 credits)
			OSB decking on timber joists and plasterboard ceiling	A+ (3 credits)

2.7 Sound

Following consultations with developers, manufacturers and independent sound consultants it is clear that further work is needed to ascertain whether the standard house types (with minor modification) will be able to achieve the highest levels of sound insulation required to score maximum credits for credit category Hea2 Sound Insulation.

Research has shown that, currently, there is little experience of designing construction specifications to meet the requirements for 3 or 4 credits within the Code (i.e. 5dB or 8dB improvements on Part E of Building Regulations). Manufacturers of construction systems are currently trying to produce and test products that will consistently meet these standards.

Therefore while a detached house type would achieve all four Sound credits by default (as it has no separating walls to consider) the performance of terraced houses and flats is more difficult to determine. It has been assumed that improvements of up to 5dB beyond Part E could be achieved through closer attention to workmanship and improved sealing of separating walls and floors (this is linked to the need for higher levels of airtightness to achieve Code energy standards) although this would need verification through sound testing (as it is not currently possible to guarantee these performance levels through the use of Robust Standard Details alone).

There may be some additional cost associated with achieving these improvements, however in the absence of specific specifications these have been estimated at the cost of conducting the sound testing required to verify performance. The cost of undertaking sound testing varies from site to site (based on the number of units and separating walls/ floors) but is typically between £100 and £150 per unit.

At present it is not clear what specifications would be required to achieve the 8dB improvement on Part E and as such it has been assumed that most developers would not seek this fourth credit.

A further consideration when assessing the potential costs associated with improving sound insulation beyond the requirements of Part E is the cost of remediation if the target performance is not achieved. This presents a risk of further costs where confidence in site practices or construction details are low.

2.8 Summary of costs for Code credits

The predicted costs associated with the minimum performance standards for energy and water are shown in Table 2.3 and 2.8. Table 2.11 below, provides a consolidated list of updated cost estimates based on previous estimates and the revisions described previously.

Table 2.11: Summary of cost estimates for Code credits (excluding minimum standards for energy and water)

Category	Credit Name	Performance	Credits available	Value of one credit	Credits achieved		Cost per unit		Comments
					House	Flat	House	Flat	
Energy	Low energy lighting	>40%	1	1.26	1	1	£10	£10	Allowance for additional cost of low energy light fittings.
Energy	Low energy lighting	>75%	1	1.26	1	1	£40	£30	Allowance for additional cost of low energy light fittings.
Energy	Drying Space	Providing	1	1.26	1	1	£20	£20	Cost allowance for internal clothes drying fittings in bathroom
Energy	Ecolabelled White Goods	Information or A+ rated fridges and freezers	1	1.26	1	1	£0	£0	No cost for provision of information on these goods.
Energy	Ecolabelled White Goods	Washing machines and dishwashers	1	1.26	1	1	£540	£540	Cost of providing energy and water efficient washing machine and dishwasher (providing these appliances also results in a benefit for overall water consumption calculations, see Section 4).
Energy	External Lighting	Space lighting	1	1.26	1	1	£0	£0	Costs for provision of space lighting included in base construction (additional cost is for energy efficient fittings).
Energy	External Lighting	Security lighting	2	1.26	2	2	£0	£0	If no security lighting is fitted then points are awarded by default (and if lighting is provided the additional cost of Code compliant specifications is negligible).
Energy	Cycle storage	Provision for full cycle requirement	2	1.26	2	2	£1,000	£300	Costs based on provision of full requirement (see Section 2.3)
Energy	Home office	Providing	1	1.26	1	1	£210	£210	Cost allowance for provision of telephone/data points in second bedroom (cost includes points and wiring work).
Potable water	External potable water consumption	Rainwater butt	1	1.50	1	1	£200	£30	Costs based on provision of 1 water butt for housing and communal butts for apartments. Costs include, butt, footings, downpipes and overflow. Actual costs for apartments will depend on storey number and layout.
Surface water runoff	Reduction in surface water runoff	Hard surfaces	1	0.55	1	1	£0	£0	Use of permeable surfacing.
Surface water runoff	Reduction in surface water runoff	Roofs	1	0.55	1	1	£450	£300	Cost of one swale for every 2 dwellings.

Table 2.11: Summary of cost estimates for Code credits (excluding minimum standards for energy and water)

Category	Credit Name	Performance	Credits available	Value of one credit	Credits achieved		Cost per unit		Comments
					House	Flat	House	Flat	
Surface water runoff	Flood risk	Low risk	2	0.55	2	2	£0	£0	No cost (provided development is in low flood risk area).
Surface water runoff	Flood risk	Medium/high risk	1	0.55	1	1	£16,635	£4,159	Costs based on use of flood resilient materials on the ground floor, costs for flat based on a 4 storey block (i.e. costs are a quarter of those for housing). Sources detailed in report
Materials	Environmental impact of materials	3 points (roof)	3	0.30	3	3	£0	£0	Standard specifications achieve an A rating (not A+) in the draft GGS, an A+ rated specification can be achieved at no cost by the use of interlocking concrete tiles.
Materials	Environmental impact of materials	6 points (external walls)	3	0.30	2	2	£0	£0	Standard specifications achieve an A rating (not A+) in the draft GGS,
Materials	Environmental impact of materials	9 points (internal walls)	3	0.30	2	2	£0	£0	Standard specifications achieve an A rating (not A+) in the draft GGS,
Materials	Environmental impact of materials	12 points (floors)	3	0.30	2	0.25	£0	£0	Ratings for floors based on 50% of housing floors being A+ (upper floors) and 50% being B (ground floors), for flats it is assumed that both upper and lower floors would average D. There is no cost uplift as these are standard specifications.
Materials	Environmental impact of materials	15 points (windows)	3	0.30	3	3	£140	£140	No Green Guide information is available on window specifications however it is assumed that a softwood timber window would still achieve the highest (A+) rating.
Materials	Responsible sourcing of basic materials	2 points	2	0.30	2	2	£0	£0	No additional cost, should be readily achievable with some analysis of supply chain, could require significant internal/consultant time in product analysis.
Materials	Responsible sourcing of basic materials	3 points	1	0.30	1	1	£0	£0	As above.
Materials	Responsible sourcing of basic materials	4 points	1	0.30	1	1	£300	£300	Additional cost associated with achieving higher supply chain performance (notional value based on potential restrictions on supply chain

Table 2.11: Summary of cost estimates for Code credits (excluding minimum standards for energy and water)

Category	Credit Name	Performance	Credits available	Value of one credit	Credits achieved		Cost per unit		Comments
					House	Flat	House	Flat	
Materials	Responsible sourcing of basic materials	6 points	2	0.30	2	2	£300	£300	Additional cost associated with achieving higher supply chain performance (notional value based on potential restrictions on supply chain
Materials	Responsible sourcing of finishing elements	1 point	1	0.30	1	1	£0	£0	No additional cost. Should be readily achievable with some analysis of supply chain; could require significant internal/consultant time in product analysis.
Materials	Responsible sourcing of finishing elements	2 points	1	0.30	1	1	£0	£0	As above
Materials	Responsible sourcing of finishing elements	3 points	1	0.30	1	1	£300	£300	Additional cost associated with achieving higher supply chain performance (notional value based on potential restrictions on supply chain
Waste	Construction Waste	Monitor, sort and recycle construction waste	2	0.91	2	2	£100	£100	No cost, routinely implemented by several large housebuilders.
Waste	Household Recycling Facilities	2 points	2	0.91	2	2	£160	£160	Cost allowance for provision of internal bins
Waste	Household Recycling Facilities	4 points	2	0.91	2	2	£0	£0	Assumed that local authority will provide kerbside collection service.
Waste	Composting facilities	home composting facilities	1	0.91	1	1	£30	£30	Cost based on 220l composter
Health and wellbeing	Daylighting	Kitchen	1	1.17	1	1	£140	£140	Cost allowance for additional glazing (based on needs of typical house); costs for specific houses will vary according to design and size of glazed area.
Health and wellbeing	Daylighting	Living room	1	1.17	1	1	£150	£150	Cost allowance for additional glazing (based on needs of typical house); costs for specific houses will vary according to design and size of glazed area.
Health and wellbeing	Daylighting	View of sky	1	1.17	1	1	£0	£0	No additional cost, although achieving a view of the sky from all homes requires careful layout.
Health and wellbeing	Sound insulation	3dB	1	1.17	1	1	£0	£330	No cost for detached properties, costs for terraced properties and flats based on costs of testing activities.
Health and wellbeing	Sound insulation	5dB	2	1.17	2	2	£0 (£160 for terraced properties)	£330	No cost for detached properties, costs for terraced properties and flats based on costs of testing activities.

Table 2.11: Summary of cost estimates for Code credits (excluding minimum standards for energy and water)

Category	Credit Name	Performance	Credits available	Value of one credit	Credits achieved		Cost per unit		Comments
					House	Flat	House	Flat	
Health and wellbeing	Sound insulation	8dB	1	1.17	1	0	£0	£0	No cost for detached properties, at present it is not clear how this performance standard will be achieved (and if it can be achieved with the construction methods used here.
Health and wellbeing	Private space	Provide	1	1.17	1	1	£0	£0	Housing has private space, can be designed into apartment blocks.
Health and wellbeing	Lifetime Homes	all features	4	1.17	4	4	£550	£75	Allowance for additional supports/fixing points within partitions and drainage point in first floor toilets.
Management	Home user guide	Provide for home	2	1.11	2	2	£20	£10	Assuming that housing is relatively standard.
Management	Home user guide	Provide for surroundings	1	1.11	1	1	£80	£40	Cost estimate for commissioning consultant to provide necessary location information (costs lower for larger sites).
Management	Considerate constructors	1 point	1	1.11	1	1	£0	£0	No cost for compliance (other than nominal site registration fee).
Management	Considerate constructors	2 points	1	1.11	1	1	£0	£0	No cost for compliance (other than nominal site registration fee).
Management	Construction site impacts	1 point	1	1.11	1	1	£0	£0	No cost for compliance, already implemented by several large house builders.
Management	Construction site impacts	2 points	1	1.11	1	1	£100	£75	Estimated cost for monitoring.
Management	Security	Secure by Design	2	1.11	2	2	£0	£0	No cost (although there may be an impact on site layout).
Pollution	Insulant GWP	Use	1	0.70	1	1	£0	£0	No cost, mineral wool, air blown and several types of rigid insulation comply.
Pollution	NOx emissions	<40 mg kWh	3	0.70	3	3	£0	£0	No cost; high efficiency boilers meet highest performance standards.

Chapter 3

Development scenarios against which costs have been considered

While location characteristics are less influential in achieving credits under the Code than was the case with EcoHomes (where proximity to public transport and local amenities were significant factors), the type of development and its location are still significant factors in determining the likely approach to (and associated costs of) achieving a Code level.

Therefore, to further refine the understanding of the achievability and costs of achieving the higher levels of the Code in different house types on a range of different development sites, scenarios have been developed using a range of parameters. These include:

- Dwelling type – 4 dwelling types are considered:
  - Detached houses
  - End terrace/semi detached houses
  - Mid terrace houses
  - Flats
- Development type – 4 scenarios are considered:
  - A 'Small scale' development of 9 houses
  - A 'City Infill' development of 18 flats
  - A 'Market town' development of 100 homes, predominantly houses
  - An 'Urban Regeneration' development of 750 homes, predominantly flats
- Ecological value – 3 land types are considered:
  - High ecological value, i.e. several features of ecological value are present on the site and it will be difficult to achieve a net increase in ecological value as a result of development
  - Medium ecological value, i.e. some features of ecological value are present, however it should be possible to protect/enhance ecological value
  - Low ecological value, i.e. no features of ecological value are present
- Flood risk – 2 risk levels are considered:
  - Low flood risk
  - Medium/High flood risk

Given the large number of potential combinations for these parameters a series of best, typical and worst case scenarios have been developed for each house type. These serve to provide high, medium and low estimates of the sorts of costs that could be incurred from implementation of the Code. The scenarios proposed for the 3 houses and for flats are described in Table 3.1.

Table 3.1: Scenarios for determining high, medium and low cost estimates

House type	Best case (lowest cost)	Medium	Worst case (highest cost)
Detached End/Mid terrace	• Market town development • Low ecological value • Low flood risk	• Market town development • Medium ecological value • Low flood risk	• Small scale development • High ecological value • Med/High flood risk
Flat	• Urban Regeneration development • Low ecological value • Low flood risk	• Market Town development • Medium ecological value • Low flood risk	• City Infill development • High ecological value • Med/High flood risk

The costs associated with achieving each Code level for the Best, Medium and Worst scenarios are described in Section 4.

Chapter 4

Estimated costs in 2008

Tables 4.1 to 4.3 show the estimated 2008 costs of compliance for each level of the Code for the detached house, end terraced house and flat under the best, medium and worst case scenarios described in Section 3, in all cases it is assumed that no electricity generation from wind turbines is possible at any scale[9]. The results for the mid terrace house are very similar to those for the end terrace and are not presented separately.

As well as presenting the overall costs of compliance, the costs are broken down into the mandatory entry level code requirements, the minimum standards for energy and for water and the remaining flexible credits required to achieve the credits threshold at each Code level.

Table 4.1: Detached house

CSH Level	Mandatory (£)	Energy (£)	Water (£)	Flexible (£)	Total cost (£)	Cost £ per m²	Percentage increase on 2006 Building Regs
Best Case (Market town scenario with low ecological value and low flood risk)							
1	£490	£275	£0	£0	**£765**	£7	1%
2	£490	£1,648	£0	£50	**£2,188**	£19	2%
3	£490	£3,916	£125	£220	**£4,751**	£41	5%
4	£490	£9,868	£125	£1,110	**£11,593**	£100	13%
5	£490	£17,132	£2,625	£1,600	**£21,847**	£188	24%
6	£490	£32,752	£2,625	£1,950	**£37,817**	£326	41%
Medium Case (Market town scenario with medium ecological value and low flood risk)							
1	£490	£275	£0	£0	**£765**	£7	1%
2	£490	£1,648	£0	£120	**£2,258**	£19	2%
3	£490	£3,916	£125	£460	**£4,991**	£43	5%
4	£490	£9,868	£125	£1,250	**£11,733**	£101	13%
5	£490	£17,132	£2,625	£1,950	**£22,197**	£191	24%
6	£490	£32,752	£2,625	£2,950	**£38,817**	£335	43%
Worst Case (Small scale scenario with high ecological value and medium/high flood risk)							
1	£490	£275	£0	£30	**£795**	£7	1%
2	£490	£1,648	£0	£585	**£2,723**	£23	3%
3	£490	£3,916	£125	£1,110	**£5,641**	£49	6%
4	£490	£10,914	£125	£2,000	**£13,529**	£117	15%
5	£490	£22,367	£2,625	£3,350	**£28,832**	£249	32%
6	£490	£40,228	£2,625	£4,190	**£47,533**	£410	52%

[9] On sites where medium or large scale wind technologies are suitable overall compliance costs would be expected to be significantly lower.

Table 4.2: End terraced house

CSH Level	Mandatory (£)	Energy (£)	Water (£)	Flexible (£)	Total cost (£)	Cost £ per m²	Percentage increase on 2006 Building Regs
Best Case (Market Town scenario with low ecological value and low flood risk)							
1	£490	£275	£0	£10	**£775**	£8	1%
2	£490	£1,648	£0	£220	**£2,358**	£23	3%
3	£490	£3,692	£125	£620	**£4,927**	£49	7%
4	£490	£7,115	£125	£1,270	**£9,000**	£89	12%
5	£490	£12,353	£2,625	£2,060	**£17,528**	£174	23%
6	£490	£24,822	£2,625	£3,270	**£31,207**	£309	41%
Medium Case (Market town scenario with medium ecological value and low flood risk)							
1	£490	£275	£0	£30	**£795**	£8	1%
2	£490	£1,648	£0	£460	**£2,598**	£26	3%
3	£490	£3,692	£125	£720	**£5,027**	£50	7%
4	£490	£7,115	£125	£1,760	**£9,490**	£94	13%
5	£490	£12,353	£2,625	£3,270	**£18,738**	£186	25%
6	£490	£24,822	£2,625	£3,810	**£31,747**	£314	42%
Worst Case (Small scale scenario with high ecological value and medium/high flood risk)							
1	£490	£275	£0	£120	**£885**	£9	1%
2	£490	£1,648	£0	£745	**£2,883**	£29	4%
3	£490	£3,916	£125	£1,270	**£5,801**	£57	8%
4	£490	£5,880	£125	£1,920	**£8,415**	£83	11%
5	£490	£13,292	£2,625	£3,810	**£20,217**	£200	27%
6	£490	£29,393	£2,625	£5,160	**£37,668**	£373.0	50.07%

Table 4.3: Flat

CSH Level	Mandatory (£)	Energy (£)	Water (£)	Flexible (£)	Total cost (£)	Cost £ per m2	Percentage increase on 2006 Building Regs
Best Case (Urban regeneration scenario with low ecological value and low flood risk)							
1	£0	£460	£0	£0	**£460**	£8	1%
2	£0	£1,648	£0	£115	**£1,763**	£30	2%
3	£0	£2,622	£125	£145	**£2,892**	£49	4%
4	£0	£4,782	£125	£580	**£5,487**	£93	7%
5	£0	£8,289	£805	£1,170	**£10,264**	£174	13%
6	£0	£16,775	£805	£1,500	**£19,080**	£323	24%
Medium Case (Market town scenario with medium ecological value and low flood risk)							
1	£0	£275	£0	£10	**£285**	£5	0%
2	£0	£1,648	£0	£115	**£1,763**	£30	2%
3	£0	£2,622	£125	£175	**£2,922**	£50	4%
4	£0	£5,054	£125	£880	**£6,059**	£103	8%
5	£0	£9,962	£805	£1,500	**£12,267**	£208	15%
6	£0	£18,596	£805	£1,850	**£21,251**	£360	27%
Worst Case (City infill scenario with high ecological value and medium/high flood risk)							
1	£0	£460	£0	£40	**£500**	£8	1%
2	£0	£1,648	£0	£205	**£1,853**	£31	2%
3	£0	£2,622	£125	£420	**£3,167**	£54	4%
4	£0	£5,054	£125	£1,020	**£6,199**	£105	8%
5	£0	£12,055	£805	£1,850	**£14,710**	£249	19%
6	£0	£18,430	£805	£3,320	**£22,555**	£382	28%

For each house type the analysis shows a substantial increase in cost between Code levels 5 and 6, largely as a result of the additional costs associated with achieving Zero carbon status together with the Code 6 requirement that the home's heat loss parameter must be 0.8 W m^2K. The heat loss parameter requirement has the combined effect of increasing capital costs whilst also reducing the home's demand for heat (and therefore the amount of low carbon electricity generated by a CHP system).

The range in cost estimates from the best to worst case scenarios is most marked for the houses, particularly the detached house, and there is a clear link between development density and scale and cost. The costs at Code level 6 do not take into account the benefit of zero stamp duty associated with achieving the zero carbon standard, if these were included it could reduce costs (assuming all of the benefit were to accrue to the house builder) by up to £15k per home, depending on sale price. If this benefit were factored into the analysis it could mean that it would be more cost effective to build to Code level 6 than Code level 5 (i.e. where the cost differential is less than the level of stamp duty avoided). Further work would be required to determine the likely percentage of avoided stamp duty that could be added to property value, although it would seem likely that this would be a relatively high percentage given that a Code 6 home is offering measurable performance improvements over a Code 5 home.

Chapter 5

Potential for cost reduction

Section 2.2 illustrated the potential for reduction in the costs associated with achieving the energy components of the Code with reductions of up to 35 per cent occurring by 2025. It would be expected that other Code elements could also be subject to reduced compliance costs in the future[10]. Potential sources of cost reduction include:

- Learning effects similar to those modelled for energy in Section 2.2
- Wholesale revision of base product to deliver at a new benchmark (e.g. the use of low energy light fittings is expected to become a standard product across the domestic sector by 2011)
- Ability to remove costs wholesale once the industry becomes more familiar with delivering the required performance standards. For example, it would be expected that within the next 18 months Robust Standard Details would begin to emerge that deliver the 8dB enhancement on Part E required for full Code credits in this area. This would avoid the need for expenditure on sound testing.

It is assumed that the relative cost of measures required to achieve savings in water consumption would follow a similar pattern to that seen for energy (although further modelling would be required to substantiate this). Table 5.1 summarises the key areas where it is expected that the costs of non mandatory Code credits would reduce by 2016 respectively. These reductions in compliance cost estimates are then used to estimate costs of compliance (in current prices) for homes in 2016 as shown in Table 5.2 (for the terraced house type only). It should be remembered, that by 2016 the energy elements of the Code up to Level 4 will be required to achieve compliance with Building Regulations.

[10] Notwithstanding the potential for Code standards to be revised as performance benchmarks improve

Table 5.1: Potential for reduction in cost for specific Code credits by 2016

Category	Credit Name	Performance	Credits available	Cost per house in 2008	Potential for cost reduction by 2016	Cost per house in 2016
Energy	Low energy lighting	>40%	1	£10		£0
Energy	Low energy lighting	>75%	1	£40		£0
Energy	Drying Space	Providing	1	£20		£20
Energy	Ecolabelled White Goods	Information or A+ rated fridges and freezers	1	£0	No change	£0
Energy	Ecolabelled White Goods	Washing machines and dishwashers	1	£540		£540
Energy	External Lighting	Space lighting	1	£0	No change	£0
Energy	External Lighting	Security lighting	2	£0	No change	£0
Energy	Cycle storage	Provision for full cycle requirement	2	£1,000		£1,000
Energy	Home office	Providing	1	£210		£210
Potable water	External potable water consumption	Rainwater butt	1	£200		£200
Surface water runoff	Reduction in surface water runoff	Hard surfaces	1	£0	No change	£0
Surface water runoff	Reduction in surface water runoff	Roofs	1	£450		£450
Surface water runoff	Flood risk	Low risk	2	£0	No change	£0
Surface water runoff	Flood risk	Medium/high risk	1	£16,635		£16,635
Materials	Environmental impact of materials	3 points (roof)	3	£0	No change	£0
Materials	Environmental impact of materials	6 points (external walls)	3	£0	No change	£0
Materials	Environmental impact of materials	9 points (internal walls)	3	£0	No change	£0

Table 5.1: Potential for reduction in cost for specific Code credits by 2016

Category	Credit Name	Performance	Credits available	Cost per house in 2008	Potential for cost reduction by 2016	Cost per house in 2016
Materials	Environmental impact of materials	12 points (floors)	3	£0	No change	£0
Materials	Environmental impact of materials	15 points (windows)	3	£140	No predictable change (although if widely adopted as a means of meeting Code or planning requirements costs could reduce by 2016.	£140
Materials	Responsible sourcing of basic materials	2 points	2	£0	No change	£0
Materials	Responsible sourcing of basic materials	3 points	1	£0	No change	£0
Materials	Responsible sourcing of basic materials	4 points	1	£300	It is expected that by 2016 sustained supply chain and investor pressure would result in most product suppliers being able to achieve Code requirements at no cost	£0
Materials	Responsible sourcing of basic materials	6 points	2	£300		£0
Materials	Responsible sourcing of finishing elements	1 point	1	£0	No change	£0
Materials	Responsible sourcing of finishing elements	2 points	1	£0	No change	£0
Materials	Responsible sourcing of finishing elements	3 points	1	£300	It is expected that by 2016 sustained supply chain and investor pressure would result in most product suppliers being able to achieve Code requirements at no cost	£300
Waste	Construction Waste	Monitor, sort and recycle construction waste	2	£100	It is expected that this initiative would form part of routine project activities and would therefore not be identified as a discrete additional cost	£0
Waste	Household Recycling Facilities	2 points	2	£160	No predictable change (although if widely adopted as a means of meeting Code or planning requirements costs could reduce by 2016.	£160

Table 5.1: Potential for reduction in cost for specific Code credits by 2016

Category	Credit Name	Performance	Credits available	Cost per house in 2008	Potential for cost reduction by 2016	Cost per house in 2016
Waste	Household Recycling Facilities	4 points	2	£0	No change	£0
Waste	Composting facilities	home composting facilities	1	£30	No change	£30
Health and wellbeing	Daylighting	Kitchen	1	£140	No change	£140
Health and wellbeing	Daylighting	Living room	1	£150	No change	£150
Health and wellbeing	Daylighting	View of sky	1	£0	No change	£0
Health and wellbeing	Sound insulation	3dB	1	£0	No change	£0
Health and wellbeing	Sound insulation	5dB	2	£0 (£160 for terraced properties)	It is expected that a broader range of robust standard details would be in use to avoid the need for sound insulation testing in most circumstances	£0
Health and wellbeing	Sound insulation	8dB	1	£0	It is expected that a broader range of robust standard details would be in use to avoid the need for sound insulation testing in most circumstances	£0
Health and wellbeing	Private space	Provide	1	£0	No change	£0
Health and wellbeing	Lifetime Homes	all features	4	£550	No change	£550
Management	Home user guide	Provide for home	2	£20	No change	£20
Management	Home user guide	Provide for surroundings	1	£80	No change	£80
Management	Considerate constructors	1 point	1	£0	No change	£0
Management	Considerate constructors	2 points	1	£0	No change	£0

Table 5.1: Potential for reduction in cost for specific Code credits by 2016

Category	Credit Name	Performance	Credits available	Cost per house in 2008	Potential for cost reduction by 2016	Cost per house in 2016
Management	Construction site impacts	1 point	1	£0	No change	£0
Management	Construction site impacts	2 points	1	£100	It is expected that these initiatives would form part of routine project activities and would therefore not be identified as a discrete additional cost	£0
Management	Security	Secure by Design	2	£0	No change	£0
Pollution	Insulant GWP	Use	1	£0	No change	£0
Pollution	NOx emissions	<40 mg kWh	3	£0	No change	£0

Table 5.2: End terraced house cost estimate for 2016

CSH Level	Mandatory (£)	Energy (£)	Water (£)	Flexible (£)	Total cost (£)	Cost £ per m²	Percentage increase on 2006 Building Regs
Best Case (Market Town scenario with low ecological value and low flood risk)							
1	£490	£248	£0	£0	**£738**	£7	1%
2	£490	£1,483	£0	£0	**£1,973**	£20	3%
3	£490	£3,323	£101	£20	**£3,934**	£39	5%
4	£490	£6,404	£101	£860	**£7,855**	£78	10%
5	£490	£10,624	£2,126	£1,150	**£14,390**	£142	19%
6	£490	£18,368	£2,126	£1,490	**£22,475**	£223	30%
Medium Case (Market town scenario with medium ecological value and low flood risk)							
1	£490	£248	£0	£0	**£738**	£7	1%
2	£490	£1,483	£0	£0	**£1,973**	£20	3%
3	£490	£3,323	£101	£70	**£3,984**	£39	5%
4	£490	£6,404	£101	£860	**£7,855**	£78	10%
5	£490	£10,624	£2,126	£1,490	**£14,730**	£146	20%
6	£490	£18,368	£2,126	£2,700	**£23,685**	£235	31%
Worst Case (Small scale scenario with high ecological value and medium/high flood risk)							
1	£490	£248	£0	£0	**£738**	£7	1%
2	£490	£1,483	£0	£70	**£2,043**	£20	3%
3	£490	£3,524	£113	£860	**£4,987**	£49	7%
4	£490	£5,292	£113	£1,150	**£7,045**	£70	9%
5	£490	£11,431	£2,363	£2,700	**£16,984**	£168	23%
6	£490	£21,751	£2,363	£3,690	**£28,293**	£280	38%

This predictive (and therefore uncertain) analysis suggests that while substantial cost reductions are achievable by 2016 there will still be a sizeable increase in overall capital costs in comparison to the current benchmark. In 2016, the majority of the additional costs are still likely to be associated with the achievement of energy standards. The proportion of these total costs directly attributable to the Code (rather than to Building Regulations) will reduce as building regulations become progressively tighter.

Chapter 6

Conclusions

This update to previous analysis of the costs of associated with achieving different standards of the Code for Sustainable Homes refines the analysis by:

- Considering the relative costs on four discrete development scenarios
- Incorporating a more detailed analysis of the costs associated with achieving the minimum energy standards required at each level including for Code Level 6.
- Adjusting the analysis of some Code categories to reflect the detail of the September 2007 Code technical guide
- Assessing the potential for reduction in cost over time

This revised analysis shows that the costs of achieving the higher code levels can vary quite substantially as a result of dwelling type, development type and site characteristics (e.g. ecological value and flood risk). The range in per dwelling cost estimates varies from £19k to £47k per unit. Lowest costs are typically seen for those developments where there is potential to use site wide carbon saving technologies (e.g. CHP systems), these are typically sites with relatively high numbers and densities of development. Nonetheless, in the absence of medium/large scale wind solutions it is necessary to make extensive use of microgeneration technologies (e.g. PV) to achieve the standards required at level 6.

The costs of achieving the specific energy standards required level 6 are typically higher than those associated with achieving zero carbon status (without the need for a heat loss parameter of less than 0.8 w/m^2 K). This is because of the cost associated with the additional thermal efficiency measures and the impact of reduced heat demand on the carbon savings arising from CHP systems. Where it is possible to utilise medium/large scale wind turbines on site (or connected via a private wire) costs are expected to be substantially lower than for the approaches detailed in this analysis (assuming the distance of private wire required is not prohibitively expensive).

It is expected that costs of compliance will fall over time and that by 2016 they could have reduced by between 16 and 25 per cent depending on Code level.