Communities and Local Government

Code for Sustainable Homes:

A Cost Review

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The findings and recommendations in this report are those of the authors and do not necessarily represent the view of the Department for Communities and Local Government.

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Glossary

ASHP	Air source heat pump
BM	Biomass
CHP	Combined heat and power
CLG	Department for Communities and Local Government
COP	Coefficient of performance
CSH	Code for Sustainable Homes
DER	Dwelling Emission Rate
Dph	Dwellings per hectare
E/O	Extra over (cost)
FRA	Flood risk assessment
GWP	Global warming potential
HW	Hot water
kW	Kilowatt (a unit of power)
kWe	Kilowatt electric (electrical power)
kWp	Kilowatt peak
kWth	Kilowatt thermal (thermal power)
LZC	Low or Zero Carbon (technologies)
MVHR	Mechanical Ventilation with Heat Recovery
PV	Photovoltaic (array / system)
SAP	Standard Assessment Procedure
SHW	Solar hot water (solar thermal water heating)
SUDS	Sustainable urban drainage systems
SWMP	Site waste management plan
TER	Target Emission Rate
TPPS	Total percentage points score
ZCH	Zero Carbon Home

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KeepMoat Homes

Kier Residential

Kingerlee

Mar City Developments

McCarthy & Stone

Metropolitan Housing Association

National House Building Council

Taylor Wimpey

Zero Carbon Hub

1 EXECUTIVE SUMMARY

Background and Motivation

Approximately twenty-five percent of the UK's total CO_2 emissions come from the country's housing stock. While improvements in the energy performance of existing dwellings is possible, and much work is on-going in this area, the approach to new build housing presents a unique opportunity to influence the performance of homes to be added to the stock. The Code for Sustainable Homes has been designed to guide the house building industry towards creating more sustainable homes, with a lower impact on the environment, both in their construction and throughout the buildings' lifetimes. While the Code is voluntary, providing a rating against the Code is mandated by legislation. In addition to promoting the conservation of energy, the Code addresses wider issues including water conservation, environmental impact of building materials, and encouraging the construction of well-designed, adaptable homes suitable for an ageing population.

An update to the Code is due in 2010 to maintain alignment with amended building regulations and to incorporate feedback on current guidelines received from stakeholders within the construction industry. The Department for Communities and Local Government, which is responsible for administering the Code, requires an impact assessment on proposed changes before taking a decision on the most appropriate policy option. Element Energy and Davis Langdon were commissioned to undertake research into the costs of building to the Code, based on the practical experience of developers building Code homes. A comprehensive data set of market-tested costs is a fundamental requirement for undertaking the impact assessment, the results of which are presented in a separate document. This report presents the findings of research into the costs of building to the Code, based on recent real cost experience, superseding costing studies undertaken by Cyril Sweet in 2007/08.[1]

Methodology

This study considers the extra over cost of building to the Code above constructing homes to comply with building regulations. Four dwelling types were defined for this work, and were combined in a variety of ways (in terms of number of dwellings, dwelling mix and dwelling density) to create development scenarios. Cost data was obtained through a direct consultation with the house building industry, and was validated in order to retain the costs of typical mass-market measures, while filtering out any atypical costs, for bespoke solutions for example. These validated cost data were entered into a model, along with definitions of the dwelling types, development scenarios, and alternative approaches to meet the energy performance targets, which facilitated an analysis of the costs of building to each Code level. The approach taken also allowed the sensitivities of total cost of Code compliance to be explored.

Key Results

The Code for Sustainable Homes rates the sustainability of homes from level 1 to 6 on the basis of a points scoring system, where level 1 is a modest improvement on minimum regulatory standards and level 6 is an extremely challenging standard. Points are awarded under nine categories of sustainability on the basis of certain targets being met, e.g. reduced CO_2 emissions or water consumption, or incorporation of certain elements of sustainable design. Under some categories, such as energy, minimum standards are stipulated that must be met to achieve a certain Code level, these are the

[1] Cost Analysis of The Code for Sustainable Homes
Final Report, published 21 July 2008 available at www.communities.gov.uk/thecode

mandatory standards, whereas under other categories developers are given the flexibility to choose which actions to take to score the points required for a certain target Code level.

As a result of the mandatory standards, all dwellings achieving a certain Code level will have certain features and performance standards in common. However, because the home-builder has flexibility to select what measures to implement to achieve many of the points necessary to achieve a certain Code level, there are a great many possible combinations of measures at each level. The modelling methodology has been designed to identify the lowest cost means of achieving each Code level in each scenario (i.e. each combination of dwelling type and development scenario). This is achieved by first applying all measures required to achieve the mandatory standards (some of which are credited with points, others have no points attached) and then adding further measures in order of cost-effectiveness (i.e. £/point) until enough points have been scored to achieve a particular Code rating. The minimum costs associated with achieving each level of the Code are tabulated below for each dwelling type and in a range of development scenarios. The costs are reported as the extra-over cost from a baseline of building a 2006 Building Regulation compliant dwelling.

There is significant variation in the extra-over costs at each Code Level between the dwelling types and across the development scenarios. Typically, however, the extra-over costs expressed as a percentage of base build cost are < 1% for Code level 1, 1–2% at Level 2, 3–4% at level 3, 6–8% at Level 4, 25–30% at Level 5 and anything from 30 to 40 % at Level 6.

Costs are those currently applicable to building to the existing version of the Code, with no assumptions regarding potential future revisions. An analysis of how the extra-over cost of the Code (i.e. the costs associated with achieving a Code level in excess of constructing a Building Regulation compliant dwelling) changes with anticipated tightening of the Building Regulations is provided. In forecasting future extra-over cost of the Code, an allowance has been made for expected cost reductions in certain technologies (assumptions regarding cost reductions are based on industry consultation – see Section 10.1).

The most critical factor in determining the total cost of building to the Code is the approach taken to meeting the mandatory reduction in carbon emissions. At the lower Code levels (up to Code level 3) fabric improvement measures may be sufficient to achieve the required reduction in Dwelling Emission Rate (note that calculation of Dwelling Emissions Rates have been performed using SAP 2005). However, from Code level 4 and above it becomes necessary to employ some form of low or zero carbon technology to meet some or all of the dwelling's thermal and / or electrical demands. These costs tend to dominate the overall expense of meeting a given Code level for all dwelling types.

The Department for Communities and Local Government has consulted on the definition of zero carbon homes and has announced certain decisions which are expected to reduce the cost of reaching zero carbon, when compared to the zero carbon definition utilised within the current version of Code level 6.

The variation in Code costs between development scenarios is largely a result of the variation in energy strategy costs, which can be dependent on the development's scale and density. This is particularly the case when the energy strategy is based around some common, site-wide infrastructure, such as a district heating system. Furthermore, development scale and / or density may restrict the technology options available. For example an attractive means of meeting the very high DER reductions required at Code Levels 5 and 6 can be to utilise a biomass CHP system connected to a district heating network but, due to current limitations on technology availability, a large heat load (i.e. a significant scale development) is required for this strategy to be available. Limited availability of biomass CHP technology at smaller scales and the constraints on installation of medium to large-scale wind turbines in many development sites mean that the Code Level 6 energy strategy is very challenging.

Summary of extra-over costs of building to each level of the Code in each of the dwelling types and for a range of development scenarios.

Extra-over costs (E/O) costs are measured from a baseline of constructing a 2006 Building Regulation compliant dwelling and are tabulated as an absolute cost and as a % increase over the base build cost.

Code Level	2b-Flat		2b-Terrace		3b-Semi		4b-Detached	
	E/O cost	%	E/O cost	%	E/O cost	%	E/O cost	%
Small brownfield (20 dwellings at 80 dph)								
1	£310	0.5%	£230	0.3%	£360	0.4%	£310	0.3%
2	£1,670	2.8%	£1,620	1.9%	£1,040	1.1%	£970	1.0%
3	£2,460	4.1%	£2,420	2.8%	£3,020	3.2%	£2,680	2.7%
4	£5,610	9.4%	£7,360	8.5%	£8,140	8.7%	£6,030	6.0%
5	£17,740	29.7%	£24,370	28.2%	£26,830	28.6%	£30,130	30.1%
6	£28,510	47.7%	£34,810	40.3%	£38,730	41.2%	£42,770	42.8%
Medium Urban (350 dwellings at 80 dph)								
1	£260	0.4%	£170	0.2%	£260	0.3%	£270	0.3%
2	£1,560	2.6%	£1,500	1.7%	£890	0.9%	£810	0.8%
3	£2,340	3.9%	£2,000	2.3%	£2,900	3.1%	£2,510	2.5%
4	£5,440	9.1%	£7,190	8.3%	£7,970	8.5%	£5,860	5.9%
5	£17,570	29.4%	£24,200	28.0%	£26,650	28.4%	£29,960	30.0%
6	£19,580	32.8%	£26,550	30.7%	£28,390	30.2%	£31,230	31.2%
Large Urban (3600 dwellings at 80 dph)								
1	£250	0.4%	£160	0.2%	£250	0.3%	£260	0.3%
2	£1,550	2.6%	£1,490	1.7%	£890	0.9%	£810	0.8%
3	£2,340	3.9%	£2,000	2.3%	£2,890	3.1%	£2,510	2.5%
4	£6,360	10.6%	£6,200	7.2%	£6,580	7.0%	£6,470	6.5%
5	£16,640	27.9%	£23,210	26.8%	£25,580	27.2%	£28,790	28.8%
6	£23,210	38.9%	£29,920	34.6%	£32,390	34.5%	£36,040	36.0%
Small greenfield (10 dwellings at 40dph)								
1	£320	0.5%	£230	0.3%	£330	0.4%	£320	0.3%
2	£1,620	2.7%	£1,560	1.8%	£990	1.1%	£880	0.9%
3	£2,160	3.6%	£2,120	2.5%	£2,720	2.9%	£2,380	2.4%
4	£5,350	9.0%	£7,150	8.3%	£7,860	8.4%	£6,910	6.9%
5	£17,310	29.0%	£26,970	31.2%	£29,260	31.1%	£32,270	32.3%
6	£27,650	46.3%	£37,400	43.3%	£40,800	43.4%	£45,230	45.2%
Medium edge of town (650 dwellings at 40 dph)								
1	£270	0.5%	£190	0.2%	£370	0.4%	£290	0.3%
2	£1,550	2.6%	£1,500	1.7%	£920	1.0%	£810	0.8%
3	£2,090	3.5%	£2,050	2.4%	£2,650	2.8%	£2,310	2.3%
4	£5,280	8.8%	£7,080	8.2%	£7,800	8.3%	£6,840	6.8%
5	£17,240	28.9%	£26,900	31.1%	£29,190	31.1%	£32,200	32.2%
6	£24,080	40.3%	£31,250	36.1%	£33,090	35.2%	£36,180	36.2%
Large edge of town (3,300 dwellings at 40 dph)								
1	£270	0.5%	£180	0.2%	£370	0.4%	£290	0.3%
2	£1,550	2.6%	£1,490	1.7%	£920	1.0%	£810	0.8%
3	£2,090	3.5%	£2,050	2.4%	£2,640	2.8%	£2,310	2.3%
4	£5,280	8.8%	£7,080	8.2%	£7,790	8.3%	£6,830	6.8%
5	£17,230	28.8%	£26,890	31.1%	£29,190	31.1%	£32,200	32.2%
6	£27,710	46.4%	£34,620	40.0%	£37,090	39.5%	£40,990	41.0%

2 INTRODUCTION

2.1 Overview

This report presents the findings of research into the cost of building to the Code for Sustainable Homes. The study was conducted for the Department for Communities and Local Government (CLG), which is responsible for planning policy and building regulation in England, including administration of the Code. As part of its strategy to protect the environment and address carbon emissions, CLG is proposing to gradually tighten building regulations to increase the energy efficiency of new homes and thus reduce their carbon impact. In parallel with these changes to building regulations, the Code for Sustainable Homes has been introduced as a tool to encourage home builders to create more sustainable dwellings, and to inform buyers about the green credentials of their new property. The Code is intended to provide a route map, signalling the direction of change toward low carbon, sustainable homes that will be mandated through the Building Regulations.

The changes to building regulations will be phased over a number of years. The current strategy includes introducing changes to Part L (Conservation of Fuel and Power) in 2010 and 2013. A number of incremental changes to Code assessment are also being proposed, which aim to ensure that it remains effective in fulfilling its aims and to retain alignment with building regulations. Before any changes to Code assessment can be formally adopted, an Impact Assessment must be conducted to assess the costs and benefits of the proposed amendments. The requirement for an Impact Assessment, including a full cost-benefit analysis for all proposed amendments to the Code, provides the principal driver for the cost review detailed in this report.

2.2 Objectives

The objectives of this study were to:

- Consult with the construction industry to build a comprehensive dataset of market-tested costs for complying with each level of the Code for Sustainable Homes.
- Assess the cost implications of building to the Code, including an analysis of the sensitivity of overall cost to the approach taken to Code compliance.
- Conduct an Impact Assessment in relation to the proposed changes to Code assessment criteria.

3 BACKGROUND

The Code for Sustainable Homes is a vital 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.

The Code was launched by the Department for Communities and Local Government in December 2006. Around that time and in the months following the introduction of the Code, studies were undertaken to review the cost of building to the Code and the technical implications of the different Code levels.[2] Whilst the industry had some experience of achieving some of the targets set in the Code (through experience of the EcoHomes standard, for example), the cost estimations were based on a limited amount of data.

The CSH technical guidance came into effect in April 2007, and it became possible to assess new homes built in England from this date. Since then, the number of Code homes completed has steadily increased, leading to increased volume and robustness of cost data in terms of extra over cost of building to the Code. A review of and update to the costs was required by CLG in order to quantitatively assess the impacts of proposed future changes to the Code.

Although building to the Code remains voluntary, the number of Code homes is expected to increase significantly in the coming years. When the proposed changes to Part L of the building regulations come into effect in 2010 the energy efficiency standards required (in terms of Dwelling Emission Rate) will correspond to the mandatory requirement for Code level 3. Since meeting the energy performance targets is one of the more costly aspects of the Code, the extra over spend to build to Code level 3, will have declined. Furthermore, many local authorities now require some level of Code compliance in large scale developments, and Code level 3 is mandatory for social housing if a Government grant is sought.

The remainder of this section gives an overview of the Code, including proposed changes to the requirements. For full details of the Code please refer to the Technical Guide.[3]

3.1 Categories and Issues

The Code requires new homes to be assessed against nine design categories:

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

[2] See for example:
http://www.communities.gov.uk/documents/planningandbuilding/pdf/codecostanalysis.pdf
[3] http://www.communities.gov.uk/publications/planningandbuilding/codeguide

Each category is further sub-divided into a number of discrete issues, for example, the Materials category consists of three issues: Mat 1 (Environmental impact), Mat 2 (Sourcing – basic elements), and Mat 3 (Sourcing – finishing elements).

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.

3.2 Mandatory Issues

Building to any given level of the Code is currently voluntary. However, a Code rating for new dwellings became mandatory from May 1st 2008. If no target Code level is sought, the dwelling is given a 'Nil Rated' status. In order to achieve any of the Code levels from 1–6, certain mandatory requirements must be met; these are summarised below.

Table 1: Mandatory issues

Issue Code	Description	Code Level						
		1	2	3	4	5	6	
Mat 1	*Environmental impact*[4]	At least three key elements to achieve a Green Guide rating of A+ to D						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 British Standard 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 TER*	10%	18%	25%	44%	100%	ZCH	Mandatory issues
	Mandatory Credits	1	3	5	8	14	15	
Hea 4	*Mandatory to comply with all principles of Lifetime Homes*	No	No	No	No	No	Yes	
	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	

Current Code assessment defines four mandatory issues with no associated credits. For each of these a single requirement must be met, irrespective of the Code level sought. Provided the minimum performance standards are met for each of the uncredited issues, further mandatory issues must be

[4] Key elements include: Roof, External Walls, Internal Walls, Upper and Ground Floors, Windows.

considered before a Code rating is granted. Minimum mandatory standards increase with Code level sought 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 DER to a sufficient level to offset all predicted electricity use in the dwelling, and is calculated in accordance with the Code Technical Guide.

3.3 Credits and Scoring

The overall Code level attained is based upon the *Total Percentage Points Score* (TPPS), subject to the mandatory requirements described above being met. The TPPS 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.

The following table summarises the Code issues, including the maximum number of credits available by issue and the weighting factors for each category.

Table 2: Summary of Code categories, issues, and available credits

Category	*Issue key*	*Issue title*	*Maximum credits available*	*Weighting factor (%)*	*Weighted value of each credit*
Energy / CO_2	Ene 1	Dwelling Emission Rate (DER)	15	36.4	1.26
	Ene 2	Building Fabric	2		
	Ene 3	Internal Lighting	2		
	Ene 4	Drying Space	1		
	Ene 5	Eco-labelled White Goods	2		
	Ene 6	External Lighting	2		
	Ene 7	LZC Energy Technologies	2		
	Ene 8	Cycle Storage	2		
	Ene 9	Home Office	1		
Water	Wat 1	Internal Water Consumption	5	9	1.50
	Wat 2	External Water Consumption	1		
Materials	Mat 1	Environmental Impact	15	7.2	0.30
	Mat 2	Sourcing - Basic Elements	6		
	Mat 3	Sourcing - Finishing Elements	3		
Surface Water	Sur 1	SW Run-Off Management	2	2.2	0.55
	Sur 2	Flood Risk	2		

Waste	Was 1	Waste Storage	4	6.4	0.91
	Was 2	Construction Waste Management	2		
	Was 3	Composting Facilities	1		
Pollution	Pol 1	Insulant GWP	1	2.8	0.70
	Pol 2	NO_x Emissions	3		
Health & Well-Being	Hea 1	Daylight	3	14	1.17
	Hea 2	Sound Insulation	4		
	Hea 3	Private Space	1		
	Hea 4	Lifetime Homes	4		
Management	Man 1	Home User Guide	3	10	1.11
	Man 2	Considerate Constructors Scheme	2		
	Man 3	Construction Site Impacts	2		
	Man 4	Security	2		
Ecology	Eco 1	Ecological Value of Site	1	12	1.33
	Eco 2	Ecological Enhancement	1		
	Eco 3	Protection of Ecological Features	1		
	Eco 4	Change in Ecological Value	4		
	Eco 5	Building Footprint	2		

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 TPPS is the sum of all the percentage points scores and the minimum TPPS requirement increases with Code level, as summarised below.

Table 3: Minimum Total Percentage Points Score requirement by Code level

Code Level	1	2	3	4	5	6
Minimum TPPS	36	48	57	68	84	90

3.4 Changes to the Code

There have been a number of changes to the Code Technical Guide since its first publication in April 2007. Changes are made in response to feedback from Code assessors, developers, and other stakeholders, and also to keep the Technical Guide in line with other related legislation (building regulations, SAP, etc).[5]

For the purposes of continuity, CLG generally aims to minimise changes to the Code. Details of currently proposed revisions to the Code are given in the December 2009 Impact Assessment which accompanies the consultation on the Code for Sustainable Homes and the Energy Efficiency standard for Zero Carbon Homes.[6]

[5] See, for example:
http://www.planningportal.gov.uk/uploads/code_for_sustainable_homes_techguide_changes_summary_april08.pdf
http://www.planningportal.gov.uk/uploads/code_for_sustainable_homes_techguide_changes_summary.pdf

[6] http://www.communities.gov.uk/publications/planningandbuilding/futureofcodeconsultation.

4 RESEARCH METHODOLOGY

4.1 Industry Consultation

The assembly of a high quality and comprehensive data set of the costs of achieving credits against each Code issue was central to this study. This involved an extensive consultation with the house building industry to understand the approaches taken to Code compliance and the associated costs of meeting various Code levels.

The industry consultation also guided the modelling approach taken, ensuring that the dwellings and developments considered were suitably representative. Furthermore, working with developers across the industry gave an understanding of the perception of the Code and the likely impacts on house builders.

A key finding arising from the industry consultation was that as-constructed cost data on Code homes remains relatively scarce. Despite the plans of many developers to build Code homes, at the time of the research the number of post-construction certificates (certifying Code homes) stood at a relatively modest figure at around 40. Feedback from the industry revealed a consensus that due to the relatively low number of Code homes completed, there has not yet been a convergence toward standard solutions for which the costs are well-understood. Instead, a wide variety of strategies are being adopted leading to large variations in the costs incurred at any given Code level.

Variation in extra over cost between developers also arises due to differences in standard practice between developers. For example, where measures to achieve Code compliance are added to a developer's base specification the extra over cost is sensitive to the details of that base specification; i.e. measures that are standard for one developer may not be for another, and could therefore be viewed as free in one case but seen as an extra over cost in another.

Given the limited data, particularly at high Code levels, and variability in solutions adopted, the consultants' own experience and costing expertise has been required to produce a complete cost data set for use in the cost modelling exercise.

4.2 Cost Data Validation

The ultimate aim of consulting with the construction industry and gathering a cost data set was to obtain market-tested costs representative of mass market solutions that could be input into a model designed to analyse the costs of building to the Code. Given the wide range of data sources, a data validation exercise was necessary to ensure valid data was retained while atypical costs (such as expensive one-off bespoke solutions) were filtered out. This data validation process also highlighted where significant cost variations occur, against which issues for example, and therefore led to an understanding of the key sensitivities in deriving costs of building Code homes.

4.3 Modelling Methodology

The key outputs of this work include estimations of the additional cost of building homes to the Code, above the base cost of construction in line with building regulations. These costs were derived from a model, designed to allow assessment of the extra over costs of building to each Code level, for different dwellings in a range of development types. Furthermore, the model can be used to analyse the costs of building to the Code in future years, based on technology cost projections and assumptions regarding the building regulations in the future. The following figure summarises the model operation.

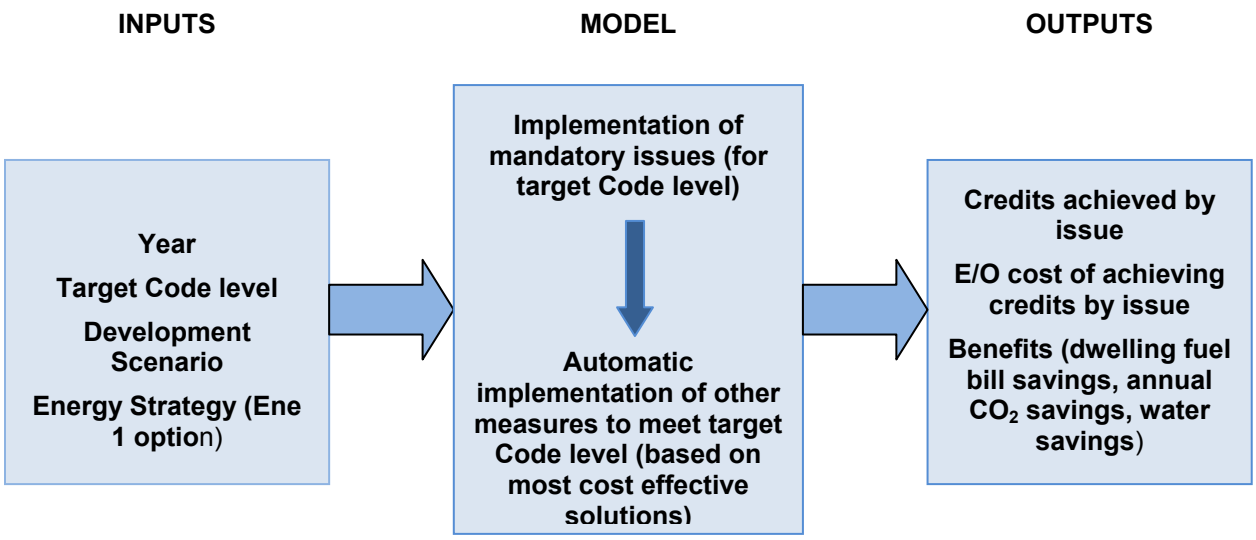


Figure 1: Overview of modelling methodology

The extra over costs to a developer of building to a given Code level are sensitive to numerous factors, including:

- Approach taken to achieve the required reduction in dwelling emission rate (DER) relative to target emission rate.
- Standard practice of the developer, including working practices and standard specifications.
- Development location – site characteristics may influence the cost of achieving the required DER and also affect the cost of achieving credits in categories such as Surface Water, Management, and Ecology.
- Building regulations in force in the year in question. Reported costs are over and above the cost of building to building regulations.

In order to capture and model these sensitivities a semi-automated modelling approach was adopted. Figure 1 shows that the inputs to the model, which include specification of the 'Ene 1 option'. This is the strategy designed to achieve the mandatory improvement in DER for the target Code level. A variety of Ene 1 options was defined for each Code level, reflecting the range of alternative approaches possible. The options include individual (house-by-house) energy solutions and community (site-wide) energy schemes and are described in detail in section 6.

As well as the year in question and the target Code level, the other manual input to the model is the development to be modelled. The different development scenarios were characterised by varying scale (total number of dwellings constructed), ecology of site (greenfield and brownfield), dwelling mix (proportion of different dwelling types), and dwelling density. The main impact of development type is on the energy solutions available and their costs, as some technologies are only applicable at or above certain scales and district heating costs are sensitive to dwelling density.

Once all manual inputs are defined, the model checks whether all mandatory issues have been satisfied (including uncredited and credited issues), and if not corrective action is taken through the

implementation of appropriate measures. Following this, any zero-cost measures are automatically implemented, based on the assumption that developers building Code homes would aim to achieve credits that represent little or no extra over cost.

With the manual inputs defined, all mandatory issues satisfied, and all zero cost credits attained, the model then checks whether the target Code level has been met. If not, the model implements measures one-by-one until the target Code level is met. It is assumed that developers aim for the most cost effective method of achieving the target Code level and the automatic implementation of measures is therefore based on a £/point rating. Measures to achieve credits against each Code issue were defined and costed through the industry consultation and data validation exercises (see section 6). Credits for each issue are converted to weighted credits (points) by applying the appropriate weighting factor. This allows a £/point metric to be derived for each measure, and the measures are implemented in order of increasing £/point.[7]

The above procedure is followed for each dwelling type for the development in question, yielding a set of data with credits and extra over costs by dwelling type for the given development with the selected Ene 1 option. Repeating this method for all target Code levels, all relevant Ene 1 options, all developments and for all years in question leads to a large data set from which specific results of interest may be analysed.

Further assumptions relating to the modelling approach are discussed in the following section.

[7] It is acknowledged that in some circumstances developers may not follow a strictly rational approach to gaining Code credits. Measures that are not necessarily the most cost effective may be preferred in some instances, for example if they are perceived to increase the home saleability.

5 BASELINE ASSUMPTIONS

5.1 Basic Dwelling Types

The house types used for evaluating the cost of the Code are based on average types that are common to most developments, covering houses and flats. For consistency with other relevant policy work, the dwellings modelled are equivalent to those considered in recent analysis of changes to Part L (in support of the recent public consultation[8]).

Table 4: Dwelling types

	2 bed mid-floor flat	*2 bed mid-terrace*	*3 bed semi-detached*	*4 bed detached*
Total floor area (m^2)	61	73	88	118
Ground floor area (m^2)	61	36.5	44	59
First floor area (m^2)	N/A	36.5	44	59
Gross external wall area (m^2)	38.8	52	101.5	154.5
Net external wall area (m^2)	32.8	38	83.5	132.5
Roof area[9] (m^2)	61	36.5	44	59
Area of external doors (m^2)	0	4	4	4
Window area (m^2)	6	10	14	18
Average storey height (m)	2.5	2.5	2.5	2.5

The 'ground floor area' and 'roof area' figures for the flat were set to zero for the purposes of the SAP calculations; i.e. it is assumed that the flats above and below this mid-floor flat have the same internal temperature as the flat modelled, hence there is no heat loss through the ceiling or floor. A mid-floor flat is assessed rather than a ground floor or a top floor flat, since a mid-floor flat has the best baseline energy performance in a block, which makes achieving the required reduction in DER more challenging. It can then be concluded that, based on the same areas and plan configurations between all flats in a block, achieving Code levels 3, 4 and 5 for a top or a ground flat is no more expensive than achieving the same levels for a mid-floor flat.

5.1.1 Specifications of the Basic Dwelling Types

Baseline specifications of the dwellings were set to achieve compliance with 2006 building regulations. Traditional masonry construction is the default construction method used in this study. Base specifications are summarised in the table below.

[8] Proposals for amending Part L and Part F of the Building Regulations – Consultation, June 2009

[9] This is the roof area for insulation, rather than area available for roof-mounted technologies such as PV arrays. Assumptions relating to LZC technologies are given in appendix 2.

Table 5: Specifications of baseline dwellings

Element	Specification		U-value (W/m^2K)			
	Masonry	Timber Frame	Flat	Terrace	Semi-detached	Detached
Ground floors, solid	Concrete screed (70mm) Rigid PIR board (65mm) 25mm edge insulation		0.25	0.20	0.25	0.20
External walls	Brick outer leaf (100mm) MiF batts λ=0.032m^2K/W (65mm) Ties (12.5mm csa) AAC Block (100mm) Plaster	Brick outer leaf (100mm) Air gap Vapour permeable layer Rigid PIR board (75mm) between 125 timber stud VCL Air gap Plasterboard	0.35	0.25	0.25	External walls
Roof (cold loft)	Cold loft, timber truss: Wool insulation (100mm) Wool insulation between joists (100mm) Concrete roof tile		0.25	0.18	0.18	0.18
Windows & doors	Timber frame with trickle vents Double glazing 4/18/4 Air		2.2	1.8	1.8	2.2
Heating & hot water	90% efficient gas boiler to meet 90% of thermal demands 100% efficient electric heating to meet 10% of thermal demands		N/A	N/A	N/A	N/A
Thermal bridging	y value = 0.08W/m^2K		N/A	N/A	N/A	N/A
Air permeability	q_{50} = 10m^3/m^2/hr		N/A	N/A	N/A	N/A
Ventilation	Natural ventilation		N/A	N/A	N/A	N/A
Lighting	25% low energy light fittings		N/A	N/A	N/A	N/A

5.1.2 Energy Performance of Baseline Dwellings

Carbon dioxide emissions from domestic dwellings are expressed as a Dwelling Emission Rate (DER), in kilograms of CO_2 per square metre of floor area per year, and are calculated using the government's Standard Assessment Procedure (SAP). The SAP methodology is also used to determine a Target

Emission Rate (TER) for the dwelling in question. The TER is calculated for a building of the same form as the actual dwelling, but with specific areas of openings (windows, doors etc) and specific U-values for each of the primary elements (defined in the SAP Technical Guide). For the purposes of Part L, the performance of a dwelling in terms of CO_2 emissions is measured by comparing the DER to the TER and expressing the difference as a percentage improvement (relative to TER).

The TER calculation was performed for each of the four dwelling types defined, giving a benchmark against which the effectiveness of alternative improvement measures was compared. The TER values and performance of the dwellings with baseline specifications are given below.

Table 6: Target emission rate and DER of reference dwellings

Dwelling	*TER ($kgCO_2/m^2/yr$)*	*DER with baseline specification ($kgCO_2/m^2/yr$)*	*% improvement (DER vs TER)*
Flat	18.3	18.1	1.2%
Terrace	20.6	20.5	0.6%
Semi	22.6	22.1	2.0%
Detached	22.3	21.9	1.7%

The SAP methodology is currently being updated. However, the new version of SAP was not available for this study and all energy / CO_2 modelling was performed using the existing SAP 2005 method (version 9.82).

5.1.3 Baseline Build Costs

Detailed cost plans were prepared for each baseline dwelling, based on a Quantity Surveyor's take-off from the drawings and an analysis of the baseline specifications. The cost plan for the flats was drawn up for a four storey block of eight flats. The estimated capital costs for each baseline dwelling are summarised below. The costs of Code compliance are over and above these base capital costs.

Table 7: Baseline build costs

Dwelling type	*Gross floor area (m^2)*	*Total Capital Cost (£)*	*Cost (£/m^2)*
2 bed mid-floor flat	61	£59,725	£980
2 bed mid-terraced	73	£86,470	£1,185
3 bed semi-detached	88	£93,940	£1,070
4 bed detached	118	£99,975	£850

These costs exclude VAT, professional fees and any abnormal / foundation costs such as piling works. Costs are based on competitively tendered 4th Quarter 2008 prices with no allowance for future inflation.

5.2 Development Scenarios

The dwelling types described above were combined in various ways to create a range of development scenarios. These scenarios were derived taking into account input from the house building industry, so as to best represent typical developments. The scenarios represent developments constructed and the range of developer sizes, from small scale developers with up to a few tens of completions per year to the largest national house builders with the expertise to develop sites of thousands of homes. The development scenarios are summarised in the table below.

Table 8: Development scenarios

Scenario number	Description	Dwelling density (dph)	Total number of dwellings	Dwelling mix			
				Flats	Terraced	Semi	Detached
Brownfield							
1	Small brownfield	80	20	40%	35%	20%	5%
2	City infill	160	10	100%	0%	0%	0%
3	Medium urban (mixed)	80	350	50%	25%	20%	5%
4	Medium urban (flats)	160	400	100%	0%	0%	0%
5	Large urban (mixed)	80	3,600	50%	25%	20%	5%
6	Large urban (flats)	160	4,300	100%	0%	0%	0%
Greenfield							
7	Small infill	40	10	0%	60%	20%	20%
8	Small greenfield	40	50	40%	30%	20%	10%
9	Small edge of town	40	10	0%	40%	20%	40%
10	Medium edge of town	40	650	30%	30%	20%	20%
11	Large edge of town	40	3,300	30%	30%	20%	20%
12	Strategic	40	5,000	30%	20%	25%	25%

The variation in the costs of meeting each Code Level are analysed with reference to these representative development scenarios.

5.3 Key Assumptions

The modelling work is based on a number of key assumptions. The costs of measures used to achieve credits and assumptions on an issue-by-issue basis are summarised in section 6 and the LZC technology costs and technical assumptions are given in appendix 2 (see Section 10). This section presents other key assumptions made in deriving the costs presented in section 7.

5.3.1 Changes to Building Regulations over Time

Part L of the building regulations is due to change in 2010 and 2013, and will tighten the energy performance standards of all new dwellings. Changes in 2010 / 2013 will require new dwellings to achieve a 25% / 44% improvement in DER relative to TER, equivalent to Code 3 / Code 4 mandatory Ene 1 requirements.

This work considers the extra over cost of building to the Code, over and above the cost of constructing dwellings to comply with building regulations. The minimum cost of satisfying Part L in the year in question is therefore subtracted from the cost of whichever Ene 1 option is implemented. For example, analysis of the costs of achieving a 25% improvement in DER via the alternative Ene 1 options defined showed that the lowest cost method in certain scenarios is to specify 'Better' fabric and a small PV system (see section 6.1.1 for full list of options). The cost of this energy option is therefore subtracted from the cost of the energy option implemented in the years 2010 to 2012 inclusive in those development scenarios in order to determine the extra-over cost of the energy system. Similarly, the lowest cost solution for achieving the 44% improvement target is based on an air source heat pump with PV. This cost is subtracted from all energy options in the years from 2013.

The effect of tightening Part L standards was taken into account in the modelling work. For example, the Ene 1 options defined to satisfy the mandatory requirements of Code levels 1 and 2 (10% and 18% improvements respectively) become redundant after 2010 since building regulations require at least a 25% improvement in DER relative to TER. Similarly, the Code 3 Ene 1 options, which give a 25% improvement, are not implemented in the years from 2013. The implications of changes to the Building Regulations on the extra-over costs of the Code are specifically addressed in Section 7.4.

5.3.2 Low and Zero Carbon Technologies

In order to meet the higher Code level requirements, some sort of LZC technology is generally required. It was assumed that developers would aim to just achieve the required improvement in DER in order to minimise the additional cost; hence PV and SHW technologies were sized to just allow the target to be met.

Where a technology able to meet all of the dwelling's thermal demands was specified an offset benefit was included to account for the fact that a traditional heating system (gas boiler) would not be required. The installed cost of a high efficiency condensing gas boiler was assumed to be £1,000 for flats and terraced houses, £1,100 for semi-detached houses, and £1,200 for detached houses.

6 MEETING CODE STANDARDS

6.1 Energy

6.1.1 Mandatory Requirement: Ene 1 – Dwelling Emission Rate

With nine distinct issues and an overall weighting factor of 36.4%, the Energy category represents a major source of Code credits. In the Energy category Ene 1, Dwelling Emission Rate, is the only issue with mandatory requirements for each Code level. A mandatory requirement under Ene 2, Building Fabric, forces all Code 6 homes to achieve a Heat Loss Parameter of 0.8W/m^{2}K or below. As discussed above, the required improvement in DER may be achieved via various methods, however a common approach is to improve the building's fabric to reduce heat loss and minimise air permeability. Three different fabric improvement packages were therefore defined, giving the dwellings superior thermal performance compared to baseline specifications. These packages are referred to as 'Good', 'Better', and 'Best', and are summarised below. Details of the cost breakdown by element are included in appendix 1 (see Section 9).

Table 9: U-values for the fabric improvement packages

Element	*U-value (W/m^{2}K)*		
	Good	*Better*	*Best*
Ground floors	0.20	0.15	0.10
External walls	0.25	0.20	0.15
Roof	0.18	0.15	0.10
Windows and Doors	1.5	1.10	0.70
Thermal bridging y value (W/m^{2}K)	0.08	0.04	0.02
Air permeability, q_{50} (m^3/m^2/hr)	7	4	1

Table 10: Total fabric package costs (including costs of improving U-values, reducing air permeability and thermal bridging, and MVHR systems where necessary)[10]

Fabric package	*Flat*	*Terrace*	*Semi*	*Detached*
Reference – base cost	£5,266	£17,260	£25,516	£36,165
Good – E/O cost relative to 'Reference' package	£215	£42	£186	£243
Better – E/O cost relative to 'Reference' package	£1,358	£1,992	£2,539	£3,066
Best – E/O cost relative to 'Reference' package	£4,268	£6,845	£8,642	£10,334

Standard practice dictates that when the air tightness of a dwelling is reduced to very low values (from c.3m^3/m^2/hr and below), a mechanical ventilation system becomes necessary. In this study it was assumed that where a mechanical ventilation system is required, a system incorporating heat recovery

[10] For a full breakdown of cost assumptions see section 9.

would be specified. Therefore, all dwellings with the 'Best' fabric package also include a mechanical ventilation with heat recovery (MVHR) system.

In order to meet the requirements of Code levels 3 and above it is often necessary to employ some form of low or zero carbon technology to provide the dwelling with heat and/or electricity. A variety of options for meeting the different mandatory DER targets were defined and are summarised below. It should be noted that while some of these options are used by developers, not all have necessarily been tested in practice. Some of the options are based on assumptions regarding the availability of future technology, for example the micro gas CHP unit in option 12 is based on a fuel cell system with a low heat to power ratio. Furthermore, this list is not intended to be fully comprehensive, but aims to represent the most common and most likely energy solutions. It is acknowledged that there are other alternative methods of achieving the target DER levels.

Table 11: Ene1 options for meeting required improvements in DER

Option no.	Target %	Description	Actual % improvement (DER on TER)			
			Flat	Mid-terrace	Semi	Detached
1	10%	'Good' fabric – flat, semi, detached 'Good +' fabric – terrace (see Note 1)	11%	10%	11%	11%
2	18%	'Better +' fabric – flat 'Better' fabric – terrace 'Good+' – semi, detached	18%	19%	19%	20%
3	25%	'Good' fabric, PV	30%	27%	26%	27%
4	25%	'Better' fabric – detached 'Best' fabric, MVHR – flat, terrace, semi Add SHW for flat	25%	29%	36%	27%
5	25%	'Good' fabric, ASHP	30%	27%	30%	31%
6	25%	'Better' fabric – detached 'Better' fabric, PV – flat, terrace, semi	26%	26%	30%	27%
7	25%	'Better' fabric – detached 'Better' fabric, SHW – flat, terrace, semi	25%	25%	27%	27%
8	44%	'Better' fabric, ASHP Add PV for flat, terrace, semi	48%	46%	46%	45%
9	44%	'Best' fabric, MVHR, biomass block heating – flat 'Best' fabric, MVHR, individual biomass boilers – houses	73%	71%	74%	75%
10	44%	'Best' fabric, MVHR, PV	47%	48%	45%	44%
11	44%	'Good' fabric, community gas CHP	67%	67%	68%	68%
12	44%	'Good' fabric, micro gas CHP	73%	76%	79%	80%
13	100%	'Best' fabric, MVHR, PV, biomass block heating – flat 'Best' fabric, MVHR, PV, individual biomass boilers – houses	101%	101%	101%	101%
14	100%	'Best' fabric, MVHR, PV, community gas CHP	100%	101%	101%	101%
15	ZCH	'Best' fabric, MVHR, PV, community gas CHP	185%	172%	163%	151%

16	ZCH	'Best' fabric, MVHR, PV, community biomass CHP	186%	173%	162%	152%
17	ZCH	'Best' fabric, MVHR, PV, biomass block heating – flat 'Best' fabric, MVHR, PV, individual biomass boilers – houses	185%	172%	161%	151%

Note 1 – The 'Good+' and 'Better+' fabric packages describe fabric specifications that are in the range between Good to Better and Better to Best, respectively. These packages have been defined in order to closely match the DER reductions required by Code Levels 1 & 2, in cases where the 'Good', 'Better' and 'Best' packages do not provide a close match (e.g. for the terrace house type, the 'Good' fabric specification falls short of the 10% DER/TER improvement required at Code Level 1, whereas the 'Better' package is adequate to meet Code Level 2).

Due to the requirement to deal with unregulated emissions, to achieve Code 6 (ZCH) the target improvements of DER over TER are 184%, 171%, 160%, and 150% for the flat, terraced, semi-detached, and detached houses respectively.

The capital costs associated with each of the Ene 1 options described in Table 11 are shown in Figure 2. Capital costs are shown for each house type. Note that the cost of a number of these energy options, in particular those that involve an element of site-wide infrastructure such as a heating network, vary depending on the nature of the development the particular development. For the purposes of the chart shown below, a development scenario has been selected where all energy options are available (i.e. there is sufficient scale and density for site-wide systems to considered) and each house type is represented.

Assumptions on the cost of the technologies and sizing methods used are given in the Appendices (Section 10).

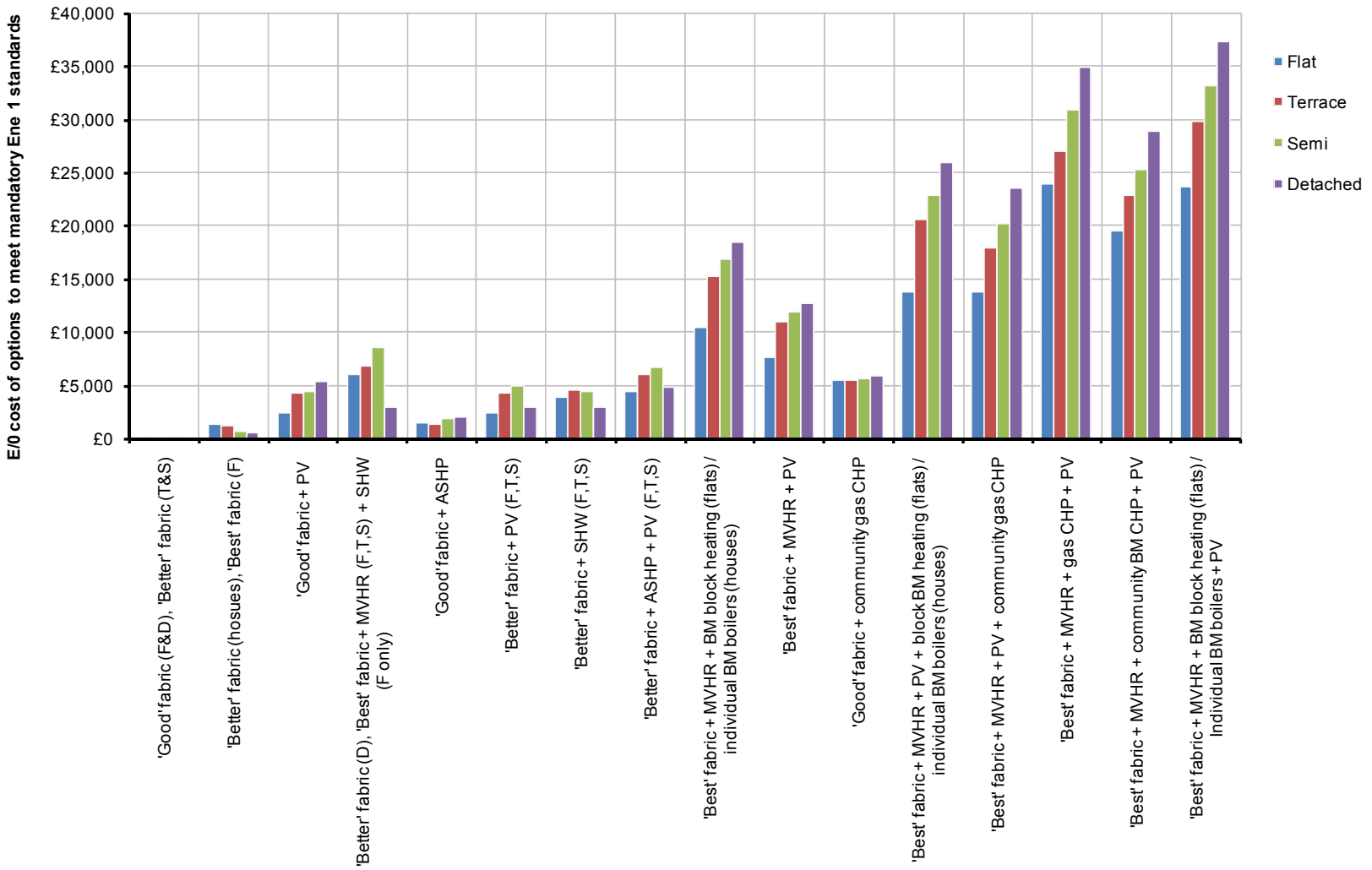


Figure 2: Variation in extra-over cost of energy strategy for each house type in a Large Urban development scenario

6.1.2 Other Issues in the Energy Category

With up to 15 credits available, the DER issue (Ene 1) accounts for the majority of credits in this category. However, there are a further 14 credits allocated against the remaining eight issues, which are summarised below.

Table 12: Energy issues

Issue	*Credits available*	*Scoring criteria*
Ene 1 – DER	15	Credits awarded based on percentage improvement of DER over TER.
Ene 2 – Building Fabric	2	Credits for achieving a heat loss parameter below given levels: HLP ≤ 1.3 = 1 credit, HLP ≤ 1.1 = 2 credits.
Ene 3 – Internal Lighting	2	Credits based on percentage of internal light fittings that are dedicated energy efficient: ≥40% = 1 credit, ≥75% = 2 credits.
Ene 4 – Drying Space	1	Provide adequate drying space (see Technical Guide).
Ene 5 – Eco-labelled White Goods	2	1 credit if fridges and freezers have an A+ rating. 1 further credit if washing machines/dishwashers have an A rating and/or washer-driers have a B rating. If such goods are not supplied, 1 credit is awarded for supplying information on the benefits of selecting efficient white goods.
Ene 6 – External Lighting	2	1 credit if all external lighting is provided by dedicated energy efficient fittings. 1 credit if all security light fittings are designed for energy efficiency and are adequately controlled.
Ene 7 – LZC Energy Technologies	2	1 credit if LZC technology leads to 10% (or greater) reduction in carbon emissions. 2 credits if LZC technology gives a 15% (or greater) reduction in carbon emissions.
Ene 8 – Cycle Storage	2	Up to 2 credits for providing adequate safe, weatherproof cycle storage facilities.
Ene 9 – Home Office	1	1 credit for providing sufficient space and services to allow a room to be set up as a home office.

The costs of achieving certain heat loss parameters derives from the cost of the fabric improvement packages and are given in appendix 1 (see Section 9). Credits may be scored against Ene 7 as a result of the package of energy measures adopted to achieve the mandatory requirement of Ene 1, and hence the costs of these credits are included in the cost of those packages.

Table 13: Cost of credits in the Energy category

Issue	*Requirement*	*Cost/dwelling*
Ene 1 – DER	Meet DER improvement target for given dwelling	For cost of Ene 1 options see appendix 2
Ene 2 – Building Fabric	Achieve given HLP targets	Dependent on fabric improvement package – see appendix 1
Ene 3 – Internal Lighting	Increase proportion of dedicated energy efficient light fittings	£10 per additional energy efficient fitting
Ene 4 – Drying Space	Provide adequate drying space	£15 for internal tidy-dry over bath
Ene 5 – Eco-labelled White Goods	High efficiency ratings	£150 Assume £50 per unit and three units per dwelling[11]
	Information on benefits of efficient white goods	£5
Ene 6 – External Lighting	All energy efficient fittings	£0
	Sensors, timers etc	£45
Ene 7 – LZC Energy Technologies	Reduce CO_2 emissions by 10% or 15%	Cost included in cost of Ene 1 options
Ene 8 – Cycle Storage	Provide adequate storage	£200 for flat (communal storage) £650 for terrace / semi (shed) £900 for detached house (shed)
Ene 9 – Home Office	Provide space and services	£80

[11] Based on the assumption that the developer provides white goods as part of the base build. If this is not the case, the cost of white goods should also be included if this credit is sought.

6.2 Water

As for the first Energy issue, Dwelling Emission Rate, the internal water consumption issue has an increasing mandatory requirement. In order to meet each of the water consumption targets, packages of water-saving measures were defined in conjunction with the Code Water Calculator Tool. The tables below summarise the credits available for achieving increasingly stringent water consumption targets and the measures required.

Table 14: Packages of measures to achieve Wat 1 credits – detached house

Measure	*Water Consumption litres/person/day (CSH credits)*				
	120 (1)	*110 (2)*	*105 (3)*	*90 (4)*	*80 (5)*
6/4 litre low flush WCs	✓	✓			
4/2.5 litre low flush WCs			✓	✓	✓
2 litre/min washbasin taps	✓	✓	✓	✓	✓
9 litre/min shower	✓				
7.5 litre/min shower		✓			
7 litre/min shower			✓	✓	✓
120 litre bath	✓	✓	✓		
100 litre bath				✓	✓
6 litre/min kitchen taps	✓	✓	✓	✓	✓
Rainwater harvesting				✓	
Greywater recycling					✓
Water efficient washing machine					✓

Table 15: Packages of measures to achieve Wat 1 credits – flat, terraced, semi-detached

Measure	*Water Consumption litre/person/day (CSH credits)*				
	120 (1)	*110 (2)*	*105 (3)*	*90 (4)*	*80 (5)*
6/4 litre low flush WCs	✓				
4/2.5 litre low flush WCs		✓	✓	✓	✓
2 litre/min washbasin taps	✓	✓	✓	✓	✓
9 litre/min shower					
7.5 litre/min shower	✓	✓			
7 litre/min shower			✓	✓	✓
120 litre bath	✓	✓			
100 litre bath			✓	✓	✓
6 litre/min kitchen taps	✓	✓	✓	✓	✓
Rainwater harvesting				✓	
Greywater recycling					✓
Water efficient washing machine					✓

The above packages of fittings were priced based on cost data received from developers and the costs of each package of measures are shown below.

Table 16: Cost of meeting internal water consumption targets

Water consumption (litres/person/day)	*Extra over cost*			
	Flat	*Terraced*	*Semi*	*Detached*
120	£0	£0	£0	£0
110	£0	£0	£0	£0
105	£200	£200	£200	£240
90	£1,550	£3,200	£3,200	£3,500
80	£1,750	£4,200	£4,200	£4,500

All of the fittings in the packages required to achieve water consumption of 120 and 110 litres/person/day can be obtained at no extra cost, since most of these fittings are now adopted as standard by developers.

Achieving a water consumption of 105 litres/person/day would incur an additional cost that relates to specifying more water efficient fittings that are not yet mainstream in the market. Developers reported various costs, with an average of £200. It is worth noting that certain developers, especially the volume house builders, reported that this specific package would incur no extra cost based on volume orders and due to the fact that the Code 3 minimum requirements are set as standard specifications.

Low flow fittings combined with rainwater harvesting (individual or communal) is sufficient to achieve 90 litres/person/day consumption. Costs listed are for an individual system for houses and a communal system for flats. A communal system may be available for houses (specifically for terraced) and could be a lower cost solution than the individual system.

A greywater recycling system is required to achieve the Code 6 level of 80 litres/person/day. This must be accompanied by a water efficient washing machine. Costs listed are for an individual greywater recycling system for houses and a communal system for flats. No extra cost is given for the washing machine, since if it is part of the base build, then upgrading to a water efficient model would not incur extra cost. If the washing machine is not part of the base build, the cost would then be part of achieving the Ene 5 credit (eco-labelled white goods).

The credit under the Wat 2 issue, external water consumption, may be achieved by specifying a water butt. An extra over cost of £50 per house is used based on a 200 litre water butt and assuming that roof to ground piping is part of the existing roof drainage system. For flats, it was assumed that two water butts per block would be sufficient (at a cost of £100) and the per dwelling cost was found by dividing this figure by number of flats per block.

6.3 Materials

A common feature of the responses received during the consultation was the lack of data on extra over cost of achieving credits in the materials category. The general approach towards acquiring materials credits is that points are gained for the base specifications where possible. Where specifications can be slightly altered to gain extra points, then the enhanced specifications are adopted as long as no significant extra cost is incurred. Trying to achieve all points available would most likely mean a drastic change in specifications, construction and supply for certain developers, leading to a significant cost and unquantifiable impact to the developer. This implies that the maximum credits are not likely to be sought, at least for Code levels 3 and 4.

The base specifications for the dwellings considered in this study would ensure that 9 credits are achieved in the Mat 1 category. It is assumed for the purpose of this study that 4 credits and 2 credits can be achieved for no extra cost under Mat 2 and Mat 3 respectively.

Table 17: Cost of credits in the Materials category

Issue	*Scoring*	*Cost / dwelling*
Mat 1: Environmental Impact of Materials	Higher Green Guide rating – up to 9 credits	£0
	Higher Green Guide rating – additional 6 credits	Unquantifiable
Mat 2: Responsible Sourcing – Basic Elements	Up to 4 credits	£0
	Additional 2 credits	Unquantifiable
Mat 3: Responsible Sourcing – Finishing Elements	Up to 2 credits	£0
	Additional 1 credit	Unquantifiable

6.4 Surface Water Run-off

The mandatory requirement of this category forces the developer to ensure that the peak run-off rate of water into watercourses is no greater for the developed site than it was for the site pre-development. The industry consultation revealed no significant cost to meet this condition; hence for this study it is assumed

that there is no extra over cost to achieve the uncredited requirement. Reducing surface water run-off and mitigating flood risk is often governed by planning conditions and hence is not an extra over cost due to the Code. The credited issues in this category are shown in the following table.

Table 18: Surface water run-off issues

Issue	*Credits available*	*Scoring criteria*
Sur 1 – Surface Water Run-Off Management	2	2 credits are awarded if SUDS are used to improve the quality of discharged rainwater or if the quality of receiving waters is protected.
Sur 2 – Flood Risk	2	2 credits available for developments situated in low flood risk areas, if Flood Risk Assessment indicates there is a low risk of flooding from all sources. 1 credit is available for developments in areas with a medium or high annual probability of flooding if floors and access routes are raised by at least 600mm above the design flood level of the flood zone.

Costs for flood mitigation are not easily quantified; however a study for the Association of British Insurers in 2005 identified benchmark costs for incorporating flood resilient materials on ground floors.

Table 19: Cost of credits in the surface water run-off category

Credit	*Requirement*	*Cost*
Sur 1: Management of Surface Water Run-off	Sustainable Drainage Systems	£1,100 per site[12]
Sur 2: Flood risk	Flood risk assessment	£30 – £50 per dwelling
	Flood risk mitigation[13]	£4,160 per flat £16,635 per house

The high cost of measures in this category suggests it is unlikely that developers would seek these credits, unless required by a development/planning condition, or when Code level 5 or 6 is sought.

Feedback from the industry consultation implied that the flood risk assessment is a zero extra over cost activity, but others provided a cost in the range of £30 to £50 per dwelling, based on fees for carrying out the flood risk assessment including surveys. In addition, most developers did not report a cost for sustainable drainage systems, due to either being naturally compliant with the requirement or because specific cost data for specific sites was lacking. A cost of £1,100 per dwelling was reported by one developer, based on whole site SUDS measures.

6.5 Waste

The first uncredited mandatory requirement in the Waste category stipulates that space able to accommodate containers with at least the minimum volume recommended by British Standard 5906 must

[12] As reported by one developer only.
[13] Cost for houses based on data from Association of British Insurers report: http://www.abi.org.uk/display/File/Child/554/Making_Communities_Sustainable_housingsummary.pdf Costs for flats assuming four storey blocks.

be allocated for waste storage. Space provision for non-recyclable waste is considered to be part of the base specifications, hence no additional costs are included to meet this requirement. The second mandatory requirement is for a Site Waste Management Plan (SWMP) to be implemented to monitor and report on waste generated on site. A Site Waste Management Plan is a legal requirement on all major sites[14] in England and Wales and therefore represents no extra cost.

A total of seven credits are available against voluntary issues in this category.

Table 20: Waste issues

Issue	*Credits available*	*Scoring criteria*
Was 1 – Waste Storage	4	2 credits awarded for providing dedicated internal storage for recyclable household waste (at least three internal storage bins, of at least 15 litres capacity each, with a minimum total capacity of 60 litres). 4 credits for providing adequate internal storage with either a Local Authority collection scheme, or adequate external storage capacity.
Was 2 – Construction Site Waste Management	2	1 credit if the SWMP includes procedures and commitments to reduce waste generated on site in accordance with best practice and defined waste groups. 1 further credit if waste is sorted and diverted from landfill.
Was 3 – Composting Facilities	1	1 credit for providing individual home composting facilities or a local / community composting service (run by Local Authority).

None of the respondent developers provided costs for external recyclable waste storage, since most Local Authorities have a collection scheme in place, which in addition to the internal storage space is sufficient to achieve all available credits under Was 1.

It is in developers' interest to reduce waste generated and to reclaim / recycle materials on site as achieving best practice in this area reduces the demand for materials and reduces the need for waste disposal, which is becoming an increasingly costly activity. Achieving the maximum credits against Was 2 is therefore assumed to be free. This assumption was validated by the feedback received from developers in the consultation.

Table 21: Cost of credits in the Waste category

Credit	*Requirement*	*Cost / dwelling*
Was 1: Waste Storage	Internal recyclable waste storage	£25
	External recyclable waste storage	N/A
Was 2: Construction Waste Management	Site Waste Management Plan	£0
	Waste reduction/recovery	£0
Was 3: Composting Facilities	Garden composter for houses and internal composter for flats	£50 per house £30 per flat

[14] The SWMP regulations are applicable to any development of value greater than £300k which applies to all developments reviewed for this study.

6.6 Pollution

Four credits are available in this category, which covers the global warming potential (GWP) of insulants and NO_x emissions from the heating system.

Table 22: Pollution issues

Issue	*Credits available*	*Scoring criteria*
Pol 1 – GWP of Insulants	1	1 credit if all materials in certain key elements of the dwelling only use substances with a GWP<5 in manufacture and installation.
Pol 2 – NO_x Emissions	3	Credits awarded based on NO_x emissions from the space heating and hot water systems: Dry NO_x level (mg/kWh) ≤ 100 = 1 credit. Dry NO_x level (mg/kWh) ≤ 70 = 2 credits. Dry NO_x level (mg/kWh) ≤ 40 = 3 credits.

Compliance with the GWP requirement for insulation materials can be achieved at no extra cost, as confirmed by all respondent developers. Individual gas boilers with NO_x emissions lower than 40mg/kWh are now standard for many developers and hence no extra cost is incurred to achieve all 3 credits for Pol 2. It is worth noting that it is not possible to achieve any of these 3 credits where biomass boilers (individual or site wide) are adopted. This is due to the relatively high NO_x emissions resulting from burning biomass or other types of biofuel.

Table 23: Cost of credits in the Pollution category

Credit	*Requirement*	*Cost / dwelling*
Pol 1: Insulant GWP	GWP of materials in key elements is less than 5	£0
Pol 2: NO_x emissions	Reduction of NO_x emissions below 100, 70 or 40 mg/kWh	£0

6.7 Health & Well-Being

A total of 12 credits are available in the Health & Well-Being category, against four distinct issues as shown below.

Table 24: Health & Well-Being issues

Issue	*Credits available*	*Scoring criteria*
Hea 1 – Daylighting	3	1 credit if kitchens achieve a minimum average daylight factor of at least 2%. 1 credit if all living and dining rooms achieve a minimum average daylight factor of at least 1.5%. 1 credit if 80% of the working planes in kitchens, living rooms, dining rooms and studies receive direct light from the sky.
Hea 2 – Sound Insulation	4	Credits awarded based on improvement in sound insulation above Part E: 3dB improvement = 1 credit. 5dB improvement = 3 credits. 8dB improvement = 4 credits. Detached dwellings are awarded 4 credits by default.
Hea 3 – Private Space	1	1 credit for providing private or semi-private outdoor space that allows all occupants to sit outside, allows easy access to all occupants (including wheelchair users) and is accessible only to occupants of designated dwellings.
Hea 4 – Lifetime Homes	4	4 credits for complying with all principles of Lifetime Homes (see Technical Guide for details).

On some developments, the clear view of the sky is achieved by default, however, it might be impossible to achieve on others due to site constraints and unavoidable blockages. Nevertheless, careful layout at the design stage that takes into consideration the clear view of the sky requirements can lead to achieving the credit at no extra cost.

Developers provided mixed responses to the cost of achieving the required average daylight factors in living rooms and kitchens. Some developers are revising their designs to ensure sufficient glazing is provided to achieve both credits for daylight factors at a zero cost in future developments. For non compliant designs, an average additional cost of £150 is allowed for extra glazing in kitchens and the same is allowed for extra glazing in living rooms. It is assumed that detached houses have more external wall exposure and hence larger windows are expected to be part of the design, leading to compliance with the required daylight factors.

Several developers reported that a 3dB and a 5dB improvement in sound insulation can be achieved at zero extra cost; however more robust details are required to achieve an 8dB improvement leading to extra works and higher costs. The costs presented in the table below for Hea 2 cover sound testing costs only per dwelling (based on testing requirements in Approved Document E) for the 3dB and 5dB improvements, and sound testing costs and improved details for the 8dB improvement.

Table 25: Cost of credits in the Health & Well-Being category

Credit	*Requirement*	*Cost / dwelling*
Hea1: Daylight	Achieve view of the sky	£0
	Daylight factors in kitchen of 2%	£150
	Daylight factors in living rooms of 1.5%	£150 in flats, terraced, semi £0 in detached
Hea2: Sound insulation	3dB improvement	£150 for a flat £100 for terraced & semi
	5dB improvement	£150 for a flat £100 for terraced & semi
	8dB improvement	£250 for a flat £200 for terraced & semi
Hea 3: Private Space	Provide a private or semi-private outdoor space	£0
Hea 4: Lifetime Homes	Comply with all principles of Lifetime Homes	£75 for a flat £235 for houses

Feedback from developers revealed a significant level of uncertainty in the cost of meeting Lifetime Homes standards. The costs used in this study are based on data from published studies.[15]

Table 26: Cost breakdown for Lifetime Homes

Measure	*Cost of measure / dwelling*	*Measure part of standard specification (✓ = 'yes')*			
		Flat	*Terraced*	*Semi*	*Detached*
Entrance level WC	£120	✓	✓	✓	✓
Bathroom/WC walls	£50	-	-	-	-
Entrance level bed space	£100	✓	-	-	-
Provision of space for a stair lift or through floor lift	£60	✓	-	-	-
Tracking hoist route	£25	-	-	-	-
Increasing 2 bed house area to 70m^2	£192	✓	✓	✓	✓
Lift in low-rise flats	£1,190	✓*	✓	✓	✓

[15] Reference report(s).

* It was assumed that a lift would be part of the standard specification in any development with more than c. 10 flats. The cost of a lift was included for those developments with a small number of flats – i.e. for development scenarios 1 and 2.

The cost of the above measures was included for each dwelling type only if the measure was not part of the standard specification.

6.8 Management

This category covers issues from monitoring and reducing the impact of the construction site to providing occupants with information to allow them to operate their home efficiently.

Table 27: Management issues

Issue	*Credits available*	*Scoring criteria*
Man 1 – Home User Guide	3	2 credits for providing a home user guide (in accordance with the checklist given in the Technical Guide). 1 further credit if the guide also includes information relating to the site and its surroundings.
Man 2 – Considerate Constructors Scheme	2	1 credit for committing to meet best practice under a recognised certification scheme. 2 credits for committing to go significantly beyond best practice under a recognised certification scheme.
Man 3 – Construction Site Impacts	2	1 credit for implementing procedures to cover two items such as energy and water use from site activities, dust pollution, etc (see Technical Guide for full list). 2 credits for implementing procedures to cover four or more items.
Man 4 – Security	2	2 credits for consulting an Architectural Liaison Officer or Crime Prevention Design Advisor at the design stage and following their recommendations.

Most of the Code requirements for the home user guide can be obtained through preparing the Home Information Pack, hence no extra cost is incurred in achieving the first 2 credits of Man 1. For achieving the third credit, extra time, and hence extra cost, is allowed for collecting site/locality information. A £500 extra over cost is an average additional cost per site for achieving the third credit.

The Considerate Constructors Scheme is common on all sites and hence developers comply with the scheme as part of standard practice. Furthermore, the consultation with developers suggested that exceeding the best practice threshold of the scheme can also be attained at zero cost.

Most developers gain the first credit of Construction Site Impacts easily and at zero cost. The measures usually adopted are air pollution and water pollution reductions. However not all developers adopt as standard the extra measures of monitoring and reporting CO_2 production and water consumption. An average extra cost of £1,000 per site is reported, covering the extra monitoring of CO_2 and water consumption on site.

Costs of achieving the Security credits are those for upgrading window/doors/fencing specifications to meet the required security standards. Such standards are not generally adopted as base specifications amongst developers.

Table 28: Cost of credits in the Management category

Credit	Requirement	Cost
Man 1: Home Use Guide	Provision of user guide	£0
	Provision of user guide including information related to site and surroundings	£500 per site
Man 2: Considerate Constructors	Commitment to meet best practice and exceed best practice	£0
Man 3: Construction Site Impacts	Procedures to cover 2 items	£0
	Procedures to cover 4+ items	£1,000 per site
Man 4: Security	Appoint an ALO and comply with Secure by Design standards for windows/doors	£450 for flats £515 for terraced/semi £650 for detached

6.9 Ecology

The final Code category is Ecology, which offers the potential for up to nine credits to be attained.

Table 29: Ecology issues

Issue	Credits available	Scoring criteria
Eco 1 – Ecological Value of Site	1	1 credit awarded if the development site is on land confirmed as being of low ecological value.
Eco 2 – Ecological Enhancement	1	1 credit awarded for appointing a suitably qualified ecologist and adopting all key recommendations and 30% of additional recommendations.
Eco 3 – Protection of Ecological Features	1	1 credit for adequately protecting all existing features of ecological value during site clearance, preparation and construction works.
Eco 4 – Change in Ecological Value	4	The site's ecological value is measured before and after development and credits are awarded based on overall change in species per hectare: Minor negative change = 1 credit. Neutral = 2 credits. Minor enhancement = 3 credits. Major enhancement = 4 credits.
Eco 5 – Building Footprint	2	Issue assessed on a site-wide basis. 1 or 2 credits awarded based on net internal floor area : net internal ground floor ratio.

Achieving a maximum number of Ecology credits is site specific to a great extent, however the developer can adopt a proactive approach to the site ecology and achieve credits under ecological protection and enhancement. Conducting an ecological survey, which is a prerequisite to most ecology credits, often falls under planning requirements. It is assumed that in medium and large developments an ecologist would be employed as standard, hence the cost of conducting the survey, which covers ecologist fees, is

not considered an extra cost for most development scenarios. However, an ecologist would not necessarily be employed as standard in small developments and an extra over cost of £1,000 per site is assumed to cover an ecologist's fees in the small brownfield, city infill, small infill, small greenfield, and small edge of town developments.

The model assumes that credits under Eco 2, Eco 3 and Eco 4 are only available if an ecologist has been employed. While protection of ecological features is an inexpensive activity and hence developers reported it as a zero cost credit, ecological enhancement does incur extra cost and £100 per dwelling is allowed for basic enhancement measures such as bird boxes. The change in ecological value (Eco 4) depends on the change in number of species on site as a result of development. It is assumed that up to two credits may be achieved at zero extra over cost (provided an ecologist has been employed) under Eco 4, and extra costs of £10 and £15 are allowed for planting native plant species to achieve three and four credits respectively.

No cost is allocated for achieving either one or two credits under Eco 5, building footprint. Whether or not these credits are achieved is a site-dependent issue and the method defined in the Technical Guide was followed to determine the number of credits awarded against this issue on a development-by-development basis.

Table 30: Cost of credits in the Ecology category

Credit	*Requirement*	*Cost/dwelling (£)*
Eco 1: Ecological Value of Site	Confirm site is of low ecological value	£0
Eco 2: Ecological Enhancement	Follow and implement recommendations of ecologist	£100 £1,000 per site is also added for small developments to cover cost of employing ecologist
Eco 3: Protection of Ecological Features	Protect ecological features during construction Credits only available if ecologist is employed	£0
Eco 4: Change in Ecological Value	Level of negative or positive change in ecological value after development Credits only available if ecologist is employed	£0 for 2 credits £10 for 3 credits £15 for 4 credits
Eco 5: Building footprint	Floor area : net internal ground floor area ratio	£0

7 ASSESSMENT OF THE COST OF BUILDING TO THE CODE

This section presents the results of the analysis of costs of building to each level of the Code for Sustainable Homes in each of the four typical dwelling types and in the range of twelve development scenarios. Unless otherwise stated, the costs presented are the extra-over costs from a baseline of building a 2006 Building Regulation compliant home and assume the home is built in 2009. The results presented here are a summary of the outputs of extensive cost modelling. A full set of results are provided in the Appendices (see Section 12).

It will be seen that a dominant factor in the overall Code cost is the cost of meeting the mandatory requirements for reduction of the Dwelling Emissions Rate at each Code Level. To reflect the importance of costs under the Energy category, this section begins with a detailed discussion of the energy options available at the various Code levels and their associated cost implications.

7.1 Introduction

The Code is flexible in that credits can be gained against many different issues, and hence a wide range of alternative approaches may be taken to achieve Code compliance. The modelling approach used (described in section 4) facilitated an analysis of the sensitivity of the overall cost to many of the input variables. For example, the total cost of meeting a given Code level might be expected to vary with approach taken to meeting the required DER, scale of development, characteristics of the development site, standard practice of the developer etc.

However, certain features will be common to all dwellings built to a given Code level, as dictated by the mandatory issues. The uncredited mandatory issues discussed in section 3.2 must be met regardless of Code level sought. These include environmental impact of basic elements (Mat 1), surface water run-off management (Sur 1), waste storage (Was 1), and construction waste management (Was 2).

In addition to the uncredited mandatory issues, a number of increasingly stringent credited mandatory issues must also be satisfied to comply with the Code, as summarised in the following table.

Table 31: Summary of credited mandatory requirements by Code level

Code level	*Mandatory issue (credited)*	*Mandatory requirement*
1	Ene 1 – Dwelling Emission Rate	Achieve a 10% improvement relative to TER
	Wat 1 – Internal Water Consumption	Water consumption not to exceed 120 litres/person/day
2	Ene 1 – Dwelling Emission Rate	Achieve an 18% improvement relative to TER
	Wat 1 – Internal Water Consumption	Water consumption not to exceed 120 litres/person/day
3	Ene 1 – Dwelling Emission Rate	Achieve a 25% improvement relative to TER
	Wat 1 – Internal Water Consumption	Water consumption not to exceed 105 litres/person/day
4	Ene 1 – Dwelling Emission Rate	Achieve a 44% improvement relative to TER
	Wat 1 – Internal Water Consumption	Water consumption not to exceed 105 litres/person/day
5	Ene 1 – Dwelling Emission Rate	Achieve a 100% improvement relative to TER
	Wat 1 – Internal Water Consumption	Water consumption not to exceed 80 litres/person/day
6	Ene 1 – Dwelling Emission Rate	Achieve a ZCH emission rating

	Ene 2 – Building Fabric	Building's HLP to be ≤ 0.8W/m^2K
	Wat 1 – Internal Water Consumption	Water consumption not to exceed 80 litres/person/day
	Hea 4 – Lifetime Homes	Comply with all principles of Lifetime Homes

7.2 Energy Strategies options

There are a wide variety of approaches that house-builders could adopt to achieve the maximum dwelling emissions rate (DER) requirements of each level of the Code. Whatever technical approach is taken, the costs of achieving the mandatory DER requirement (i.e. the cost of gaining credits under Ene 1) is likely to dominate the overall costs of achieving a particular Code level.

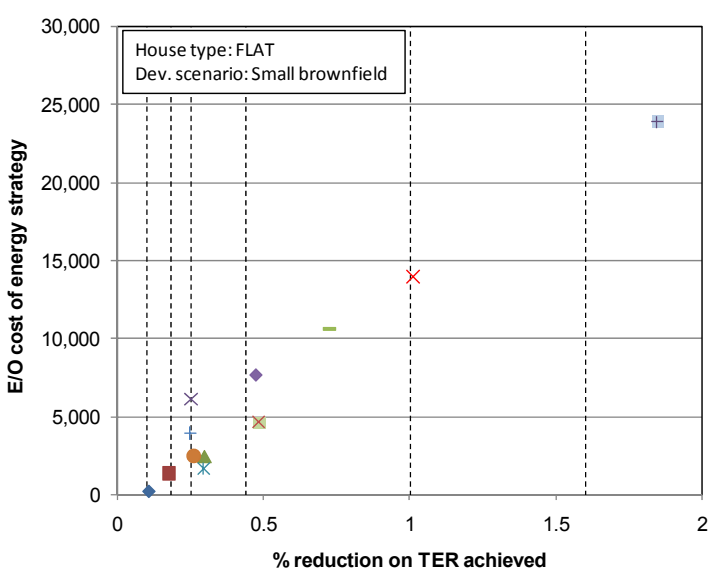
At lower levels of the Code, the mandatory DER levels stipulated under Ene 1 can be met by improving the performance of the dwelling fabric. At higher Code levels, improved fabric performance must be combined with low or zero carbon generation technologies (LZCT) in order to meet the DER requirements. House-builders may choose to go further than the mandatory DER requirement of the target Code Level, although they are only likely to do this if the additional credits gained under Ene1 are more cost-effective than gaining credits under other categories.

A range of energy strategy options assessed in this study has been defined in Section 6.1 (see Table 11). The capital costs associated to each energy option are shown in Figure 2 for each house type and for a particular development scenario – the Large Urban (mixed brownfield) development scenario. A detailed description of the energy system options, including the required capacities of LZCTs, is given in the Appendices for the Medium Urban (brownfield) and Medium Edge of Town (greenfield) developments (see Section 10.3, Table 54 and Table 55).

The cost of each energy strategy varies between the house types, as the fabric costs and sizing and costs of LZCTs for any particular target DER will tend to be dependent on the size of the dwelling and its occupancy. The energy strategy cost will be largely independent of development scenario where the strategy involves fabric improvements and LZCTs at the individual dwelling scale (i.e. microgeneration technologies). However, where the energy strategy involves shared infrastructure, such as a district heating system, the cost will be dependent on the development type.

The energy strategy extra-over costs are plotted against the reduction of DER/TER they deliver in Figure 3. Plots are shown for the 2-bed flat and 3-bed semi dwelling types in a range of development scenarios. The plots highlight the general trend of increasing energy strategy extra-over costs with increasing reduction on TER and the variability of energy strategy extra-over cost at a particular DER/TER level, depending on the energy strategy chosen. These plots also allow the lowest cost energy strategy (of those assessed) at each Code Level to be identified.

At higher reductions on TER, consistent with Code Levels 5 and 6, energy strategies involving community heating infrastructure become more favourable. This is particularly the case in the higher density urban developments, where district heating infrastructure becomes more cost effective. For example, consider energy strategies to achieve a reduction of DER/TER of 1, i.e. the Code Level 5 minimum requirement. In the Strategic Greenfield development the lowest cost strategy is the dwelling-scale (or block-scale in the case of flats) biomass boilers with photovoltaics. In the Large Urban development, the gas CHP and district heating strategy becomes the more cost-effective approach to achieving this level of reduction of dwelling emissions rate.


House type: FLAT
Dev. scenario: Small brownfield
E/O cost of energy strategy
% reduction on TER achieved
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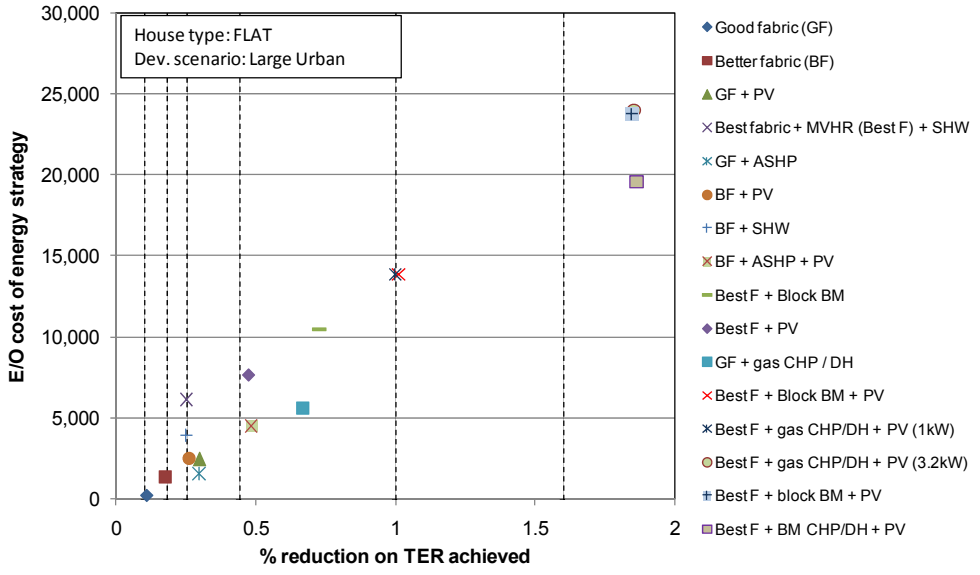
25,000
20,000
15,000
10,000
5,000
0
0
0.5
1
1.5
2


House type: FLAT
Dev. scenario: Large Urban
E/O cost of energy strategy
% reduction on TER achieved
Good fabric (GF)
Better fabric (BF)
GF + PV
Best fabric + MVHR (Best F) + SHW
GF + ASHP
BF + PV
BF + SHW
BF + ASHP + PV
Best F + Block BM
Best F + PV
GF + gas CHP / DH
Best F + Block BM + PV
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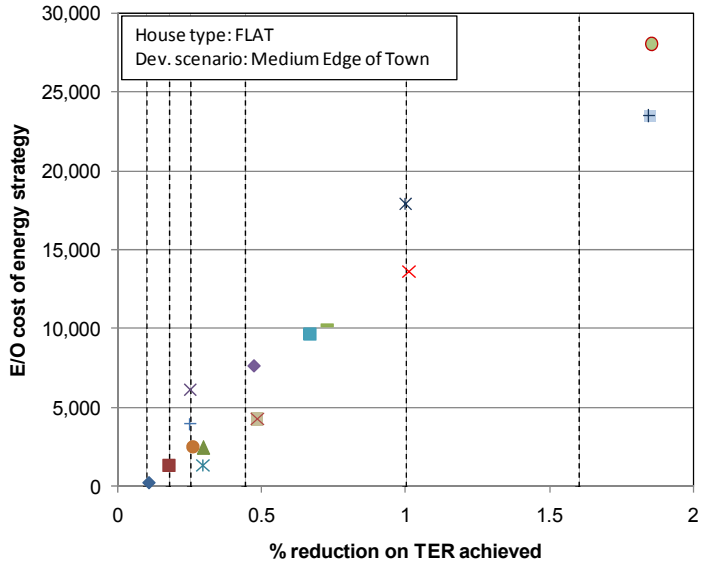
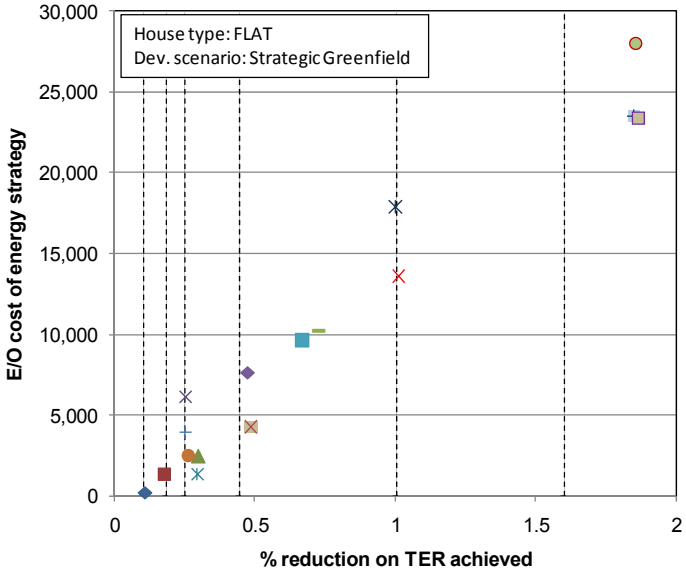
Best F + gas CHP/DH + PV (3.2kW)
Best F + block BM + PV
Best F + BM CHP/DH + PV


House type: FLAT
Dev. scenario: Medium Edge of Town
E/O cost of energy strategy
% reduction on TER achieved


House type: FLAT
Dev. scenario: Strategic Greenfield
E/O cost of energy strategy
% reduction on TER achieved

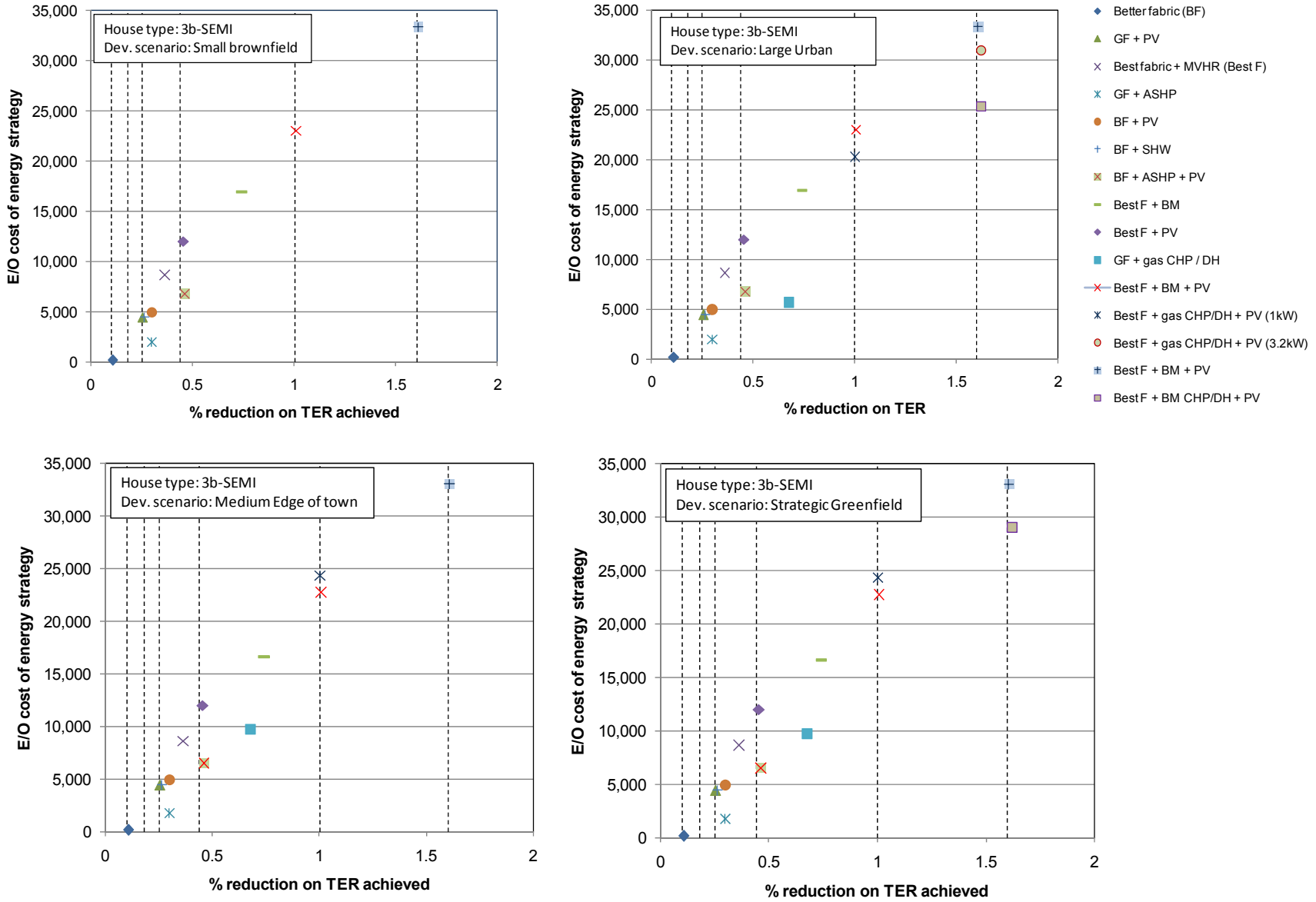


Figure 3: Plots of energy strategy E/O cost against reduction of DER/TER for a selection of dwelling types and development scenarios

For each development scenario, the energy strategy selection that results in the lowest overall cost of compliance with each Code Level has been identified. It is assumed in each case that the same energy strategy is applied to all dwelling types in the development. These lowest cost strategies are summarised in the tables in Figure 4, for each development scenario. Some of the key findings are discussed below:

- At Code levels 1 and 2, the mandatory reductions of DER/TER are most cost-effectively met by improving the fabric package. At Code Level 1, the Good fabric package provides the required level of improvement in the flat, semi and detached dwelling types. In the case of the terrace, a minor improvement over the good fabric package is necessary to achieve the 10% DER/TER reduction (an improvement of the external wall U-value from 0.25 to 0.2 $W/m^2.K$ and reduction in thermal bridging loss (y-value) from 0.08 to 0.06 $W/m^2.K$ is sufficient). The Code Level 2 DER/TER improvement is met by a slight variation on the 'Better' fabric package – a relaxation of the U-values specified in Table 9 is permissible in the case of the semi and detached dwelling types, whereas in the case of the flat a slight improvement on the 'Better' fabric specification is necessary (can be achieved by reduction of the thermal bridging loss from 0.04 to 0.02 W/m^2K).

- At Code level 3 the lowest cost energy strategy varies is the Good fabric package with Air Source Heat Pump (ASHP). The comparably low on-cost of this energy strategy is a result of the offset costs resulting from avoidance of a domestic boiler and a gas connection to the property. In the case of blocks of flats, the cost of the Good fabric with ASHP and Better fabric with PV strategies are very closely comparable.

- At Code Level 4 the lowest cost energy strategy varies between Better fabric with an ASHP and the Good fabric with community gas CHP, depending on the development type. Note that in some cases the Good fabric with community gas CHP provides the lowest overall cost of compliance, even though the Better fabric with ASHP is the least cost means of achieving a 44% reduction of DER/TER. This is because extra credits are awarded for providing a DER/TER improvement in excess of the minimum Code Level 5 standard at relatively little on-cost.

- At Code Level 5 in the higher density brownfield developments the least cost strategy is gas CHP linked to a district heating system, with photovoltaics to provide the additional CO_2 reduction. In the lower density greenfield development scenarios, this energy strategy is favoured for the large sites, but in the smaller scale developments a strategy of biomass boilers within individual properties is favoured (block-scale boilers for blocks of flats). This is a result of the economy of scale effects for CHP systems (i.e. reducing cost per kW with increasing installed capacity), which favours CHP based strategies on larger developments.

- At Code Level 6, site-wide biomass CHP and district heating systems provide the lowest cost approach to achieving the required reduction on TER (assuming the CHP system is operated to follow the heat-load, then photovoltaics will also be required to achieve the mandatory Code Level 6 standard). Due to the current lack of availability of biomass CHP systems at small-scale, alternative strategies are required for the small sites, for example individual biomass heating systems with photovoltaics. It is important to note that achieving the Code Level 6 mandatory CO_2 emissions standard on these small sites is very challenging. The area required for installation of sufficient PV capacity, for example, will not be feasible on many small-scale sites.

In addition to the challenges of meeting Code Level 6 mandatory CO_2 reduction standards on small-scale developments, it is interesting to note the reliance on biomass of the energy strategies that meet the highest levels of the Code (i.e. level 5 and 6). There are alternatives to biomass based strategies for achieving high Code levels that have not been included in the core list of energy strategies considered here. For example, integration of large-scale wind turbines may provide a cost-effective route to achieving high Code Levels, however, the developments that this strategy is applicable to will for the most part be limited to those on larger, rural sites. For this reason this has not been considered as a mass-market solution for achieving high Code Levels.

The costs associated with each of the energy strategies defined above for each dwelling type are shown in the charts in Figure 5. These charts demonstrate the variation in least cost approach to meeting the CO_2 requirement of each Code Level with the nature of the development, in terms of its scale and density.

Development Scenario	Lowest cost energy strategy at each Code Level					
	1	2	3	4	5	6
City Infill	Good fabric (F, S&D), Good+ fabric (T)	Better+ fabric (F), Better Fabric* (T) Good+ fabric (S,D)	Good fabric + ASHP	Best fabric + ASHP	Best fabric + Community gas CHP + PV	Best fabric + gas CHP + PV
Small brownfield				Good fabric + Community gas CHP		
Medium brownfield (mixed)				Best fabric + ASHP		Best fabric + community BM CHP + PV
Medium brownfield (flats)				Good fabric + Community gas CHP		
Large Urban (flats)						
Large Urban (mixed)						

Development Scenario	Lowest cost energy strategy at each Code Level					
	1	2	3	4	5	6
Small infill	Good fabric (F, S&D), Good+ fabric (T)	Better+ fabric (F), Better Fabric* (T) Good+ fabric (S,D	Good fabric + ASHP	Best fabric + ASHP	Best fabric + block BM (F) BM boilers (T,S,D) + PV	Best fabric + block BM (F) + PV BM boilers (T,S,D) + PV
Small Greenfield						
Medium Greenfield						
Medium edge of town					Best fabric + Community gas CHP + PV	Best fabric + community BM CHP + PV
Large edge of town						
Strategic Greenfield						

* To achieve Code Level 2 standard in flats, a fabric package slightly in advance of 'Better' would be required.

Figure 4: Summary of lowest cost energy strategy at each Code level for each development scenario

The costs associated with the lowest cost energy strategies at each Code Level and for each development scenario are shown in Figure 5 for the four house types. The costs shown in these plots have been derived assuming that a common energy strategy is applied to all dwellings within a development (where the energy strategy involves common infrastructure, the overall costs have been apportioned between the various dwelling types).

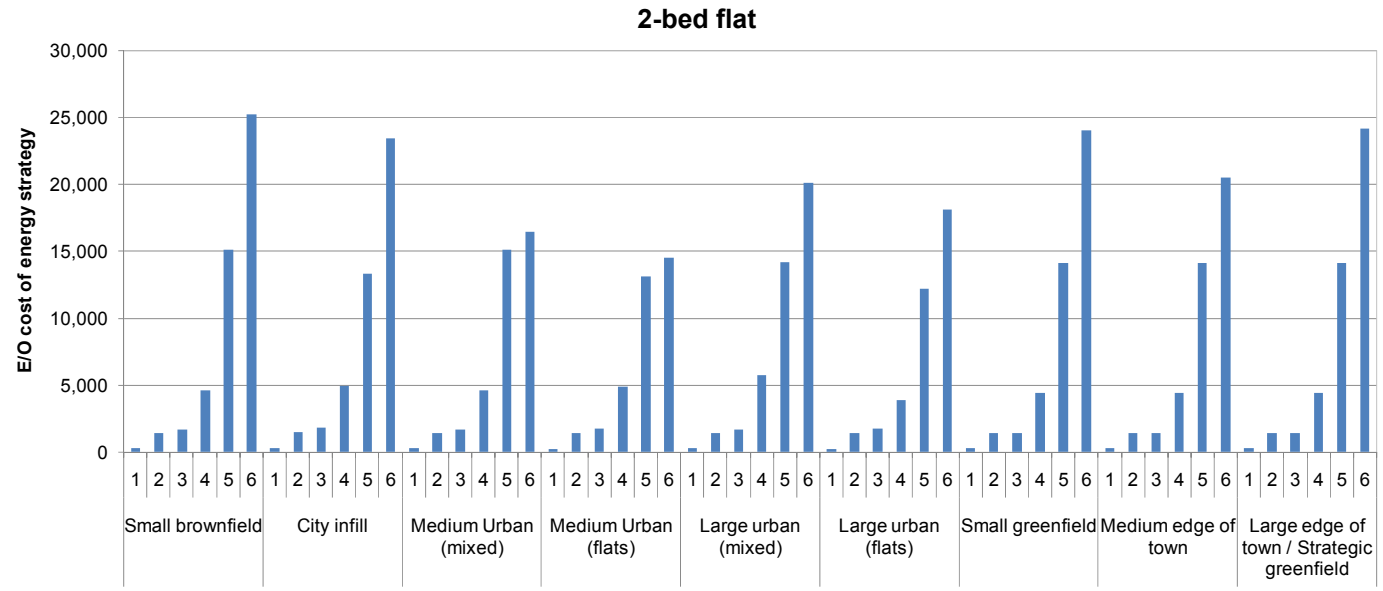
There is little variation in the energy strategy extra-over costs between development scenarios for Code Levels 1 to 3, as the lowest cost strategies involve technologies employed at individual dwelling scale (note the cost modelling does not account for the potential for cost reductions for larger orders, i.e. lager-scale developments or purchased by volume house-builders). There is some variation in the costs of energy strategy at these Code levels between the dwelling types, as the cost of fabric packages vary with dwelling scale as does the sizing of microgeneration technologies. A variation in the cost of energy strategy is seen at Code Level 4, as the least cost strategy varies between ASHP-based and community gas CHP based strategies. There is significant variation in the extra-over costs of the Code Level 5 and 6 energy strategies between the development scenarios, due to the effects of development scale and density on least cost solution selection and variations in technology costs with installed capacity.

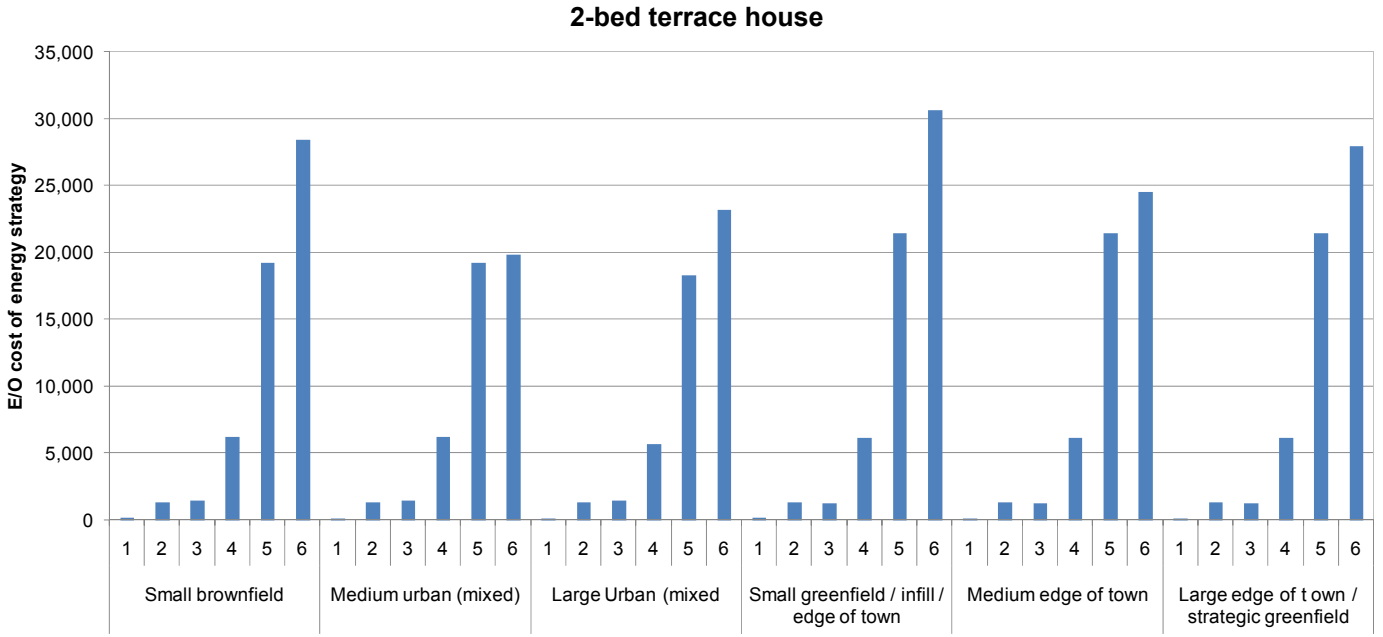
The extra-over cost of Code Level 3 compliant energy strategies varies in the range from £1,500 to £2,000. The least cost energy strategy at Code Level 4 (Best fabric with an air source heat pump or good fabric with community gas CHP, depending in the development scenario) has an associated extra-over cost of in the range from £4,750 to £6,000.

The extra-over cost of Code Level 5 compliant energy strategies is more than £15,000 for all development scenarios, with the exception of the flats, for which the extra-over cost of energy strategy in most development scenarios is in the range of £10,000 to £15,000. The highest energy strategy costs for Code Level 5 are found in larger house types in small greenfield developments, where the energy strategy is biomass heating in individual properties combined with photovoltaics (energy strategy extra-over costs of ~ £23,500 in the semi-detached dwelling type and just over £26,000 in the detached dwelling type).

The greatest variation in energy strategy extra-over cost is found at Code Level 6. The highest Code Level 6 energy strategy costs (more than £30,000 in large houses) are associated with the small-scale sites, particularly where density is low. Note that although costs are shown for Code Level 6 for each development scenario, the corresponding least cost energy solutions may not be technically feasible in many real site scenarios. For example, the capacity of photovoltaics that must be installed in combination with biomass boilers or gas CHP will not be practically accommodated in many small infill sites.

The extra-over costs of Code Level 6 compliant energy strategies are significantly reduced on sites where there is adequate scale. i.e. sufficient heat load, to justify the installation of a biomass CHP system. This is particularly the case on the higher density brownfield sites, for example large urban extensions that are predominantly flatted, where the cost of district heating network infrastructure per dwelling is reduced.


2-bed flat
E/O cost of energy strategy
30,000
25,000
20,000
15,000
10,000
5,000
0
1 2 3 4 5 6
Small brownfield
City infill
Medium Urban (mixed)
Medium Urban (flats)
Large urban (mixed)
Large urban (flats)
Small greenfield
Medium edge of town
Large edge of town / Strategic greenfield


2-bed terrace house
E/O cost of energy strategy
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1 2 3 4 5 6
Small brownfield
Medium urban (mixed)
Large Urban (mixed
Small greenfield / infill / edge of town
Medium edge of town
Large edge of t own / strategic greenfield

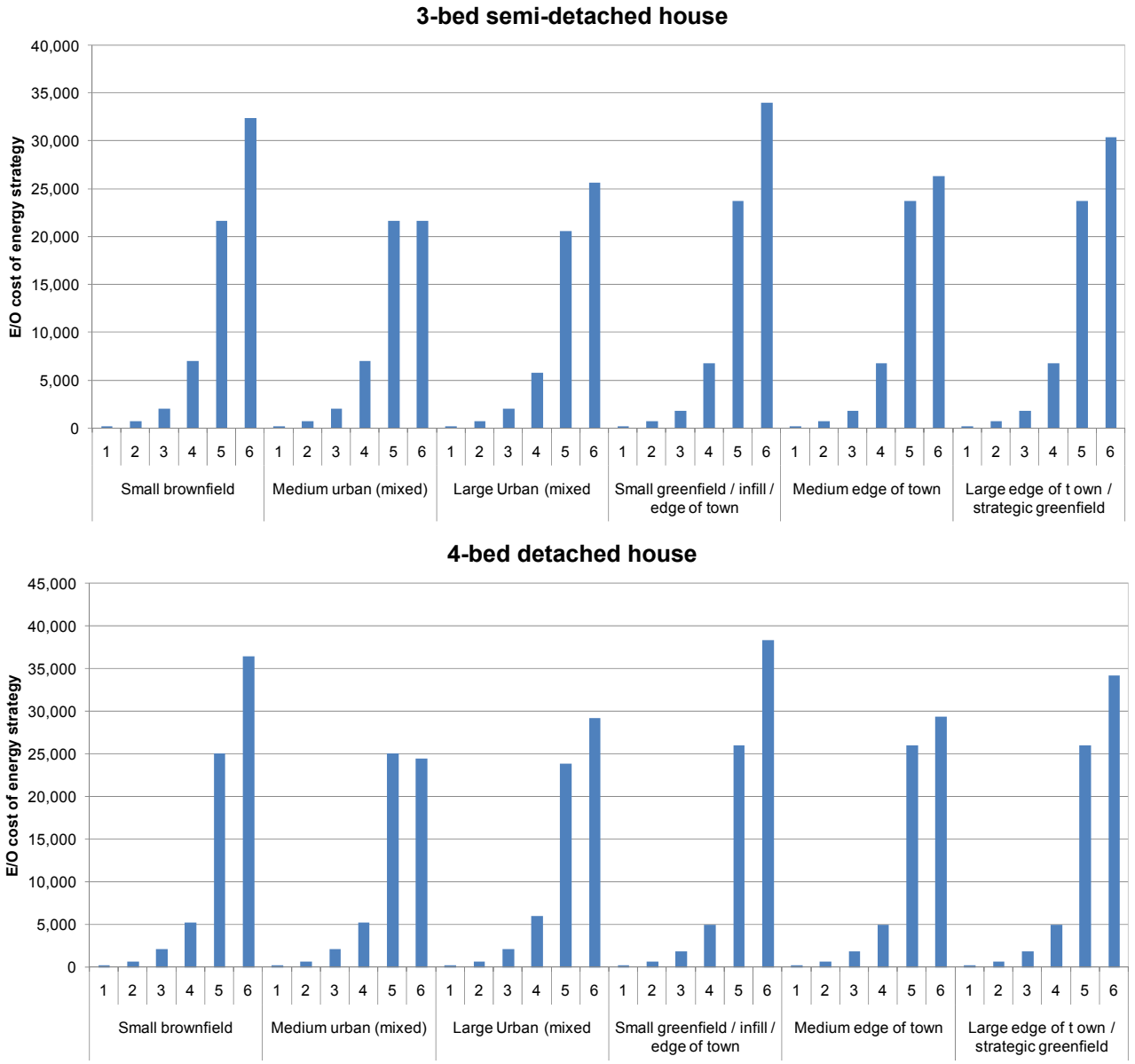


Figure 5: Variation of lowest cost energy strategy at each Code level with development scenario for each dwelling type

7.2.1 Energy strategy summary

A range of energy solutions, which provide reductions of DER/TER ranging from 10% to more than 150% (i.e. suitable to achieve the mandatory DER standard of Code Level 6) have been costed. Although this cannot be considered an exhaustive analysis of potential energy strategies, there are many possible configurations at each level of DER/TER, it is intended to represent a range of solutions that are likely to be popular choices among developers when constructing Code compliant developments. There are a number of other potential energy strategies that have been excluded from this core list, as their applicability will be limited to certain kinds of developments. These strategies include those based on large-scale wind turbines and ground source heat pumps. A discussion of these technologies is given in Section 7.3.2.

The analysis has shown that Code Levels 1 and 2 can be most cost-effectively achieved through improvement of the energy efficiency of the dwellings alone. The dwelling energy modelling has shown that the 'good' fabric package (see Table 9) is sufficient to meet the requirements of Code Level 1 in the flat, semi and detached dwelling types, but that a slight increase in fabric specification is required in the terrace (e.g. reduction in the wall U-value). The 'Better' fabric package , as defined in Table 9, is slightly short of reaching the Code Level 2 standard in the Flat dwelling type and significantly exceeds the required 18% reduction of DER/TER in the Semi and Detached dwelling types. Hence, variations on the 'Better' fabric package are likely to be used in practice to meet the Code Level 2 standard.

The energy modelling suggests that the Code Level 3 standard could be met by combination of either the Good or Better fabric package with some form of low carbon generation or by application of a very high – Best – fabric package. Due to the low air permeability standard and requirement of MVHR in the Best fabric package, it will generally be more cost-effective to combine a lower fabric standard with low carbon generation (note that in large houses, a fabric package similar to the Better standard may be sufficient to achieve a 25% reduction without low carbon generation). As shown in the charts in Figure 3, there are a number of fabric improvement plus low carbon generations options that are fairly closely clustered in terms of extra-over cost and DER/TER improvement provided, including the Good standard of fabric with an air source heat pump and the Better fabric standard combined with PV or solar hot-water heater. The lowest cost of these strategies has been found to be the Good fabric with ASHP in each of the development scenarios assessed, partly a result of the offset costs relating to avoidance of a boiler and gas connection. The use of efficient electric heating systems has the potential to deliver an increasing CO_2 benefit over time, as the electricity grid decarbonises over time (as a result of increasing renewable electricity generation or widespread implementation of carbon capture and storage at power stations). A large-scale shift from gas to electric heating will place significant extra load on the electricity transmission and distribution systems – the cost of grid reinforcement that may be required in certain locations has not been accounted for here.

Of the strategies considered, the lowest cost approach to meeting the Code Level 4 DER standard has been shown to be either a Good fabric standard with community gas CHP or a Better fabric standard with air source heat pump and PV (based on the defined dwelling types, the amount of PV required varies from zero in the detached house to 0.4 kW per flat for blocks of flats). The extra-over cost of these strategies varies from around £4,500 in flats up to £6,000 in the larger house types. The community heating based system provides the route to the lowest cost of Code compliance in several of the higher density brownfield development scenarios. In some cases even where the community gas CHP strategy is selected, the ASHP system is the lower cost route to achieving the 44% DER/TER reduction required at Code Level 4. In these cases, however, the extra credits awarded for providing the higher level of DER reduction achieved by the community gas CHP system (a DER/TER reduction of around 70%) are cost-

effective compared to other opportunities to gain credits and so selection of this energy system gives the lowest overall Code compliance cost.

In the higher density developments, the lowest cost energy strategy at Code level 5 has been found to be based on a district heating system and gas CHP, supplemented by photovoltaics (between 1 to 2 kW of PV, depending on the size of the dwelling). The same energy strategy is most cost-effective for the larger greenfield developments, but the associated extra-over costs are significantly higher. For example, the extra-over cost to achieve the Code Level 5 DER standard in a semi-detached house in the Large Urban development (density of 80 dwellings per hectare) via this strategy has been costed at £20,600, whereas the same improvement in the large edge of town (40 dwellings per hectare) has an associated cost of £24,700. In the smaller greenfield sites, the more cost effective means of achieving Code Level 5 DER standard has been found to be individual biomass boilers, rather than a community heating approach.

At Code Level 6, the lowest cost approach to achieving the zero carbon standard in the larger developments (at both 40 dph and 80 dph densities) is via a district heating system and biomass CHP system, with additional PV. The extra-over cost of this strategy varies from £23,000 to £30,500 for the semi-detached house, between the 80dph to 40 dph sites, respectively. The limited availability of small-scale biomass CHP systems currently precludes their use on smaller-scale sites. The alternative approaches, e.g. individual biomass boilers or gas CHP / district heating, are significantly more expensive due to the additional PV capacity required – extra-over costs in excess of £30k for the energy strategy alone have been estimated for the larger houses. The practicality of these strategies is also questionable, as PV capacity of 3 kW per dwelling for flats and more than 4 kW per dwelling for larger houses are required. Space constraints, particularly on smaller urban sites, may prevent installation of sufficient PV capacity to achieve the Code level 6 zero carbon standard.

7.3 Total Code costs

The overall cost of achieving a particular Code Level will depend on the energy strategy selected to meet the required DER level. In this section it is assumed that the energy solution selected for a given development type is that which gives the lowest cost of compliance with a particular Code Level for the whole development when the same energy strategy is applied to all dwellings (note the details of the energy systems, such as sizing of components, will vary between dwelling types as appropriate).

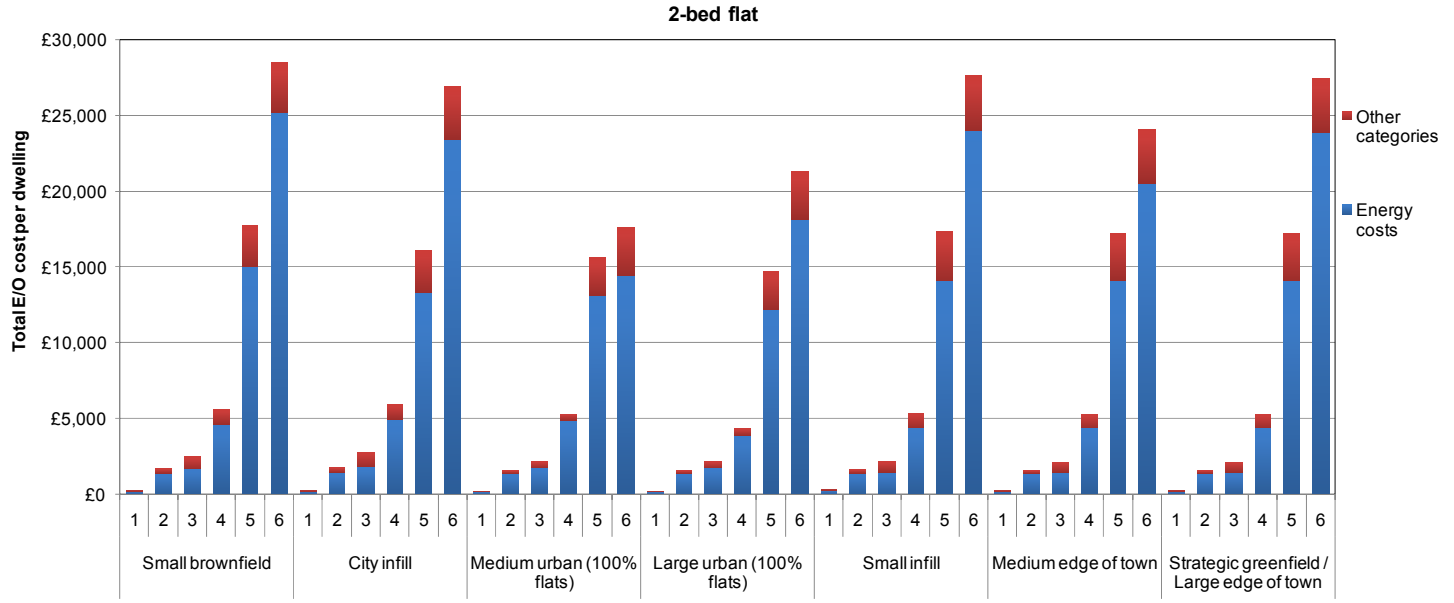
The total Code costs for a range of development scenarios are shown in Figure 6 for each of the standard dwelling types. The split of the overall Code extra-over cost between costs associated with the Energy category of the Code and costs associated with gaining credits under the other Code categories is shown in these plots.

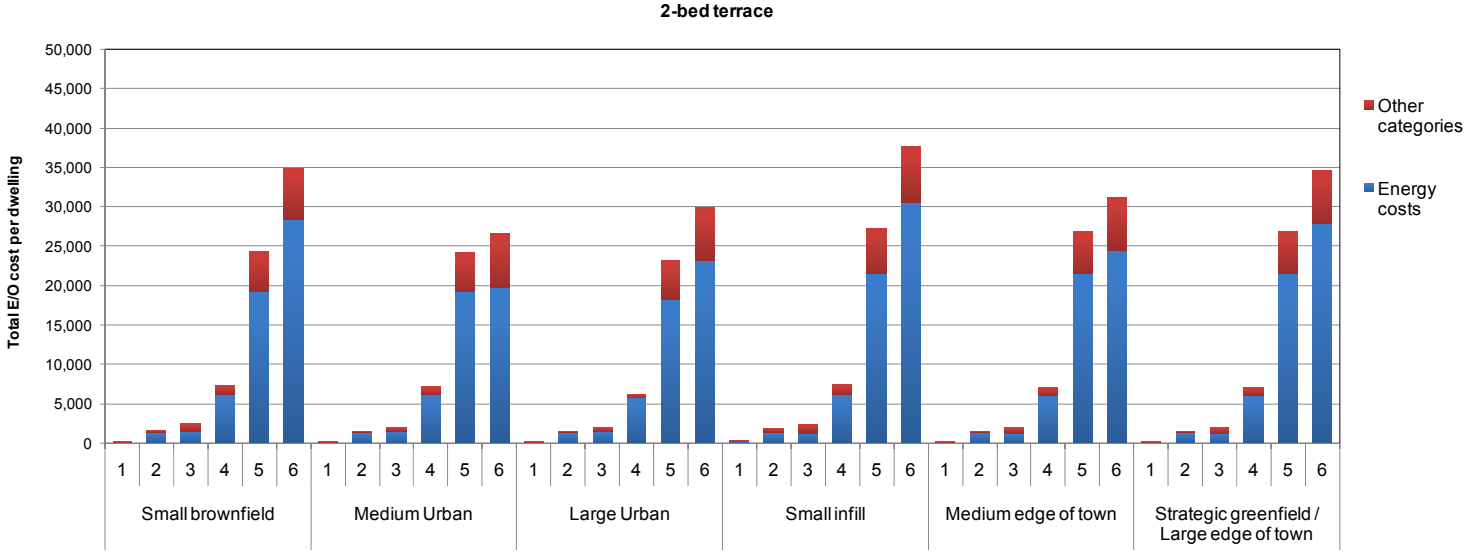
The most striking feature of the plots shown in Figure 6 is how heavily dominated the overall Code costs are by the cost of the energy strategy. As a result the variation in overall Code costs between dwelling types and development scenarios is very similar to the variation seen in the energy system extra-over costs.

The ranges of total extra-over costs for each Code level are tabulated below, for each dwelling type. Note that the range shown here encompasses all development scenarios, e.g. the lowest cost for meeting Code Level 6 in a 2-bed flat of £17,650 corresponds to the case of the Medium Urban development and the upper bound of £28,510 corresponds to the case of the Small Brownfield development (assuming the lowest cost energy strategy is applied to each development scenario). The total Code extra-over costs for dwelling type in each of the development scenarios are tabulated in the Appendices (Section 12, Table 59 to Table 70).

Table 32: Upper and lower bound on overall Code extra-over cost (assuming the energy strategy that gives the lowest overall compliance cost is selected in each development scenario)

Code Level	2-bed flat		2-bed terrace		3-bed semi		4-bed detached	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
1	£230	£320	£160	£350	£250	£430	£260	£320
2	£1,550	£1,770	£1,490	£1,840	£890	£1,260	£810	£1,090
3	£2,090	£2,760	£2,000	£2,420	£2,640	£3,020	£2,310	£2,680
4	£4,290	£6,360	£6,200	£7,410	£6,580	£8,150	£5,860	£7,190
5	£14,690	£17,740	£23,210	£27,250	£25,580	£29,550	£28,790	£32,560
6	£17,650	£28,510	£26,550	£37,690	£28,390	£41,090	£31,230	£45,510


2-bed flat
Total E/O cost per dwelling
£30,000
£25,000
£20,000
£15,000
£10,000
£5,000
£0
Other categories
Energy costs
Small brownfield
City infill
Medium urban (100% flats)
Large urban (100% flats)
Small infill
Medium edge of town
Strategic greenfield / Large edge of town


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
Other categories
Energy costs
Small brownfield
Medium Urban
Large Urban
Small infill
Medium edge of town
Strategic greenfield / Large edge of town

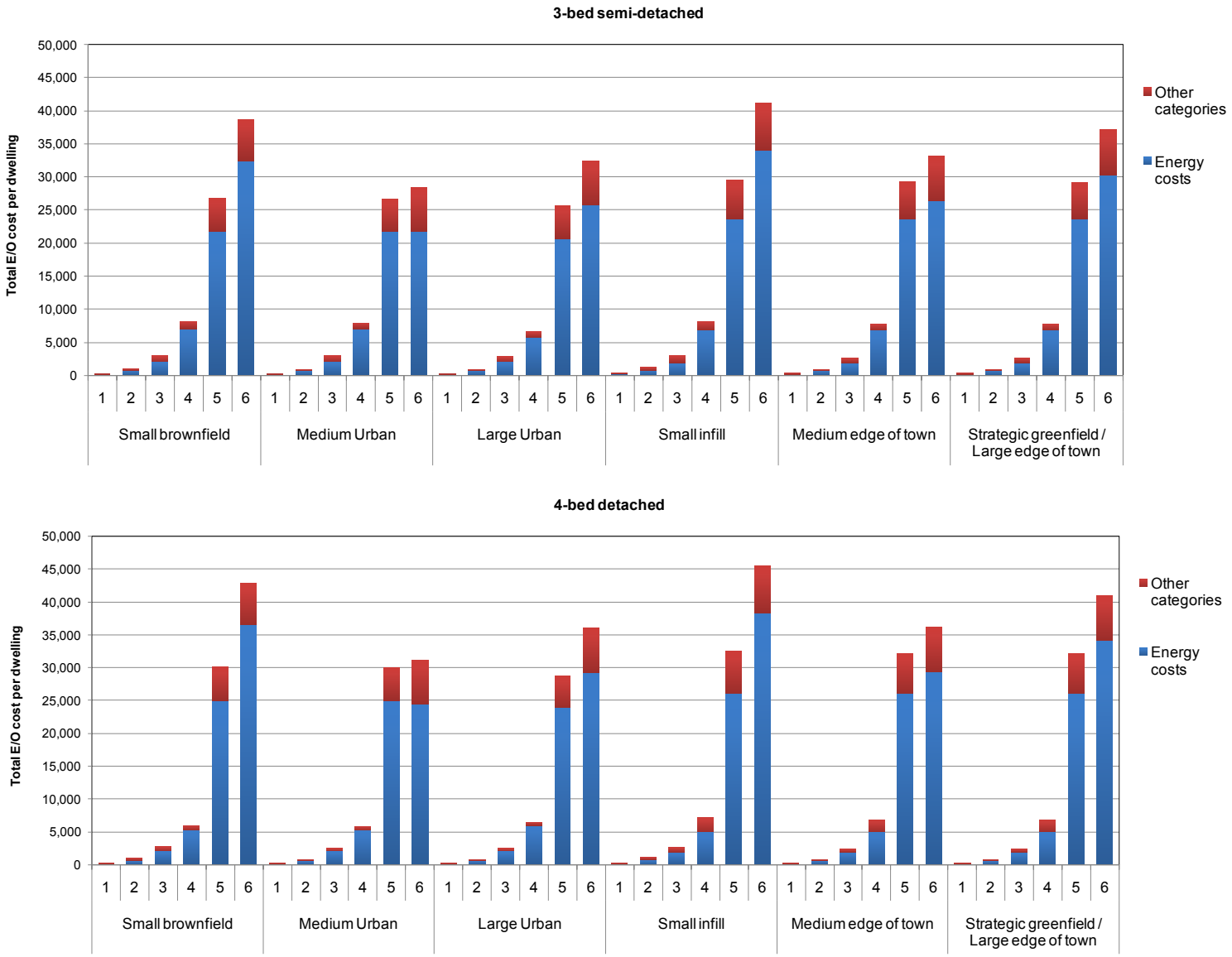


Figure 6: Variation in total Code cost at each Code level with development scenario for each dwelling type

7.3.1 Composition of non-energy Code costs

The breakdown of the non-energy Code costs are shown in Figure 7 for the 2-bed flat and 3-bed semi dwelling types in a number of development scenarios. It is immediately clear from these plots that excluding energy, the other Code extra-over costs are dominated by the costs associated with achieving credits in the Water and Health categories, with the Water-related costs becoming increasingly important at higher Code levels (i.e. Code level 5 and 6).

The model developed to assess Code extra-over costs optimises the measures applied in order to achieve the lowest cost of compliance with a particular Code Level, having achieved the mandatory Ene1 standard and satisfied the other mandatory Code requirements. The costs associated with the Water category, as shown in Figure 7, are related to meeting the mandatory internal water consumption levels (see Table 16). The costs related to the Health category increase sharply at Code level 6, due to the introduction of Lifetime Homes as a mandatory element. There are no mandatory Health category requirements below Code Level 6, however Health costs feature prominently in the Code extra-over costs at lower Code levels as there are cost-effective credits available in this category, for example by achieving daylighting and sound insulation standards.

A strong variation of non-energy Code extra-over costs with development scenario has not been found, although the composition of the costs (in terms of specific credits gained) does vary. In general, the non-energy Code costs tend to be higher in the greenfield developments compared to the brownfield sites. This is largely a result of fewer credits being available under the Ecology category on greenfield sites and higher costs being incurred to achieve those credits that are available. This means that extra-costs are incurred in other categories to achieve the required score at each Code Level. The build up of Code credits and costs associated with those credits are shown in Figure 8 for the 2-bed flat and 3-bed semi dwelling types and in a selection of development scenarios. Tables providing the detailed build up of credits at the issue-by-issue level are given in the Appendices for each Code Level and for the Small Brownfield and Strategic Greenfield development scenarios (Section 12, Table 57 and Table 58).

Note that the Code cost build-ups shown in Figure 7 and Figure 8 assume that relatively low-cost credits can be achieved in the Surface Water Run-Off category. This assumes that the development is constructed in a low flood risk area (demonstrated by a flood risk assessment) and that, at higher Code levels, SUDS measures are applied. If a development is located in an area of high or medium annual flooding probability, then the costs associated with gaining credits in this category become very high (see Table 19).

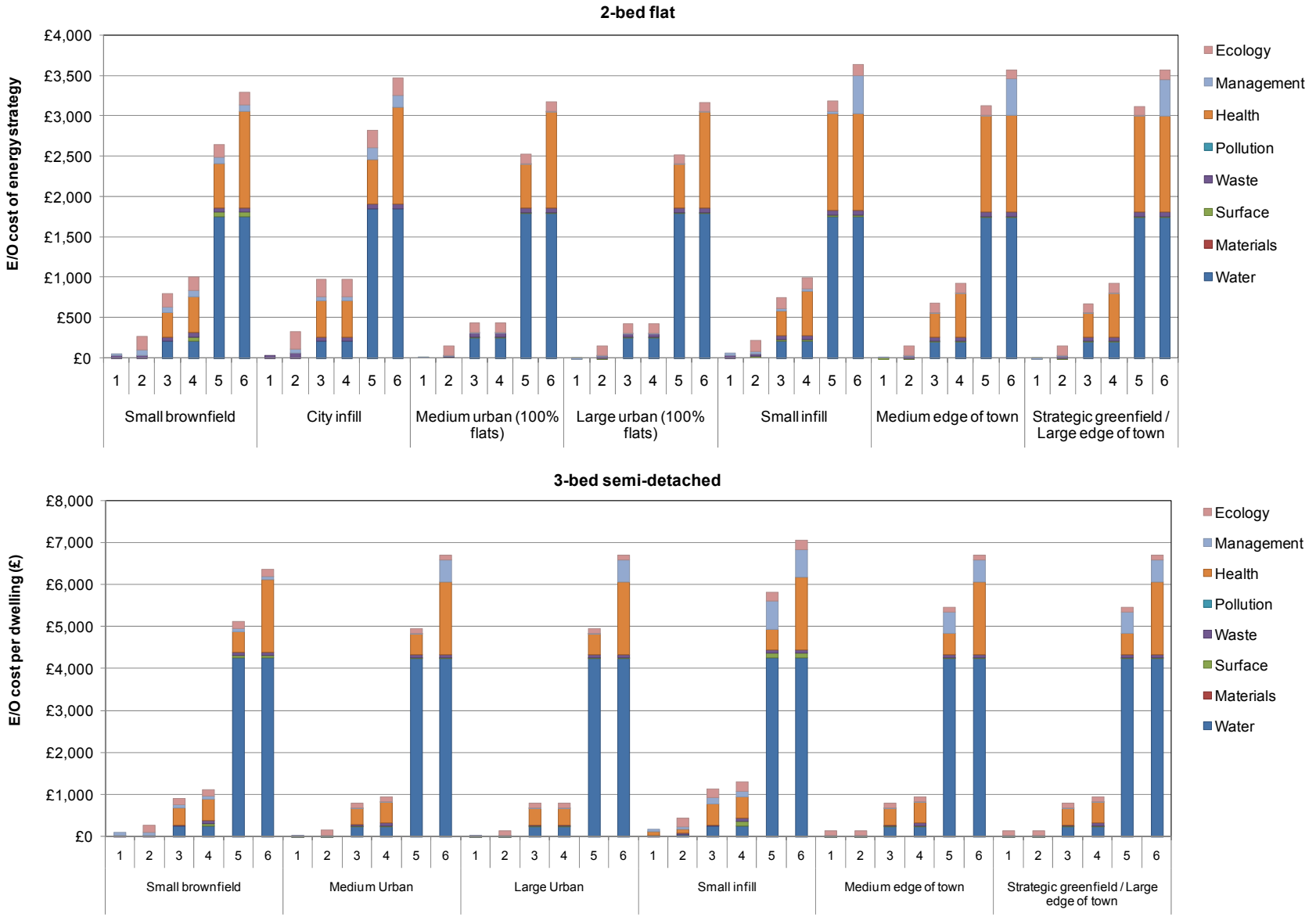


Figure 7: Build up of non-energy extra-over costs at each Code level and variation with development scenario

2-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
Small Brownfield												
Energy	6	£265	9	£1,408	11	£1,668	17	£4,611	26	£15,089	27	£25,214
Water	2	£0	2	£0	4	£200	4	£200	6	£1,750	6	£1,750
Materials	17	£0	17	£0	17	£0	17	£0	17	£0	17	£0
Surface	2	£0	2	£0	2	£0	4	£55	4	£55	4	£55
Waste	6	£25	6	£25	6	£55	7	£55	7	£55	7	£55
Pollution	4	£0	4	£0	1	£0	1	£0	4	£0	4	£0
Health	2	£0	2	£0	7	£300	8	£450	8	£550	12	£1,200
Management	7	£25	7	£75	7	£75	7	£75	7	£75	7	£75
Ecology	1	£0	7	£165	7	£165	7	£165	7	£165	7	£165
Total	**47**	**£315**	**56**	**£1,673**	**62**	**£2,463**	**72**	**£5,611**	**86**	**£17,739**	**91**	**£28,514**
Large Urban Extension												
Energy	5	£250	8	£1,408	11	£1,668	18	£5,692	26	£14,169	27	£20,091
Water	2	£0	2	£0	4	£200	4	£200	6	£1,750	6	£1,750
Materials	17	£0	17	£0	17	£0	17	£0	17	£0	17	£0
Surface	4	£0	4	£0	4	£0	4	£0	4	£0	4	£0
Waste	6	£0	6	£25	6	£55	6	£55	7	£55	7	£55
Pollution	4	£0	4	£0	1	£0	4	£0	4	£0	1	£0
Health	2	£0	2	£0	7	£300	7	£300	8	£550	12	£1,200
Management	7	£0	7	£0	7	£0	7	£0	7	£0	9	£0
Ecology	1	£0	7	£115	7	£115	7	£115	7	£115	7	£115
Total	**48**	**£250**	**57**	**£1,549**	**64**	**£2,338**	**74**	**£6,363**	**86**	**£16,640**	**90**	**£23,212**
Small Greenfield												
Energy	6	£265	9	£1,408	11	£1,418	18	£4,361	28	£14,113	29	£24,012
Water	2	£0	2	£0	4	£200	4	£200	6	£1,750	6	£1,750
Materials	17	£0	17	£0	17	£0	17	£0	17	£0	17	£0
Surface	4	£0	4	£22	4	£22	4	£22	4	£22	4	£22
Waste	6	£25	6	£25	6	£55	7	£55	7	£55	7	£55
Pollution	4	£0	4	£0	1	£0	1	£0	1	£0	1	£0
Health	2	£0	2	£0	7	£300	8	£550	8	£1,200	12	£1,200
Management	7	£30	7	£30	7	£30	7	£30	9	£30	9	£480
Ecology	0	£0	6	£135	6	£135	6	£135	6	£135	6	£135
Total	**48**	**£320**	**57**	**£1,620**	**63**	**£2,160**	**72**	**£5,353**	**86**	**£17,305**	**91**	**£27,654**
Large Edge of Town												
Energy	5	£265	9	£1,408	11	£1,418	18	£4,361	28	£14,113	29	£24,141
Water	2	£0	2	£0	4	£200	4	£200	6	£1,750	6	£1,750
Materials	17	£0	17	£0	17	£0	17	£0	17	£0	17	£0
Surface	4	£0	4	£0	4	£0	4	£0	4	£0	4	£0
Waste	6	£0	6	£25	6	£55	7	£55	7	£55	7	£55
Pollution	4	£0	4	£0	1	£0	1	£0	1	£0	1	£0
Health	2	£0	2	£0	7	£300	8	£550	8	£1,200	12	£1,200
Management	7	£0	7	£0	7	£0	7	£0	9	£0	9	£450
Ecology	6	£0	6	£115	6	£115	6	£115	6	£115	6	£115
Total	**53**	**£265**	**57**	**£1,549**	**63**	**£2,088**	**72**	**£5,282**	**86**	**£17,234**	**91**	**£27,712**

3-bed Semi

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	6	£256	9	£775	11	£2,104	17	£7,022	26	£21,705	27	£32,377
Water	2	£0	2	£0	4	£250	4	£250	6	£4,250	6	£4,250
Materials	17	£0	17	£0	17	£0	17	£0	17	£0	17	£0
Surface	2	£0	2	£0	2	£0	4	£55	4	£55	4	£55
Waste	6	£25	6	£25	6	£25	7	£75	7	£75	7	£75
Pollution	4	£0	4	£0	1	£0	1	£0	4	£0	4	£0
Health	2	£0	2	£0	7	£400	8	£500	8	£500	12	£1,735
Management	7	£75	7	£75	7	£75	7	£75	7	£75	7	£75
Ecology	1	£0	7	£165	7	£165	7	£165	7	£165	7	£165
Total	**47**	**£356**	**56**	**£1,040**	**62**	**£3,019**	**72**	**£8,142**	**86**	**£26,825**	**91**	**£38,732**
Large Urban Extension												
Energy	5	£226	8	£745	11	£2,104	18	£5,790	26	£20,642	27	£25,701
Water	2	£0	2	£0	4	£250	4	£250	6	£4,250	6	£4,250
Materials	17	£0	17	£0	17	£0	17	£0	17	£0	17	£0
Surface	4	£0	4	£0	4	£0	4	£0	4	£0	4	£0
Waste	6	£25	6	£25	6	£25	6	£25	7	£75	7	£75
Pollution	4	£0	4	£0	1	£0	4	£0	4	£0	1	£0
Health	2	£0	2	£0	7	£400	7	£400	8	£500	12	£1,735
Management	7	£0	7	£0	7	£0	7	£0	7	£0	9	£515
Ecology	1	£0	7	£115	7	£115	7	£115	7	£115	7	£115
Total	**48**	**£252**	**57**	**£886**	**64**	**£2,895**	**74**	**£6,581**	**86**	**£25,583**	**90**	**£32,392**
Small Greenfield												
Energy	6	£256	9	£775	11	£1,854	18	£6,852	28	£23,732	29	£34,036
Water	2	£0	2	£0	4	£250	4	£250	6	£4,250	6	£4,250
Materials	17	£0	17	£0	17	£0	17	£0	17	£0	17	£0
Surface	4	£22	4	£22	4	£22	4	£22	4	£22	4	£22
Waste	6	£25	6	£25	6	£25	7	£75	7	£75	7	£75
Pollution	4	£0	4	£0	1	£0	1	£0	1	£0	1	£0
Health	2	£0	2	£0	7	£400	8	£500	8	£500	12	£1,735
Management	7	£30	7	£30	7	£30	7	£30	9	£545	9	£545
Ecology	0	£0	6	£135	6	£135	6	£135	6	£135	6	£135
Total	**48**	**£333**	**57**	**£987**	**63**	**£2,716**	**72**	**£7,864**	**86**	**£29,259**	**91**	**£40,798**
Large Edge of Town												
Energy	5	£226	9	£775	11	£1,854	18	£6,852	28	£23,732	29	£30,401
Water	2	£0	2	£0	4	£250	4	£250	6	£4,250	6	£4,250
Materials	17	£0	17	£0	17	£0	17	£0	17	£0	17	£0
Surface	4	£0	4	£0	4	£0	4	£0	4	£0	4	£0
Waste	6	£25	6	£25	6	£25	7	£75	7	£75	7	£75
Pollution	4	£0	4	£0	1	£0	1	£0	1	£0	1	£0
Health	2	£0	2	£0	7	£400	8	£500	8	£500	12	£1,735
Management	7	£0	7	£0	7	£0	7	£0	9	£515	9	£515
Ecology	6	£115	6	£115	6	£115	6	£115	6	£115	6	£115
Total	**53**	**£367**	**57**	**£916**	**63**	**£2,645**	**72**	**£7,793**	**86**	**£29,187**	**91**	**£37,092**

Figure 8: Examples of lowest cost approaches to meeting each Code level, in terms of credits gained by category and associated costs, for Flat and Semi-detached dwelling types and in a selection of development scenarios

7.3.2 Non-standard energy solutions

The assessment of energy strategies given in Section 7.2 focussed on a range of potential approaches to meeting the various DER standards of Ene1 that are expected to be commonly taken up by developers building to the Code. This core list of strategies omitted a number of energy solutions that, due to their particular characteristics and constraints on their installation, are not widely applicable across the range of development types. However, these solutions, which include medium to large-scale wind turbines and ground source heat pumps, may provide attractive solutions on certain types of sites. A discussion of these options is given here.

7.3.3 Ground Source Heat Pump

Ground source heat pumps (GSHPs) are similar to air source heat pumps (ASHPs), in that they extract thermal energy from the surroundings, increase the quality of the heat (i.e. the temperature) and deliver it to meet the thermal demands of a building. The principal difference between ground and air source heat pumps is, as the names suggest, the source of the heat. GSHPs extract heat from the earth and therefore require ground loops, which are typically in the form of either coils buried in trenches or vertical boreholes. The cost associated with the ground loops, both capital and installation (which can be substantial where drilling of boreholes is required), mean that GSHPs are more expensive than air source, however the lower losses incurred in transferring heat from the ground compared to transferring heat from the air (into the heat pump's circulating fluid) mean that GSHPs are more efficient than ASHPs.

The following table summarises the assumed efficiencies for the heat pumps modelled in terms of coefficient of performance (COP).

Table 33: Co-efficient of Performance (COP) assumptions for ground and air source heat pumps

	ASHP	*GSHP*
Space heating COP	3.0	4.0
Water heating COP	2.5	3.2

The actual COP values will depend on factors such as temperature difference between heat source and heat sink, ratio of hot water to space heating demands and quality of the heat pump technology. The COP values used in this study are considered to be relatively conservative which means that carbon savings will be under-estimated rather than over-estimated.

As for the ASHP energy options, it is assumed that where specified a GSHP would be sized to meet all of the dwelling's thermal demands. The costs associated with energy strategies based on GSHPs are shown in the table below. The strategies have been devised for compliance with Code Level 4 Ene 1 standards and are based on the small greenfield development scenario (currently GSHPs tend to be installed in off-gas areas).

Table 34: Ground source heat pump based energy strategies – extra-over costs and percentage DER improvement delivered

	Flat	*Terraced*	*Semi-detached*	*Detached*
Technology	''Good' fabric Community GSHP (3kWth per flat)	'Good' fabric 5kWth GSHP	'Good' fabric 6.5kWth GSHP	'Good' fabric 8kWth GSHP
Percentage improvement (DER/TER)	57%	51%	52%	51%
E/O cost of Ene 1 option[16]	£3,375	£8,295	£8,690	£10,240

The following graph shows the total extra over cost by category for achieving Code level 4, assuming the energy strategies tabulated above.

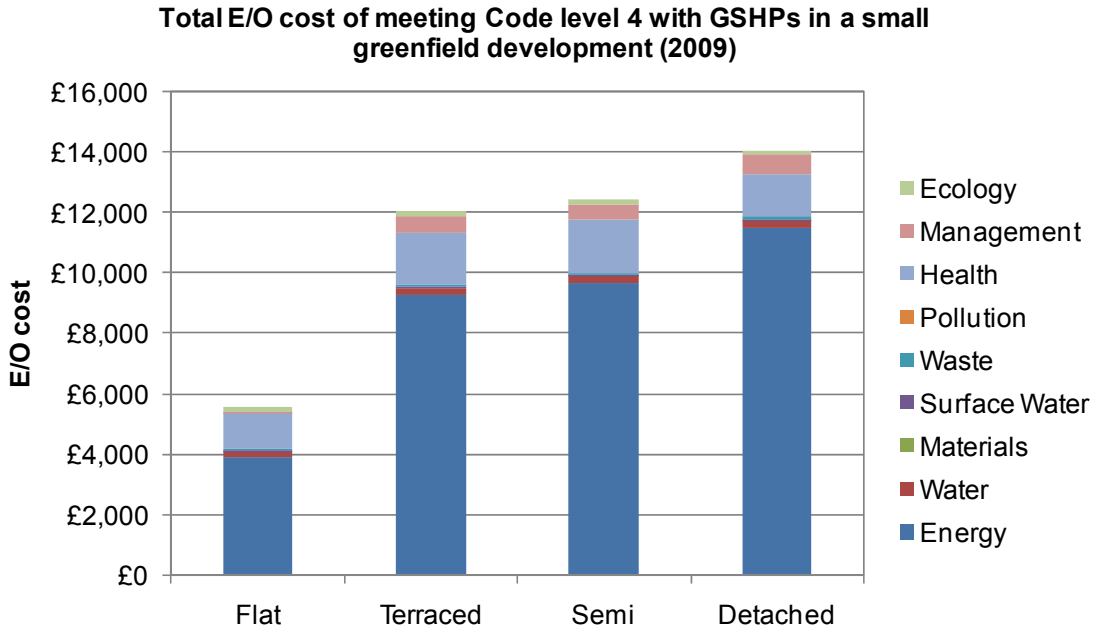


Figure 9: Extra over cost of achieving Code level 4 with a GSHP in a small greenfield development

The higher efficiency (COP) of the ground source heat pump compared to the air source system means that there is no requirement for photovoltaics to achieve the required DER/TER reduction for Code level 4. The cost saving attributable to the reduced requirement for PV is offset by the higher capital and installation cost of the ground coupled system. In flats capital costs of the ground loops and heat pump(s)

[16] Costs of GSHP systems are sensitive to many factors, include ground conditions, which are highly site-specific. Here indicative costs of between £10,000 and £12,000 have been assumed for the installed cost of the GSHP system in houses. Communal GSHP system costs are based on a figure of £1,000 per kWth, which is a reasonable estimate for systems over around 20kW capacity. Note that the E/O costs given above include the offset benefit of not requiring a gas boiler or gas connection.

can be split between dwellings. However, this benefit is offset to some degree by the costs of distributing and metering the heat in individual units.

7.3.4 Wind

Due to the nature of many housing developments and wind resource constraints, large on-site wind energy has not been considered a central technology in meeting the Code. However, where sufficient resource exists and there is adequate space for installation of medium to large wind turbines, this source of low carbon electricity can have a significant impact on the cost of building to the Code.

This section considers the case when large-scale wind energy is available on a Strategic Greenfield site (5,000 dwellings). It is assumed that wind turbines are installed to provide the additional CO_2 reduction required once fabric improvements have been applied and an efficient heating technology installed (in this case air source heat pumps). On this basis, medium to large-scale wind turbines are only relevant at Code levels 4 and above. The extra-over costs associated with heat pump and wind turbine energy strategies, sized to meet Code levels 4, 5 and 6, are shown in Figure 10 (total extra-over costs for the Strategic Greenfield site have been apportioned on a per dwelling basis).

The extra-over costs for the wind-based energy strategies are significantly lower than those shown in Figure 5 particularly at Code Levels 5 and 6. The very sharp increase in energy strategy extra-over cost between Code levels 4 and 5 that is seen when the central (i.e. widely applicable) energy strategies are applied is much less pronounced when wind energy is available. This is because the greater requirement for wind electricity at Code Level 5 justifies a switch from medium-scale (100s of kW) to large-scale (MW) wind turbines, which have lower specific costs (£/kW) and better load factors. The increase in energy strategy cost from Code Level 5 to 6 results from the increased need for wind turbine generating capacity and the requirement for the 'Best' fabric package, necessitated by the low heat loss parameter requirement.

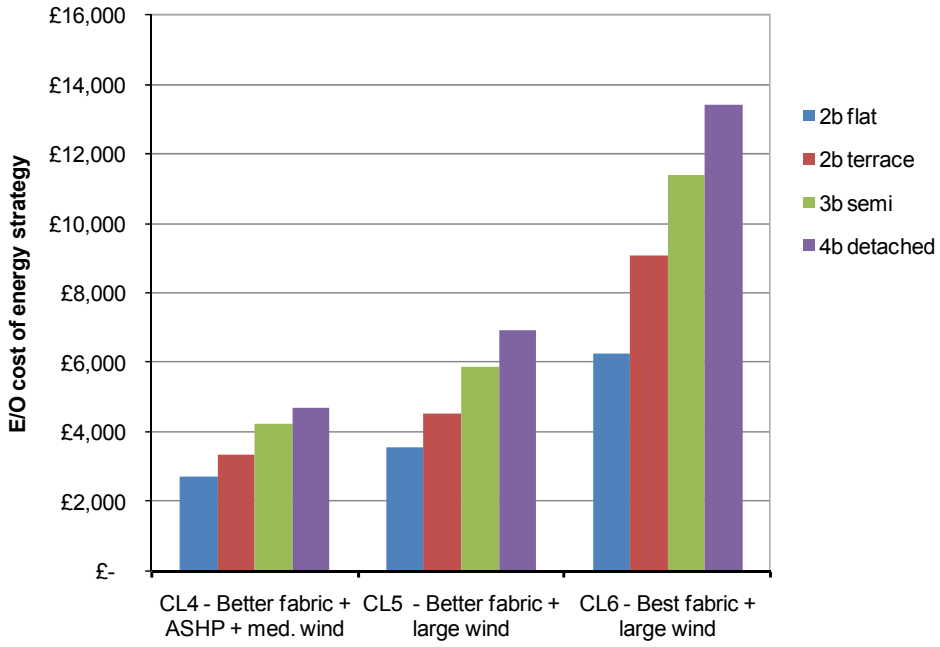


Figure 10: Extra-over cost of energy strategies involving medium to large-scale wind turbines, sized to meet Code levels 4 to 6

The overall costs for achieving Code Levels 4 to 6 with an energy strategy involving medium to large-scale wind energy deployment is shown in Figure 11 (for the Strategic Greenfield development). The comparison of overall Code costs for sites with wind deployment compared to sites based on the lowest cost non-wind energy strategies (i.e. sites that rely on photovoltaics to provide the additional CO_2 reduction needed to reach minimum DER levels) is tabulated in Table 35. The large differences in overall Code costs at Code Level 5 and 6 are virtually entirely attributable to the reduced extra-over cost of the energy system, as the credits and associated costs in other categories are largely the same.

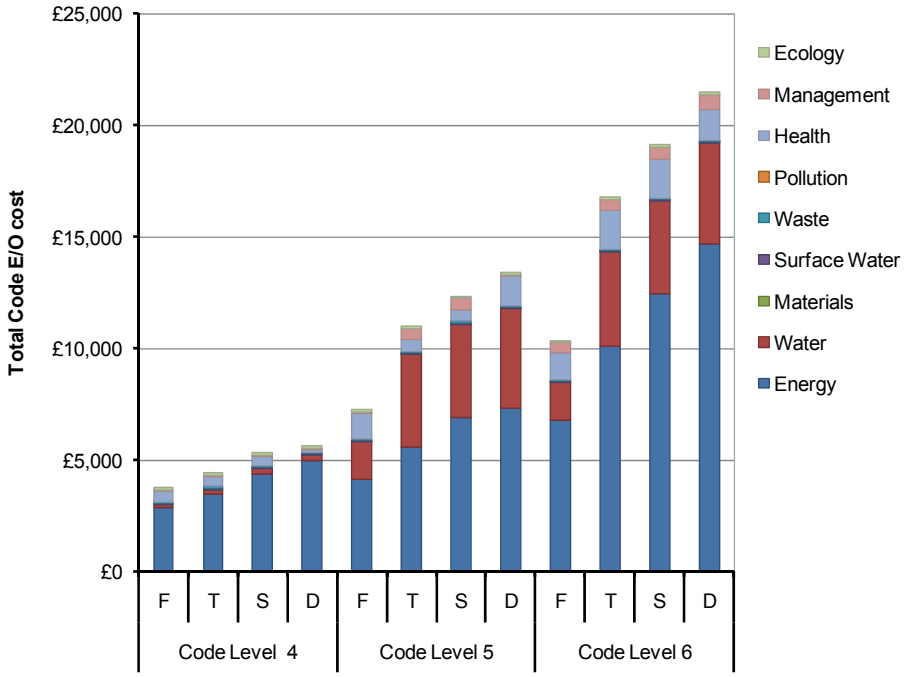


Figure 11: Total extra-over costs of achieving Code levels 4 to 6 based on an energy strategy involving medium to large scale wind

Table 35: Comparison of total Code extra-over costs between a development with a large wind based energy strategy to a similar development with a biomass CHP / district heating strategy

Energy strategy	ASHP + wind turbines			Non-wind strategy		
Code Level	**4**	**5**	**6**	**4**	**5**	**6**
2b flat	£3,770	£7,250	£10,350	£5,280	£17,250	£27,500
2b terrace	£4,400	£11,000	£16,800	£6,850	£26,900	£34,300
3b semi	£5,300	£12,350	£19,100	£7,800	£29,200	£36,750
4b detached	£5,600	£13,400	£21,450	£6,900	£32,200	£40,600

This analysis demonstrates that additional costs of compliance with higher levels of the Code, particularly Code Levels 5 and 6, can be dramatically lower on sites where there is adequate space and wind resource for installation of wind turbines compared to sites without access to this resource. These results are based on typical costs for wind turbines in the scale from 500 kW (Code Level 4) to several MW –

based on the Strategic Greenfield development scenario, there is a requirement for 10.5 MW of wind turbine capacity to achieve Code Level 6 (assuming a 20% load factor is achieved, consistent with a good wind resource).

7.4 Code cost variation with time

All costs presented in the preceding sections of this study have been extra-over costs measured in 2009 prices from a baseline of compliance with the 2006 Building Regulations. Over the period to 2016 and beyond the extra-over costs will change, due to a number of factors:

- The costs of measures implemented within new dwellings to earn credits under the Code will change, due to, for example, technology cost curves, innovation and learning effects.
- The Building Regulations will change such that credits under the Code that currently represent an extra-over cost will become the minimum standard required for compliance with the Building Regulations. This is particularly the case for Part L of the Regs, which will be tightened such that the mandatory DER standards of the Code become regulatory minimums, but will also have an impact on other categories (notably water).

The changing cost of measures is anticipated to primarily exert a downward influence on the cost of compliance with the Code (neglecting the possible effect of supply chains failing to meet increasing demand, which are assumed to be short-term).

The impact of the changes to Building Regulations will be to reduce the extra-over costs associated with meeting Code Levels, as a greater part of the construction cost becomes the cost of building a Building Regulation compliant dwelling (and not part of the cost of achieving the Code rating). This is not a change in the overall cost of constructing the dwelling, but simply a shift in accounting for a proportion of that cost from a Code cost to a cost of meeting regulations. A second effect of the tightening of the Building Regulations is that certain credited elements of the Code will fall behind the minimum requirement of the Regulations. This is particularly the case in the energy category, as the changes to Part L will mean that by 2016 the mandatory DER standards of all but Code Levels 5 and 6 will be behind the minimum standards required by Building Regulations and Zero Carbon Homes policy. The impact of these changes are summarised below:

Table 36: Impact of Building Regulation changes on minimum DER/TER reductions required at each Code Level

Date	Reduction of DER/TER enforced by Building Regs / ZCH policy	Mandatory reduction of DER / TER at each Code Level					
		CL1	CL2	CL3	CL4	CL5	CL6
2009	0	10%	18%	25%	44%	100%	100% + Unreg.
2010	25%	25%	25%	25%	44%	100%	100% + Unreg.
2013	44%	44%	44%	44%	44%	100%	100% + Unreg
2016	70%	70%	70%	70%	70%	100%	100% + Unreg

Assuming the Code credit scoring system is not modified as the Building Regulations change, e.g. credits are still awarded under the Energy category for achieving a standard that is a minimum regulatory requirement, then the extra-over cost of achieving Code Levels 1 and 2 will fall to a low level once Part L changes in 2010 (and will be zero or negligible from 2013). The change in Code 3 and 4 costs are shown in Figure 12. In this chart, the change in construction cost from a baseline of Part L2006 compliance is shown by the bars, i.e. the cost of building to the Code combined with the impact of changes to the Building Regs. The broken red lines indicate the increase in construction cost associated with Building Reg changes alone and, therefore, the height of the bars above the broken lines is the extra-over cost associated with the Code above the cost of compliance with the Building Regulations in force at the time.

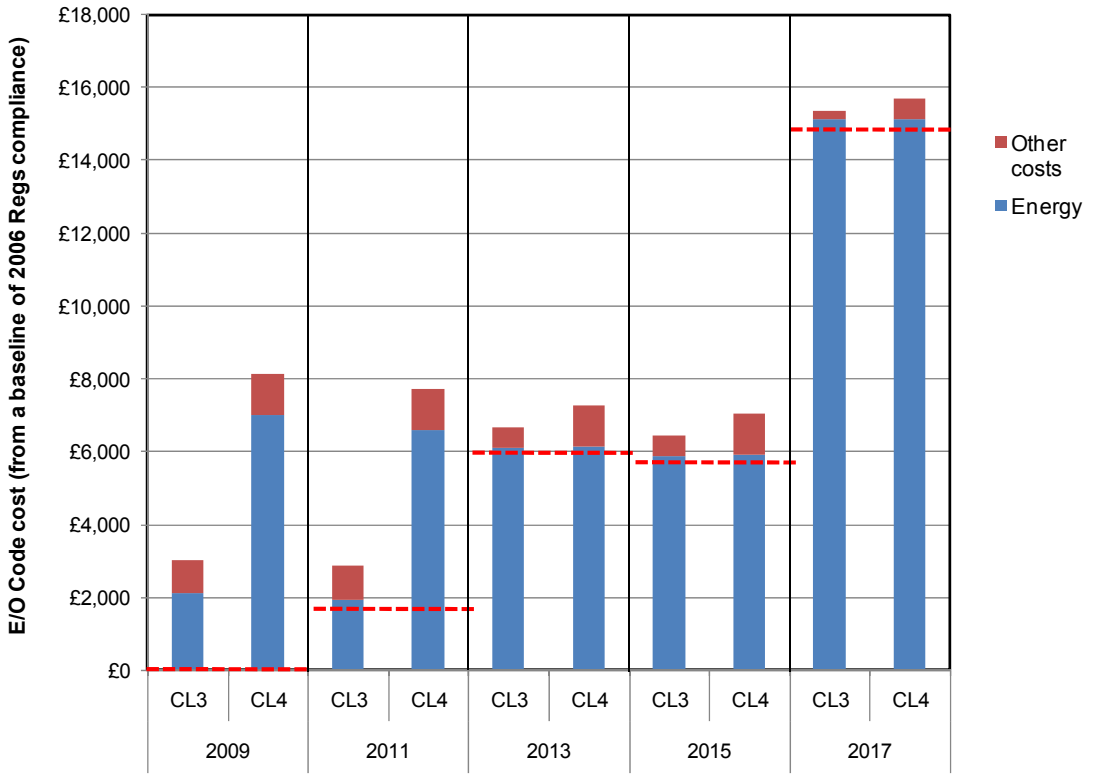


Figure 12: Changing additional cost of building a Code Level 3 and 4 compliant dwelling (3-bd semi) over time as Building Regulations change, measured from a baseline of building a 2006 Building Regulation compliant dwelling. The height of the bars below the broken red lines indicate the cost associated with meeting the higher Building Regulation standard and the height of the bars above the broken red line is the extra-over cost associated with the Code.

As shown in Figure 12, the extra-over cost associated with Code Level 3 compared with the cost of meeting Building Regulations drops considerably following the 2010 changes to the Regs. The overall cost of constructing a Code Level 3 compliant dwelling increases in 2013 due to the need to meet the increased minimum regulatory DER standards, such that the cost difference between achieving Code Level 3 and 4 becomes fairly small. The diminishing overall additional cost of building a Code Level 4 compliant dwelling between 2009 and 2015 is a result of reductions in the cost of measures over time. In 2016 there is a sharp increase in the cost of building a regulation compliant home, due to the introduction

of the Zero Carbon Homes policy. The extra-over cost associated with reaching Code Level 3 and 4 post-2016 is small. (Note that the Energy costs shown in this chart post-2016 relate to achieving a 70% Carbon Compliance level, the cost of Allowable Solutions is not shown in the chart and would be additional).

The future change in the costs associated with building Code Level 5 and 6 homes is shown in Figure 13, below. Again, the bars represent the additional cost of building a Code Level 5 or 6 rated dwelling, from a baseline of a 2006 Building Regulation compliant dwelling, and the broken red lines indicate the increasing additional cost of only meeting the Building Regulations.

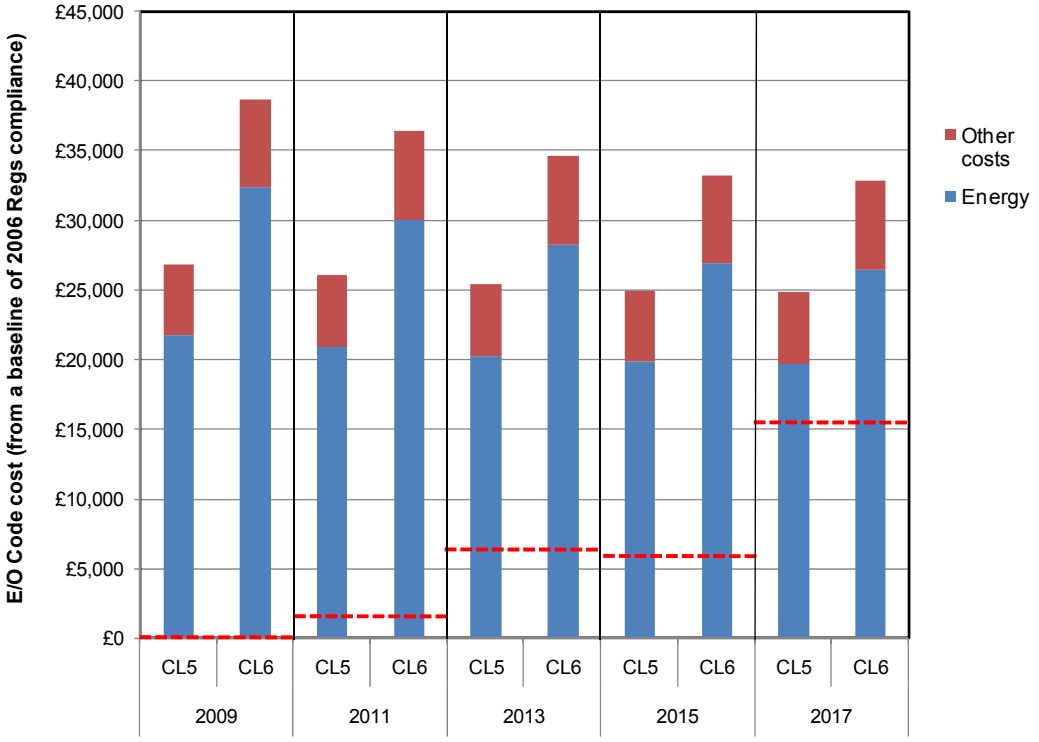


Figure 13: Changing additional cost of building a Code Level 5 and 6 compliant dwelling (3-bd semi) over time as Building Regulations change, measured from a baseline of building a 2006 Building Regulation compliant dwelling. The height of the bars below the broken red lines indicate the cost associated with meeting the higher Building Regulation standard and the height of the bars above the broken red line is the extra-over cost associated with the Code.

In the case of Code Levels 5 and 6 a gradual reduction in the cost of achieving the rating is seen over time, due to reductions in the costs associated with the measures applied. The changes to the Building Regulations and introduction of Zero Carbon Homes policy does not enforce at any point a higher DER reduction to be achieved than is required by the mandatory requirements of the Code. However, after 2016 an additional investment in Allowable Solutions will be required in the case of the Code Level 5 compliant dwelling, whereas if Code Level 6 is achieved there will be no requirement for further investment in Allowable Solutions (as all emissions have been dealt with by onsite measures). This will have the effect of bringing the overall costs of building a Code Level 5 and 6 compliant dwelling closer together after 2016, to an extent that will depend on the cost of the Allowable Solutions.

7.5 Lifecycle and management cost

This section explores the potential impact of the Code on costs experienced by individual householders. Total energy costs for each Ene 1 option were calculated using the SAP 2005 method, with the fuel prices given in appendix 3 (see Section 11).[17] However, where a community energy system was employed, the fuel price was adjusted to take into account maintenance and management charges that would have to be passed on to the householders. This adjustment was in terms of an additional premium on top of the stated fuel price (in p/kWh). The premium was calculated based on the total maintenance and management costs of the community system, and split over the total thermal output. Therefore, households with higher thermal demands would pay a proportionally higher amount of the management and maintenance charges. Assumed maintenance costs for the various technologies are stated in appendix 2 (see Section 10).

The other on-going costs considered were those related to the servicing and maintenance of any other LZC technologies employed, for PV or SHW systems, for example. These were subtracted from the fuel bill savings.

For those energy options that displaced a traditional gas boiler, a benefit was also gained as the need for boiler servicing was eliminated. This benefit was taken to be £65 per year, which is an average annual cost for gas boiler servicing. The following formula was used to calculate the net savings for each dwelling for every energy option:

Net savings (£/yr)	=	Saving due to reduced fuel bill (£/yr)	–	Maintenance cost of LZC technology (£/yr)	+	Gas boiler servicing cost (if boiler is displaced) (£/yr)

The resulting savings are shown in the following table.

[17] Note that this method considers energy use for space heating and hot water, and electricity use for fixed lighting and fans and pumps associated with the heating and ventilation system. Energy for cooking and appliance use is not considered.

Table 37: Fuel costs for Part L 2006 compliant dwellings and net savings for each Ene 1 option for a large edge of town development

	Ene 1 option	Code level	Short name	Flat	Terrace	Semi	Detached
Fuel bill (£/yr)	N/A	N/A	Part L compliant dwelling	£301	£391	£504	£657
Annual saving relative to Part L compliant dwelling (£/yr)	1	1	Good/Better fabric	£73	£122	£183	£177
	2	2	Better/Best fabric	£86	£122	£183	£252
	3	3	Good, PV	£100	£80	£121	£185
	4	3	Better/Best (SHW)	£97	£147	£217	£252
	5	3	ASHP	£60	£93	£64	£82
	6	3	Better, PV	£98	£86	£147	£252
	7	3	Better, SHW	£96	£118	£169	£252
	8	4	MVHR, ASHP (PV)	£99	£98	£197	£275
	9	4	BM heating	£254	£241	£309	£402
	10	4	MVHR, PV	£127	£131	£187	£276
	11	4	Community gas CHP	£237	£296	£376	£478
	12	4	Micro gas CHP	£99	£163	£248	£353
	13	5	BM heating, PV (100%)	£283	£14	£97	£203
	14	5	Community gas CHP, PV	£263	£296	£400	£528
	15	6	Community BM heating, PV	£245	£366	£478	£644
	16	6	BM CHP, PV	£271	£369	£473	£601
	17	6	BM heating, PV (ZCH)	£245	£101	£198	£348

The maintenance costs used cover servicing, plant maintenance, and replacement parts. It should be noted that these costs are relatively uncertain and potentially highly variable, depending on service contracts and plant reliability. The figures in the table above should be used as a guide and should not be taken as definitive. The percentage reductions in fuel bills, taking into account the servicing and maintenance costs of any LZC technologies are shown below.

Table 38: Typical net savings as a percentage of Part L dwelling's fuel bill for a large edge of town development

Code level	Ene 1 option	Net saving as a percentage of Part L dwelling's annual fuel bill			
		Flat	Terrace	Semi	Detached
1	1	24%	31%	36%	27%
2	2	29%	31%	36%	38%
3	6	32%	22%	29%	38%
4	10	42%	33%	37%	42%
5	14	88%	76%	79%	80%
6	16	90%	94%	94%	91%

8 SUMMARY OF KEY ISSUES

8.1 Energy

The results presented above highlight a number of key points concerning the Energy category of the Code:

- Overall costs of Code compliance are most sensitive to the energy strategy employed to achieve the mandatory improvement in Dwelling Emission Rate. While house-by-house energy solutions are generally available in all development types, and associated costs are relatively insensitive to development scale and dwelling density, certain community energy solutions may only be available in certain development types. Furthermore, the costs of such options depend strongly on the technology chosen (development scale) and the heat distribution costs (dwelling density).

- Very high levels of thermal insulation, combined with low air permeability and low thermal bridging can be used to achieve significant reductions in DER relative to TER. For example, the 'Best' fabric package combined with a MVHR system gives an improvement of the order 40% for the detached house. Achieving such levels of thermal performance and air tightness in practice is highly sensitive to workmanship. Particular care and attention must be paid to finishing, especially when it comes to minimising thermal bridging and achieving the target air tightness levels.

- The effectiveness of fabric improvement packages in reducing DER decreases as the ratio of exposed areas to total internal floor area decreases. (Exposed area is any area through which heat is lost). This means achieving the mandatory DER levels is generally more challenging in dwellings such as flats and terraced houses.

- The number of energy options available tends to decrease as target Code level increases. Gas boilers cannot be used to meet thermal demands at the highest Code levels (5 and 6) unless a source of low or zero carbon electricity is also available.

- Achieving the required DER to meet the current ZCH (Code 6) target represents a significant challenge. Of the energy strategies considered, only the biomass CHP with PV solution led to the target levels being met, and then only in houses. It was not possible to meet the mandatory DER improvement for the mid-floor flat considered, given the assumptions on available space for LZC technologies.

- Over time, as the Building Regulations are tightened the extra-over cost associated with building to the Code will drop, as costs that are currently Code costs will be incurred just to meet the minimum regulatory standards. A further effect of changes to the Building Regulations, in particular Part L, is that some standards currently defined in the Code will fall behind the minimum standards required by the Regulations. The overall cost of building a Code compliant dwelling may therefore increase as a result of the increased cost of construction of a Building Regulation compliant dwelling.

While the results of this study suggest that community energy systems offer the potential to meet the higher Code levels, particularly those based on biomass energy plant, realising such schemes in practice can present a wide range of issues; from technical and economic challenges to non-technical barriers. Widespread provision of heat to dwellings over community heating systems is a significant change from the currently typical model of individual heating plant in each dwelling, requiring local organisations to take on management of the infrastructure and billing of householders for their heat consumption. House builders do not typically see a role for themselves in the ongoing operation and management of energy systems (although there are some exceptions) and so there is an opportunity for third party organisations

with specialist skills in operation of energy systems and provision of energy services – Energy Service Companies (ESCOs) – to fulfil this role. There are a wide range of services that ESCOs may offer, ranging from simple maintenance contracts to complete design, build, finance and operate (DBFO) contracts. In the majority of cases, the economics of energy systems that are capable of delivering high Code level compliance, e.g. biomass based district heating systems, do not provide an adequate rate of return to attract full financing by a commercial ESCO. Typically an ESCO will make a capital contribution, based on a forecast of revenues from sale of energy services over the project lifetime, leaving a substantial amount of the capital investment to be met by the developer. With the introduction of various financial incentives to support investment in renewable energy systems, such as the renewable feed-in tariff (a kWh-based payment for generation of renewable electricity by systems of less than 5MWe) and renewable heat incentive (a kWh-based payment for local use of renewably generated heat), the economics of these systems will improve and therefore the capital contribution expected from developers may increase.

There are significant risks associated with the operation of site-wide energy systems, both financial and technical, that will be factored into any decision to implement these systems. The following are some of the challenges to implementing a successful community energy scheme:

- Perception: gaining public acceptance for the change from individual heating systems to shared infrastructure.

- Financing: community energy schemes demand a large capital outlay, often in the early stages of a development before the whole development has been built out and buildings become occupied. The early capital investment is therefore at risk, based on the expectation that revenues will develop over time.

- Phasing: site-wide energy solutions tend to be better suited to larger developments. However, a site consisting of thousands of homes may be completed over a number of years, with early occupants in residence before the whole development is complete. The plant must be sized to meet the demands of the whole site (once complete) and in the early years a trade-off must be made between under-utilisation of plant and heat dumping.

- Ownership: typically an organisation must take ownership of the community energy system and be responsible for delivering heat to consumers. Specialist companies such as ESCOs that provide this service are becoming more commonplace.

8.2 Water

This category represents one of the major concerns for house builders in terms of impact of the Code on saleability of homes. Prospective buyers will expect certain standards and might be deterred by measures such as low flow taps, low flow showers, shorter baths etc, and could have concerns in relation to maintenance and on-going costs of a greywater recycling / rainwater harvesting system where these are specified.

Not only is the cost of meeting the most stringent internal water use requirements fairly high (estimated as being up to £4,500 for a detached house), meeting these standards may have the perverse effect of underestimating water use in the medium to long term. Low flow fittings can be replaced by standard faucets, flow restrictors removed etc if the purchaser of a new home is not satisfied with the performance of taps and showers, for example.

A review of the Water category and the water calculator tool is currently underway and changes are likely to be incorporated into the revised Technical Guide from 2010.

8.3 Other Code categories

Feedback from the developers during the consultation suggested that there is no significant extra over cost associated with meeting the uncredited mandatory issues in the Materials, Surface Water Run-off and Waste categories. The Green Guide rating requirement for Mat 1 is generally met by default for base specifications and minimising peak water run-off from a site is often a planning requirement (rather than a Code related cost). Waste storage provision to satisfy the Was 1 mandatory element is generally part of the standard build and site waste management plans are now a legal requirement for sites in England and Wales where construction works will cost in excess of £300,000.

Other issues with substantial cost implications include provision of cycle storage, meeting the mandatory internal water consumption targets of Code levels 5 and 6 and achieving the credit against the flood risk issue (Sur 2) in developments situated in areas of medium or high flood risk.

Meeting Lifetime Homes standard is also a significant additional cost. This is currently limited to Code Level 6, where it is mandatory, although there is some consideration of implementing the standard at progressively lower levels of the Code. There is currently significant uncertainty surrounding what the actual cost of meeting the Lifetime Homes standard should be. During the consultation process, house builders reported high costs to meet the Lifetime Homes standard, which have been reflected in the costs used in this analysis. These costs, however, are based on adaption of current standard housing designs to incorporate Lifetime Homes principles. Many believe that the additional cost of Lifetime Homes can be reduced substantially if the standard housing templates are redesigned to incorporate the principles from the outset.

9 APPENDIX 1: FABRIC IMPROVEMENT PACKAGES

The following table summarises baseline U-values and base costs. Costs are per square metre of building element.

Table 39: Baseline U-values and costs

Element	*Baseline U-value (W/m^2K)*	*Baseline cost (£/m^2)*
Roof	0.25	£136
External wall	0.35	£115
Ground floor	0.25	£107
Windows / doors	2.2	£250

From these baseline specifications, packages of measures were designed to ensure that the baseline dwellings complied with Part L 2006, these are known as the 'Reference' packages. In addition, three other fabric packages were defined, giving increasing levels of thermal performance and air tightness. These are known as 'Good', 'Better', and 'Best'. The following table shows the U-values used in the 'Reference' fabric package for each dwelling type.

Table 40: 'Reference' U-values

Element	*'Reference' U-value (W/m^2K)*			
	Flat	*Terrace*	*Semi*	*Detached*
Roof	0.25	0.18	0.18	0.18
External wall	0.35	0.25	0.25	0.25
Ground floor	0.25	0.20	0.25	0.25
Windows / doors	2.2	1.8	1.8	2.2

Improved U-values and extra over costs (per square metre of element) for the fabric enhancement are given below. The U-values in each of the improved fabric packages were the same for each dwelling type.

Table 41: Improved fabric U-values and costs

Element	*U-value (W/m^2K)*			*E/O cost relative to baseline costs (£/m^2)*		
	'Good' fabric	*'Better' fabric*	*'Best' fabric*	*'Good' fabric*	*'Better' fabric*	*'Best' fabric*
Roof	0.18	0.15	0.10	£1	£3	£8
External wall	0.25	0.20	0.15	£6	£8	£11
Ground floor	0.20	0.15	0.10	£3	£9	£18
Windows / doors	1.5	1.1	0.7	£3	£66	£218

The two other variables that changed between fabric packages were air tightness and thermal bridging, as summarised below.

Table 42: Air tightness and thermal bridging values and costs

	Value				*E/O cost relative to baseline costs (£/dwelling)*		
	Ref.	***'Good' fabric***	***'Better' fabric***	***'Best' fabric***	***'Good' fabric***	***'Better' fabric***	***'Best' fabric***
Air permeability q_{50} ($m^3/m^2/hr$)	10	7	4	1	£0	£700	£1,000
Thermal bridging y-value (W/m^2K)	0.08	0.08	0.04	0.02	£0	£0	£0

The UK building industry has relatively limited experience in achieving very low thermal bridging values. The technical feasibility of completing dwellings with y-values as low as 0.02 has been questioned by some in the industry and the costs of reducing thermal bridging are relatively uncertain (and likely to vary with dwelling type, construction method etc). For the purposes of this study no cost has been allocated to improving the thermal bridging y-value. This means that the overall costs of fabric improvement could be regarded as relatively optimistic.

Based on the costs above, and appropriate assumptions regarding elemental areas, the total costs of the 'Reference' fabric packages were £5,266, £17,260, £25,516, £36,165 for the flat, terraced, semi-detached and detached dwellings respectively. The low cost for the flat is due to no costs being included for roof or floor insulation, since it is a mid-floor flat. The following table summarises the extra cost (above the 'Reference' fabric packages) for each of the improved fabric measures.

Table 43: Extra over cost of improved fabric package

Fabric package	***E/O cost of improved U-values, air permeability and thermal bridging relative to 'Reference' package***			
	Flat	***Terrace***	***Semi***	***Detached***
Good	£215	£42	£186	£243
Better	£1,358	£1,992	£2,539	£3,066
Best	£2,668	£5,045	£6,442	£7,934

With such a low air permeability value, dwellings with the 'Best' fabric measures require a mechanical ventilation system. It was assumed that a mechanical ventilation system with heat recovery would be specified in Code homes, due to the energy savings available by incorporating heat recovery. The MVHR system costs are given below.

Table 44: Cost of mechanical ventilation with heat recovery systems

	Flat	***Terrace***	***Semi***	***Detached***
MVHR system cost	£1,600	£1,800	£2,200	£2,400

10 APPENDIX 2: LZC TECHNOLOGY COSTS AND SIZING

10.1 Technology cost projections

The following tables summarise the technology costs used in this study. The costs are typical representative figures and include delivery and installation, but exclude VAT. Cost projections are based on market tested, pier reviewed data.

10.1.1 Photovoltaics

Table 45: Photovoltaic system costs

Year	Houses		Flats	Maintenance cost (£/yr)	Notes
	Fixed cost (£/installation)	Variable cost (£/kWp)	System cost (£/kWp)		
2009	£1,500	£3,680	£4,500	£50 / yr	Maintenance cost based on the following assumptions: Electrical inspection every 5 years at a cost of £80 (5 inspections over the lifetime of the system) One inverter replacement during the system's lifetime (of 30 years) at a cost of £1,200 Approximate maintenance cost per year = £50
2010	£1,500	£3,400	£4,157	£50 / yr	
2011	£1,500	£3,160	£3,864	£50 / yr	
2012	£1,500	£2,960	£3,619	£50 / yr	
2013	£1,500	£2,760	£3,375	£50 / yr	
2014	£1,500	£2,600	£3,179	£50 / yr	
2015	£1,500	£2,440	£2,984	£50 / yr	
2016	£1,500	£2,336	£2,856	£50 / yr	
2017	£1,500	£2,232	£2,729	£50 / yr	
2018	£1,500	£2,128	£2,602	£50 / yr	
2019	£1,500	£2,024	£2,475	£50 / yr	
2020	£1,500	£1,920	£2,348	£50 / yr	

10.1.2 Solar Hot Water

Table 46: Solar hot water system costs

Year	SHW system cost		Maintenance cost (£/yr)	Notes
	(£/kWp)	£/installation		
2009	£777	£1,335	£15	Solar thermal systems are designed for low maintenance. A cost of £15 per year is allowed for occasional cleaning and to cover the cost of a replacement pump once in the system's 30 year life.
2010	£744	£1,264	£15	
2011	£720	£1,207	£15	
2012	£687	£1,136	£15	
2013	£663	£1,065	£15	
2014	£638	£1,037	£15	
2015	£622	£994	£15	
2016	£605	£974	£15	
2017	£589	£954	£15	
2018	£573	£934	£15	
2019	£556	£914	£15	
2020	£540	£895	£15	

10.1.3 Air Source Heat Pumps

The installed cost for an ASHP in 2009 is based upon quotes from a major heat pump manufacturer. Given the smaller thermal demands of a flat or a terraced house, a slightly smaller heat pump unit may be specified, with a thermal output up to around 5kW. The semi-detached and detached house would require a slightly larger unit (with an output up to around 10kW), and this is reflected in the costs given below. Discussions with manufacturers and installers suggest that the installation of an ASHP may require around an extra day relative to fitting a standard gas boiler. An additional labour cost of £500 has therefore been allowed and is included in the stated costs. In terms of maintenance, a closed system ASHP requires an annual inspection only. Maintenance costs are therefore assumed to be no higher than for a traditional condensing gas boiler.

Table 47: Air source heat pump system costs

Year	*ASHP installed cost*		*Maintenance cost (£/yr)*
	Flat/terrace	*Semi/detached*	
2009	£2,858	£3,553	£65
2010	£2,770	£3,443	£65
2011	£2,681	£3,333	£65
2012	£2,593	£3,223	£65
2013	£2,504	£3,113	£65
2014	£2,446	£3,040	£65
2015	£2,387	£2,967	£65
2016	£2,339	£2,901	£65
2017	£2,292	£2,835	£65
2018	£2,245	£2,769	£65
2019	£2,198	£2,703	£65
2020	£2,151	£2,637	£65

10.1.4 Biomass Heating

The cost of individual biomass boilers can vary depending on the exact specification. An installed cost of £10,000 for a pellet-fed boiler for an individual house has been used as a representative figure. The community biomass heating costs are based on industry data for subterranean tip-in woodchip boilers. As for all the community energy solutions, a heat distribution cost is also added to determine the total cost.

Table 48: Biomass heating costs

Year	*Biomass boiler plant cost*			*Maintenance cost*		
	Individual boiler (£)	*Community boiler (up to 200kW) (£/kW)*	*Community boiler (above 200kW) (£/kW)*	*Individual boiler (£/yr)*	*Community boiler (up to 200kW) (% of cap.ex.)*	*Community boiler (above 200kW) (% of cap.ex.)*
2009	£10,000	£800	£250	£300	2%	2%
2010	£10,000	£800	£250	£300	2%	2%
2011	£10,000	£800	£250	£300	2%	2%
2012	£10,000	£800	£250	£300	2%	2%
2013	£10,000	£800	£250	£300	2%	2%
2014	£10,000	£800	£250	£300	2%	2%
2015	£10,000	£800	£250	£300	2%	2%
2016	£10,000	£800	£250	£300	2%	2%
2017	£10,000	£800	£250	£300	2%	2%
2018	£10,000	£800	£250	£300	2%	2%
2019	£10,000	£800	£250	£300	2%	2%
2020	£10,000	£800	£250	£300	2%	2%

10.1.5 Gas-fired Combined Heat and Power

The micro gas CHP unit modelled in this study was based on fuel cell technology, with a 1kWe system per dwelling, with a heat : power ratio of unity. For the purposes of the SAP calculation, it was assumed that such a system may meet 60% of the dwelling's thermal demands, with the remainder being met by a 90% efficient side-boiler. Although fuel cell CHP units are not currently available, development work continues and they are set to appear on the market within the next few years. Manufacturers have implied that the target price will be around £4,000 to £4,500 installed.

Table 49: Gas combined heat and power costs

Year	Gas CHP cost					Maintenance cost		
	Micro CHP (£)	Medium CHP (up to 200kWe)		Large CHP (>200kWe)		Micro (£/yr)	Medium (% of cap.ex.)	Large (% of cap.ex.)
		£/kWe	£/dwelling	£/kWe	£/dwelling			
2009	N/A	£2,045	£900	£1,000	£300	£110	4%	3%
2010	N/A	£2,045	£900	£1,000	£300	£110	4%	3%
2011	£5,000	£2,045	£900	£1,000	£300	£110	4%	3%
2012	£5,000	£2,045	£900	£1,000	£300	£110	4%	3%
2013	£4,800	£2,045	£900	£1,000	£300	£110	4%	3%
2014	£4,600	£2,045	£900	£1,000	£300	£110	4%	3%
2015	£4,400	£2,045	£900	£1,000	£300	£110	4%	3%
2016	£4,200	£2,045	£900	£1,000	£300	£110	4%	3%
2017	£4,000	£2,045	£900	£1,000	£300	£110	4%	3%
2018	£4,000	£2,045	£900	£1,000	£300	£110	4%	3%
2019	£4,000	£2,045	£900	£1,000	£300	£110	4%	3%
2020	£4,000	£2,045	£900	£1,000	£300	£110	4%	3%

10.1.6 Biomass Combined Heat and Power

The small biomass CHP plant is based on Talbott's BG100 unit, which gives 100kWe output and has a heat to power ratio of around 3:1. The cost used includes delivery, installation (including grid connection), and commissioning. The medium and medium-large systems are based on Organic Rankine Cycle technology, with a heat to power ratio of 4.3:1.

Table 50: Biomass combined heat and power costs

Year	*Biomass CHP plant cost (£/kWe)*			*Maintenance cost*		
	Small (100kWe)	*Medium (500kWe)*	*Medium-large (800kWe)*	*Small (100kWe)*	*Medium (500kWe)*	*Medium-large (800kWe)*
2009	£4,850	£6,767	£4,395	4%	4%	4%
2010	£4,702	£6,632	£4,307	4%	4%	4%
2011	£4,603	£6,429	£4,175	4%	4%	4%
2012	£4,504	£6,293	£4,087	4%	4%	4%
2013	£4,355	£6,158	£3,999	4%	4%	4%
2014	£4,256	£5,955	£3,867	4%	4%	4%
2015	£4,157	£5,820	£3,779	4%	4%	4%
2016	£4,058	£5,684	£3,692	4%	4%	4%
2017	£3,959	£5,549	£3,604	4%	4%	4%
2018	£3,860	£5,414	£3,516	4%	4%	4%
2019	£3,761	£5,278	£3,428	4%	4%	4%
2020	£3,662	£5,143	£3,340	4%	4%	4%

10.1.7 Heat Distribution

The heat distribution costs included for community heating schemes are given below. These costs were derived from a Combined Heat and Power Association report.[18]

Table 51:District heating costs

Dwelling density (dwellings/hectare)	*Pipe length*	*Cost (£/dwelling)*
40	20	£9,000
80	12	£4,700
160	8	£2,800

A heat distribution cost of £2,500 per flat was assumed for block heating in flats.

[18] www.tcpa.org.uk/press_files/pressreleases_2008/20080331_CEG.pdf

10.2 Technology sizing

10.2.1 Photovoltaics

A range of PV systems are now available on the market. This study considered polycrystalline cells, with a power density of 0.125kWp/m^2 of panel area. The following table shows the roof area assumptions made, which allowed calculation of the maximum PV system size possible for each dwelling type.

Table 52: Maximum PV capacity by dwelling type

Dwelling type	*Suitable roof area available for PV (m^2/dwelling)*	*Maximum PV power output (kWp)*
Flat	6	0.75
Terraced house	20	2.5
Semi-detached house	24	3.0
Detached house	32	4.0

The electricity generated by PV systems was calculated in accordance with SAP 2005 (Appendix M), which gives the formula:

$$\text{Electricity produced (kWh/yr)} = 0.75 \times kWp \times S \times Z_{pv}$$

Where kWp is the peak power output of the array, S is the annual solar radiation (which is given in the SAP tables and depends on orientation), and Z_{pv} is the overshading factor (also given in SAP tables).

For both the PV and SHW technologies, it was assumed that systems would be installed with a SE/SW orientation, at 30^o tilt angle and with little or no overshading.

10.2.2 Solar Hot Water

The solar hot water systems modelled in this study were based on evacuated tube systems, which were assumed to have a peak output of 0.7kW/m^2 of panel area. The maximum available area for SHW on a given dwelling was assumed to be the same as that for PV systems (though the selection of these systems was mutually exclusive). However, the areas of the systems specified did not approach these limits as the consideration of percentage of hot water demands met was the first limiting factor. Solar thermal systems are typically sized to meet up to 50–60% of hot water demands and this guideline was adhered to in this work. The energy input from the SHW systems specified was calculated in accordance with the methodology set out in SAP 2005.

10.2.3 Air Source Heat Pumps

The performance of heat pumps in terms of efficiency (or coefficient of performance, COP) increases when the temperature difference between the source of heat and the heat sink is minimised. That is, efficiency is maximised when heat is delivered at a low temperature. New houses tend to have better levels of insulation and air tightness than existing buildings, and therefore lower thermal demands. Heat may be delivered at a lower temperature in new builds (especially if an underfloor heating system is specified) and ASHPs are therefore better suited to the new build market than use in retrofit applications.

The COP of the ASHPs modelled in SAP was taken as 2.5. Based on discussions with heat pump manufacturers, this may be considered as a relatively conservative figure and higher efficiencies may be possible.

10.2.4 Biomass Heating

The size of the community biomass heating boilers for each development was derived based on total thermal demands for the development and assumed load factors in the region of 10–15%.[19] Diversity effects mean that demands tend to be smoothed to a greater extent in larger developments, which means that higher load factors may be assumed.

For biomass block heating of flats, the plant size was derived by assuming a capacity of 4kW per flat and a given number of flats per block (8, 10, or 20), depending on the development scenario.

The efficiency of community biomass boilers was taken to be 81%, and it was assumed that they would meet all thermal demands.

[19] Total thermal demands were calculated by summing the demands of each dwelling type. Since only mid-floor flats were modelled, an adjustment was made to account for the fact that the heat loss from a block of flats would be higher than the sum of the heat losses from mid-floor flats only due to ground and top floor flats. This adjustment was made by calculating the thermal demands of a typical ground or top floor flat, assuming a suitable ratio of mid-floor to ground/top floor flats and thus deriving an adjustment factor.

10.2.5 Gas-fired Combined Heat and Power

As mentioned above, the micro gas CHP unit considered in this work is based on fuel cell technology. It was assumed that a 1kWe unit could be installed per house, with a heat to power ratio of 1 and an overall efficiency of 82%. Due to a lack of detailed data (no micro CHP units are currently defined in the SEDBUK database, for example), calculation of the carbon savings from micro gas CHP could not be done following the SAP methodology. Instead, the calculations were based on the technical details mentioned above and the following assumptions:

- CHP unit meets 60% of thermal demands.
- Remaining thermal demands are met by a 90% efficient side-boiler.
- 60% of the electricity generated is available for export to the grid.
- All electricity generated is credited with a carbon saving at 0.568kgCO_2/kWh, as directed by SAP 2005.

Community CHP systems (both gas and biomass-fired) were sized using the following methodology:

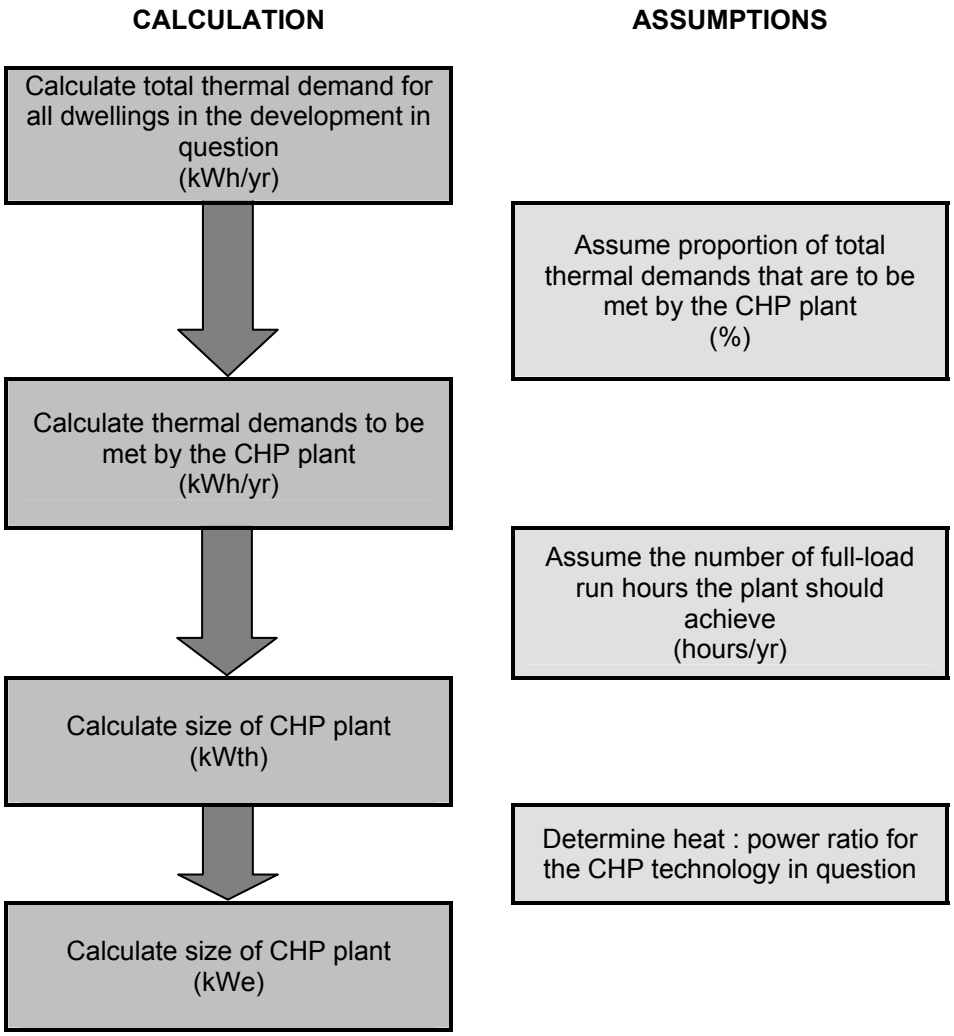


Figure 14: CHP sizing methodology

In all cases, it was assumed that the community CHP plant would meet 80% of the total thermal demands. Also, the number of full-load run hours was taken to be 5,000, which is a typical figure often cited as CHP units should generally exceed this for economic operation. For gas CHP units, a heat to power ratio of 1.5 was assumed, and an overall efficiency value of 80%. These are typical values for CHP technologies suitable for use at the community scale, such as internal combustion engines and gas turbines. For biomass CHP, the heat to power ratio depends upon the technology employed (which depends on development scenario – see below).

10.2.6 Biomass Combined Heat and Power

The sizing methodology for biomass CHP was the same as for gas CHP (see figure 2, above). However, depending on the size of the development, and therefore total thermal demands (hence CHP plant size), one of two biomass CHP technologies was considered. These are summarised in the table below.

Table 53: Biomass CHP technologies

	BG100	***Organic Rankine Cycle***
Indicative size (kWe)	100	500+
Heat to Power ratio	2.0	4.3
Overall efficiency	80%	80%

An alternative technology type is the steam turbine, which is suitable for systems of around 2,500kWe and above. However, biomass CHP was only considered for the highest Code levels, which means that thermal demands are relatively low (due to the high levels of insulation) and the required plant size did not approach this level for any of the developments considered.

10.3 Cost of Ene 1 Options

Based on the cost assumptions and sizing methodology outlined above, and the target percentage improvement in DER required, each of the Ene 1 options was costed for each dwelling in every development scenario. The costs per dwelling for community heating solutions vary depending on the characteristics of the development (scale and dwelling density) and the tables below show the costs for two development types: medium scale edge of town (650 dwellings, 40dph), and medium urban (350 dwellings, 80dph).

Table 54: Technology sizes and costs (2009) for a medium urban development

No.	*CL*	*Short name*	*Technology size*				*Total E/O cost of Ene 1 option (£k / dwelling)*			
			F	*T*	*S*	*D*	*F*	*T*	*S*	*D*
1	1	Good fabric	N/A				0.2	0.1	0.2	0.2
2	2	Good+ / Better fabric	N/A				1.4	1.3	0.7	0.6
3	3	Good, PV	0.5kW	0.75kW	0.75kW	1kW	2.5	4.3	4.4	5.4
4	3	Better/Best (SHW)	0.7kW	No SHW required			6.1	6.8	8.6	3.1
5	3	ASHP	5kW	5kW	9kW	9kW	1.6	1.4	2.0	2.0
6	3	Better, PV	0.25kW	0.25kW	0.25kW	0kW	2.5	4.4	5.0	3.1
7	3	Better, SHW	1.6kW	1.6kW	0.7kW	0kW	3.9	4.6	4.4	3.1
8	4	ASHP, PV	0.4kW PV	0.35kW PV	0.25kW PV	0kW PV	4.5	6.1	6.8	4.9
9	4	BM heating	Block heating (flats) – 4kW per flat Individual BM boilers for houses				10.5	15.3	16.9	18.6
10	4	MVHR, PV	0.75kW	0.75kW	0.5kW	0.25kW	7.6	11.1	12.0	12.8
11	4	Community gas CHP	190kWe				6.6	6.8	7.0	7.6
12	4	Micro gas CHP	1kWe unit per dwelling				Not available in 2009			
13	5	BM heating, PV (100%)	Block heating (flats) – 4kW per flat Individual BM boilers for houses				13.8	20.7	23.0	26.0
			0.75kW	1.05kW	1.25kW	1.6kW				
14	5	Community gas CHP, PV	130kWe gas CHP				14.8	18.9	21.4	24.7
			0.95kW	1.15kW	1.35kW	1.75kW				
15	6	Community gas CHP, PV	130kWe gas CHP				24.9	28.1	32.0	36.1
			3.2kW	3.65kW	4.25kW	4.85kW				
16	6	BM CHP, PV	c.100kWe				15.9	19.5	21.4	24.1
			1.3kW	1.4kW	1.4kW	1.6kW				
17	6	BM heating, PV (ZCH)	Block heating (flats) – 4kW per flat Individual BM boilers for houses				23.7	29.9	33.3	37.4
			2.95kW	3.55kW	4.05kW	4.7kW				

No. = Ene 1 option number. CL = Target Code Level.

Table 55: Technology sizes and costs (2009) for a medium edge of town development

No.	CL	Short name	Technology size				Total E/O cost of Ene 1 option (£k / dwelling)			
			F	T	S	D	F	T	S	D
1	1	Good fabric	N/A				0.2	0.1	0.2	0.2
2	2	Good+ / Better fabric	N/A				1.4	1.3	0.7	0.6
3	3	Good, PV	0.5kW	0.75kW	0.75kW	1kW	2.5	4.3	4.4	5.4
4	3	Better/Best (SHW)	0.7kW	No SHW required			6.1	6.8	8.6	3.1
5	3	ASHP	5kW	5kW	9kW	9kW	1.3	1.2	1.7	1.8
6	3	Better, PV	0.25kW	0.25kW	0.25kW	0kW	2.5	4.4	5.0	3.1
7	3	Better, SHW	1.6kW	1.6kW	0.7kW	0kW	3.9	4.6	4.4	3.1
8	4	ASHP, PV	0.4kW PV	0.35kW PV	0.25kW PV	0kW PV	4.3	5.9	6.5	4.6
9	4	BM heating	Block heating (flats) – 4kW per flat Individual BM boilers for houses				10.2	15.1	16.6	18.3
10	4	MVHR, PV	0.75kW	0.75kW	0.5kW	0.25kW	7.6	11.1	12.0	12.8
11	4	Community gas CHP	190kWe				9.6	9.7	9.7	10.0
12	4	Micro gas CHP	1kWe unit per dwelling				Not available in 2009			
13	5	BM heating, PV (100%)	Block heating (flats) – 4kW per flat Individual BM boilers for houses				13.6	20.5	22.7	25.7
			0.75kW	1.05kW	1.25kW	1.6kW				
14	5	Community gas CHP, PV	130kWe gas CHP				17.9	22.0	24.4	27.6
			0.95kW	1.15kW	1.35kW	1.75kW				
15	6	Community gas CHP, PV	130kWe gas CHP				28.0	31.2	35.0	39.0
			3.2kW	3.65kW	4.25kW	4.85kW				
16	6	BM CHP, PV	c.100kWe				20.0	23.6	25.4	28.1
			1.3kW	1.4kW	1.4kW	1.6kW				
17	6	BM heating, PV (ZCH)	Block heating (flats) – 4kW per flat Individual BM boilers for houses				23.5	29.7	33.0	37.1
			2.95kW	3.55kW	4.05kW	4.7kW				

No. = Ene 1 option number. CL = Target Code Level.

11 APPENDIX 3: FUEL AND ELECTRICITY PRICES

The gas and electricity prices used in this study were taken from a report by the government's inter-departmental analysts group, published by defra.[20] The biomass fuel prices used were those given in SAP 2005 and were assumed constant in all years: 3p/kWh for wood pellets and 1.6p/kWh for wood chips.

Table 56: Gas and electricity prices

Year	*Domestic gas price (p/kWh)*	*Domestic electricity price (p/kWh)*
2009	3.1	12.5
2010	3.1	12.3
2011	3.1	11.4
2012	3.1	11.4
2013	3.1	11.4
2014	3.1	11.5
2015	3.1	11.6
2016	3.1	11.6
2017	3.1	11.7
2018	3.1	11.7
2019	3.2	11.8
2020	3.2	11.8

[20] http://www.defra.gov.uk/environment/climatechange/uk/ukccp/pdf/greengas-policyevaluation.pdf

12 APPENDIX 4: COST DATA TABLES

Table 57: E/O costs and credits by issue: Small Brownfield development

Small Brownfield Development: Code Level 1										
Category	***Issue***	***Details of measures***	***Flat***		***Terraced house***		***Semi-detached***		***Detached***	
			Credits	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***
Energy / CO_2	Ene 1	Good fabric	1	£215	1	£118	1	£186	1	£243
	Ene 2	Credits awarded based on HLP achieved with given fabric package	2	£0	1	£0	0	£0	0	£0
	Ene 3	>40% of internal light fittings dedicated energy efficient (flat)	2	£30	2	£40	2	£50	0	£0
	Ene 4	Internal tidy-dry	1	£15	1	£15	1	£15	1	£15
	Ene 5	Information on benefits of purchasing energy efficient white goods provided	1	£5	1	£5	1	£5	1	£5
	Ene 6	One zero cost credit assumed for ensuring all external light fittings are energy efficient	1	£0	1	£0	1	£0	1	£0
	Ene 7	No LZC technologies employed	0	£0	0	£0	0	£0	0	£0
	Ene 8	Cycle storage not provided	0	£0	0	£0	0	£0	0	£0
	Ene 9	Home office fixtures not provided	0	£0	0	£0	0	£0	0	£0
Energy / CO_2 Totals			**8**	**£265**	**7**	**£178**	**6**	**£256**	**4**	**£263**
Water	Wat 1	Assumed achieving 110 litres/person/day is zero cost	2	£0	2	£0	2	£0	2	£0
	Wat 2	No water butts included	1	£0	0	£0	0	£0	0	£0
Water Totals			**3**	**£0**	**2**	**£0**	**2**	**£0**	**2**	**£0**
Materials	Mat 1	Assumed 12 zero cost credits (out	12	£0	12	£0	12	£0	12	£0

		of 15)								
	Mat 2	Assumed 4 zero cost credits (out of 6)	4	£0	4	£0	4	£0	4	£0
	Mat 3	Assumed 1 zero cost credit (out of 3)	1	£0	1	£0	1	£0	1	£0
Materials Totals			**17**	**£0**	**17**	**£0**	**17**	**£0**	**17**	**£0**
Surface Water	Sur 1	No SUDS systems specified	0	£0.0	0	£0.0	0	£0.0	0	£0.0
	Sur 2	Assumed development is in an area of low flood risk	2	£0	2	£0	2	£0	2	£0
Surface Water Totals			**2**	**£0**	**2**	**£0**	**2**	**£0**	**2**	**£0**
Waste	Was 1	Internal storage for recyclable waste provided, assumed collection scheme exists	4	£25	4	£25	4	£25	4	£25
	Was 2	Assumed maximum credits could be achieved for no extra cost	2	£0	2	£0	2	£0	2	£0
	Was 3	Composting facilities not provided	0	£0	0	£0	0	£0	0	£0
Waste Totals			**6**	**£25**	**6**	**£25**	**6**	**£25**	**6**	**£25**
Pollution	Pol 1	Zero cost credit	1	£0	1	£0	1	£0	1	£0
	Pol 2	High efficiency gas boiler meets requirement for 3 credits	3	£0	3	£0	3	£0	3	£0
Pollution Totals			**4**	**£0**	**4**	**£0**	**4**	**£0**	**4**	**£0**
Health & Well-Being	Hea 1	Assumed view of sky can be achieved at no E/O cost in all dwellings and that ADF of >1.5% in living rooms is met by default in detached house	1	£0	1	£0	1	£0	2	£0
	Hea 2	Detached house scores maximum credits by default	0	£0	0	£0	0	£0	4	£0
	Hea 3	Assumed zero cost credit	1	£0	1	£0	1	£0	1	£0
	Hea 4	Lifetime Homes standards not met	0	£0	0	£0	0	£0	0	£0
Health & Well-Being Totals			**2**	**£0**	**2**	**£0**	**2**	**£0**	**7**	**£0**

Manage-ment	Man 1	Home user guide provided, including information on site and surroundings	3	£25	£3	£25	£3	£25	£3	£25
	Man 2	Assumed zero cost credits	2	£0	2	£0	2	£0	2	£0
	Man 3	Covering two items in site management strategy assumed to be zero cost	1	£0	£1	£0	£2	£50	£1	£0
	Man 4	Credits not sought	0	£0	0	£0	0	£0	0	£0
Management Totals			**6**	**£25**	**6**	**£25**	**7**	**£75**	**6**	**£25**
Ecology	Eco 1	Brownfield site, 1 credit by default	1	£0	1	£0	1	£0	1	£0
	Eco 2	Ecologist not employed	0	£0	0	£0	0	£0	0	£0
	Eco 3	Credit only achieved if ecologist is employed	0	£0	0	£0	0	£0	0	£0
	Eco 4	Credits only achieved if ecologist is employed	0	£0	0	£0	0	£0	0	£0
	Eco 5	No credits achieved	0	£0	0	£0	0	£0	0	£0
Ecology Totals			**1**	**£0**	**1**	**£0**	**1**	**£0**	**1**	**£0**
Total Code Credits			**49**		**47**		**47**		**49**	
Total Percentage Points Score			**39**		**36**		**36**		**38**	
Total Extra Over Cost			**£315**		**£228**		**£356**		**£313**	

Small Brownfield Development: Code Level 2										
Category	***Issue***	***Details of measures***	***Flat***		***Terraced house***		***Semi-detached***		***Detached***	
			Credits	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***
Energy / CO_2	Ene 1	Good+ / Better fabric	2	£1,358	2	£1,292	3	£705	3	£626
	Ene 2	Credits awarded based on HLP achieved with given fabric package	2	£0	2	£0	1	£0	1	£0
	Ene 3	>75% of internal light fittings dedicated energy efficient	2	£30	2	£40	2	£50	2	£60
	Ene 4	Internal tidy-dry	1	£15	1	£15	1	£15	1	£15
	Ene 5	Information on benefits of purchasing energy efficient white goods provided	1	£5	1	£5	1	£5	1	£5
	Ene 6	One zero cost credit assumed for ensuring all external light fittings are energy efficient	1	£0	1	£0	1	£0	1	£0
	Ene 7	Insufficient contribution from LZC technologies	0	£0	0	£0	0	£0	0	£0
	Ene 8	Cycle storage not provided	0	£0	0	£0	0	£0	0	£0
	Ene 9	Home office fixtures not provided	0	£0	0	£0	0	£0	0	£0
Energy / CO_2 Totals			**9**	**£1,408**	**9**	**£1,352**	**9**	**£775**	**9**	**£706**
Water	Wat 1	Assumed achieving 110 litres/person/day is zero cost	2	£0	2	£0	2	£0	2	£0
	Wat 2	Water butts included for block of flats	1	£0	0	£0	0	£0	0	£0
Water Totals			**3**	**£0**	**2**	**£0**	**2**	**£0**	**2**	**£0**
Materials	Mat 1	Assumed 12 zero cost credits (out of 15)	12	£0	12	£0	12	£0	12	£0
	Mat 2	Assumed 4 zero cost credits (out of 6)	4	£0	4	£0	4	£0	4	£0
	Mat 3	Assumed 1 zero cost credit (out of	1	£0	1	£0	1	£0	1	£0

		3)								
Materials Totals			**17**	**£0**	**17**	**£0**	**17**	**£0**	**17**	**£0**
Surface Water	Sur 1	No SUDS systems specified	0	£0.0	0	£0.0	0	£0.0	0	£0.0
	Sur 2	Assumed development is in an area of low flood risk	2	£0	2	£0	2	£0	2	£0
Surface Water Totals			**2**	**£0**	**2**	**£0**	**2**	**£0**	**2**	**£0**
Waste	Was 1	Internal storage for recyclable waste provided, assumed collection scheme exists	4	£25	4	£25	4	£25	4	£25
	Was 2	Assumed maximum credits could be achieved for no extra cost	2	£0	2	£0	2	£0	2	£0
	Was 3	Composting facilities not provided	0	£0	0	£0	0	£0	0	£0
Waste Totals			**6**	**£25**	**6**	**£25**	**6**	**£25**	**6**	**£25**
Pollution	Pol 1	Zero cost credit	1	£0	1	£0	1	£0	1	£0
	Pol 2	High efficiency gas boiler meets requirement for 3 credits	3	£0	3	£0	3	£0	3	£0
Pollution Totals			**4**	**£0**	**4**	**£0**	**4**	**£0**	**4**	**£0**
Health & Well-Being	Hea 1	Assumed view of sky can be achieved at no E/O cost in all dwellings and that ADF of >1.5% in living rooms is met by default in detached house	1	£0	1	£0	1	£0	2	£0
	Hea 2	Detached house scores maximum credits by default	0	£0	0	£0	0	£0	4	£0
	Hea 3	Assumed zero cost credit	1	£0	1	£0	1	£0	1	£0
	Hea 4	Lifetime Homes standards not met	0	£0	0	£0	0	£0	0	£0
Health & Well-Being Totals			**2**	**£0**	**2**	**£0**	**2**	**£0**	**7**	**£0**
Manage-ment	Man 1	Home user guide provided, including information on site and surroundings	3	£25	£3	£25	£3	£25	£3	£25
	Man 2	Assumed zero cost credits	2	£0	2	£0	2	£0	2	£0

	Man 3	Procedures to cover four items in site management procedures	2	£50	£2	£50	£2	£50	£2	£50
	Man 4	Credits not sought	0	£0	0	£0	0	£0	0	£0
Management Totals			**7**	**£75**	**7**	**£75**	**7**	**£75**	**7**	**£75**
Ecology	Eco 1	Brownfield site, 1 credit by default	1	£0	1	£0	1	£0	1	£0
	Eco 2	Ecologist employed	1	£150	1	£150	1	£150	1	£150
	Eco 3	Credit only achieved if ecologist is employed	1	£0	1	£0	1	£0	1	£0
	Eco 4	Cost of increasing number of plant species	4	£15	4	£15	4	£15	4	£15
	Eco 5	No credits achieved	0	£0	0	£0	0	£0	0	£0
Ecology Totals			**7**	**£165**	**7**	**£165**	**7**	**£165**	**7**	**£165**
Total Code Credits			**57**		**56**		**56**		**61**	
Total Percentage Points Score			**49**		**48**		**48**		**54**	
Total Extra Over Cost			**£1,673**		**£1,617**		**£1,040**		**£971**	

Small Brownfield Development: Code Level 3										
Category	***Issue***	***Details of measures***	***Flat***		***Terraced house***		***Semi-detached***		***Detached***	
			Credits	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***
Energy / CO_2	Ene 1	Good fabric, ASHP	5	£1,573	5	£1,400	5	£1,989	6	£2,046
	Ene 2	Credits awarded based on HLP achieved with given fabric package	2	£0	1	£0	0	£0	0	£0
	Ene 3	>75% of internal light fittings dedicated energy efficient	2	£30	2	£40	2	£50	2	£60
	Ene 4	Internal tidy-dry	1	£15	1	£15	1	£15	1	£15
	Ene 5	Information on benefits of purchasing energy efficient white goods provided	1	£5	1	£5	1	£5	1	£5
	Ene 6	Cost of sensors, timers etc for external lighting	2	£45	2	£45	2	£45	1	£0
	Ene 7	No credits achieved	0	£0	0	£0	0	£0	0	£0
	Ene 8	Cycle storage not provided	0	£0	0	£0	0	£0	0	£0
	Ene 9	Home office fixtures not provided	0	£0	0	£0	0	£0	0	£0
Energy / CO_2 Totals			**13**	**£1,668**	**12**	**£1,505**	**11**	**£2,104**	**11**	**£2,126**
Water	Wat 1	Cost of low flow fittings etc to achieve 105 litres/person/day	3	£200	3	£200	3	£200	3	£240
	Wat 2	Water butts included for block of flats and for houses	1	£0	1	£50	1	£50	1	£50
Water Totals			**4**	**£200**	**4**	**£250**	**4**	**£250**	**4**	**£290**
Materials	Mat 1	Assumed 12 zero cost credits (out of 15)	12	£0	12	£0	12	£0	12	£0
	Mat 2	Assumed 4 zero cost credits (out of 6)	4	£0	4	£0	4	£0	4	£0
	Mat 3	Assumed 1 zero cost credit (out of 3)	1	£0	1	£0	1	£0	1	£0

Materials Totals			**17**	**£0**	**17**	**£0**	**17**	**£0**	**17**	**£0**
Surface Water	Sur 1	No SUDS systems specified	0	£0.0	0	£0.0	0	£0.0	0	£0.0
	Sur 2	Assumed development is in an area of low flood risk	2	£0	2	£0	2	£0	2	£0
Surface Water Totals			**2**	**£0**	**2**	**£0**	**2**	**£0**	**2**	**£0**
Waste	Was 1	Internal storage for recyclable waste provided, assumed collection scheme exists	4	£25	4	£25	4	£25	4	£25
	Was 2	Assumed maximum credits could be achieved for no extra cost	2	£0	2	£0	2	£0	2	£0
	Was 3	Composting facilities provided (flats)	1	£30	0	£0	0	£0	0	£0
Waste Totals			**7**	**£55**	**6**	**£25**	**6**	**£25**	**6**	**£25**
Pollution	Pol 1	Zero cost credit	1	£0	1	£0	1	£0	1	£0
	Pol 2	ASHP is electrically powered, credits not achieved	0	£0	0	£0	0	£0	0	£0
Pollution Totals			**1**	**£0**	**1**	**£0**	**1**	**£0**	**1**	**£0**
Health & Well-Being	Hea 1	Assumed view of sky can be achieved at no E/O cost in all dwellings and that ADF of >1.5% in living rooms is met by default in detached house, extra glazing included in flat, terraced and semi-detached	3	£300	3	£300	3	£300	2	£0
	Hea 2	Detached house scores maximum credits by default, cost of sound testing in terraced and semi-detached houses	0	£0	3	£100	3	£100	4	£0
	Hea 3	Assumed zero cost credit	1	£0	1	£0	1	£0	1	£0
	Hea 4	Lifetime Homes standards not met	0	£0	0	£0	0	£0	0	£0
Health & Well-Being Totals			**4**	**£300**	**7**	**£400**	**7**	**£400**	**7**	**£0**
Manage-	Man 1	Home user guide provided,	3	£25	£3	£25	£3	£25	£3	£25

ment		including information on site and surroundings								
	Man 2	Assumed zero cost credits	2	£0	2	£0	2	£0	2	£0
	Man 3	Procedures to cover four items in site management procedures	2	£50	£2	£50	£2	£50	£2	£50
	Man 4	Credits not sought	0	£0	0	£0	0	£0	0	£0
Management Totals			**7**	**£75**	**7**	**£75**	**7**	**£75**	**7**	**£75**
Ecology	Eco 1	Brownfield site, 1 credit by default	1	£0	1	£0	1	£0	1	£0
	Eco 2	Ecologist employed	1	£150	1	£150	1	£150	1	£150
	Eco 3	Credit only achieved if ecologist is employed	1	£0	1	£0	1	£0	1	£0
	Eco 4	Cost of increasing number of plant species	4	£15	4	£15	4	£15	4	£15
	Eco 5	No credits achieved	0	£0	0	£0	0	£0	0	£0
Ecology Totals			**7**	**£165**	**7**	**£165**	**7**	**£165**	**7**	**£165**
Total Code Credits			**62**		**63**		**62**		**62**	
Total Percentage Points Score			**57**		**58**		**57**		**57**	
Total Extra Over Cost			**£2,463**		**£2,420**		**£3,019**		**£2,681**	

Small Brownfield Development: Code Level 4										
Category	***Issue***	***Details of measures***	***Flat***		***Terraced house***		***Semi-detached***		***Detached***	
			Credits	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***
Energy / CO_2	Ene 1	Better fabric, ASHP, PV for flat (0.4kW), terraced (0.35kW), semi-detached (0.25kW)	8	£4,516	8	£6,138	8	£6,762	8	£4,869
	Ene 2	Credits awarded based on HLP achieved with given fabric package	2	£0	2	£0	2	£0	1	£0
	Ene 3	>75% of internal light fittings dedicated energy efficient	2	£30	2	£40	2	£50	2	£60
	Ene 4	Internal tidy-dry	1	£15	1	£15	1	£15	1	£15
	Ene 5	Information on benefits of purchasing energy efficient white goods provided	1	£5	1	£5	2	£150	2	£150
	Ene 6	Cost of sensors, timers etc for external lighting	2	£45	2	£45	2	£45	2	£45
	Ene 7	Credits based on CO_2 emission reduction due to LZC technologies, cost included in Ene 1 costs	2	£0	1	£0	0	£0	0	£0
	Ene 8	Cycle storage not provided	0	£0	0	£0	0	£0	0	£0
	Ene 9	Home office fixtures not provided	0	£0	0	£0	0	£0	1	£80
Energy / CO_2 Totals			**18**	**£4,611**	**17**	**£6,243**	**17**	**£7,022**	**17**	**£5,219**
Water	Wat 1	Cost of low flow fittings etc to achieve 105 litres/person/day	3	£200	3	£200	3	£200	3	£240
	Wat 2	Water butts included for block of flats and for houses	1	£0	1	£50	1	£50	1	£50
Water Totals			**4**	**£200**	**4**	**£250**	**4**	**£250**	**4**	**£290**
Materials	Mat 1	Assumed 12 zero cost credits (out of 15)	12	£0	12	£0	12	£0	12	£0
	Mat 2	Assumed 4 zero cost credits (out of	4	£0	4	£0	4	£0	4	£0

		6)								
	Mat 3	Assumed 1 zero cost credit (out of 3)	1	£0	1	£0	1	£0	1	£0
Materials Totals			**17**	**£0**	**17**	**£0**	**17**	**£0**	**17**	**£0**
Surface Water	Sur 1	Site-wide SUDS system cost of £1,100 split between all dwellings	2	£55.0	2	£55.0	2	£55.0	2	£55.0
	Sur 2	Assumed development is in an area of low flood risk	2	£0	2	£0	2	£0	2	£0
Surface Water Totals			**4**	**£55**	**4**	**£55**	**4**	**£55**	**4**	**£55**
Waste	Was 1	Internal storage for recyclable waste provided, assumed collection scheme exists	4	£25	4	£25	4	£25	4	£25
	Was 2	Assumed maximum credits could be achieved for no extra cost	2	£0	2	£0	2	£0	2	£0
	Was 3	Composting facilities provided (flats)	1	£30	1	£50	1	£50	1	£50
Waste Totals			**7**	**£55**	**7**	**£75**	**7**	**£75**	**7**	**£75**
Pollution	Pol 1	Zero cost credit	1	£0	1	£0	1	£0	1	£0
	Pol 2	ASHP is electrically powered, credits not achieved	0	£0	0	£0	0	£0	0	£0
Pollution Totals			**1**	**£0**	**1**	**£0**	**1**	**£0**	**1**	**£0**
Health & Well-Being	Hea 1	Assumed view of sky can be achieved at no E/O cost in all dwellings and that ADF of >1.5% in living rooms is met by default in detached house, extra glazing also included	3	£300	3	£300	3	£300	3	£150
	Hea 2	Detached house scores maximum credits by default, cost of sound testing in flat, terraced and semi-detached houses	3	£150	4	£200	4	£200	4	£0
	Hea 3	Assumed zero cost credit	1	£0	1	£0	1	£0	1	£0
	Hea 4	Lifetime Homes standards met in	0	£0	0	£0	0	£0	0	£0

		detached house								
Health & Well-Being Totals			**7**	**£450**	**8**	**£500**	**8**	**£500**	**8**	**£150**
Manage-ment	Man 1	Home user guide provided, including information on site and surroundings	3	£25	£3	£25	£3	£25	£3	£25
	Man 2	Assumed zero cost credits	2	£0	2	£0	2	£0	2	£0
	Man 3	Procedures to cover four items in site management procedures	2	£50	£2	£50	£2	£50	£2	£50
	Man 4	Cost of measures to comply with secured by design principles in terraced and semi-detached houses	0	£0	0	£0	0	£0	0	£0
Management Totals			**7**	**£75**	**7**	**£75**	**7**	**£75**	**7**	**£75**
Ecology	Eco 1	Brownfield site, 1 credit by default	1	£0	1	£0	1	£0	1	£0
	Eco 2	Ecologist employed	1	£150	1	£150	1	£150	1	£150
	Eco 3	Credit only achieved if ecologist is employed	1	£0	1	£0	1	£0	1	£0
	Eco 4	Cost of increasing number of plant species	4	£15	4	£15	4	£15	4	£15
	Eco 5	No credits achieved	0	£0	0	£0	0	£0	0	£0
Ecology Totals			**7**	**£165**	**7**	**£165**	**7**	**£165**	**7**	**£165**
Total Code Credits			**72**		**72**		**72**		**72**	
Total Percentage Points Score			**68**		**68**		**68**		**68**	
Total Extra Over Cost			**£5,611**		**£7,363**		**£8,142**		**£6,029**	

Small Brownfield Development: Code Level 5										
Category	***Issue***	***Details of measures***	***Flat***		***Terraced house***		***Semi-detached***		***Detached***	
			Credits	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***
Energy / CO_2	Ene 1	Best fabric, community gas CHP, PV (0.75kW, 1.05kW, 1.25kW, 1.6kW for flat, terraced, semi, detached)	14	£14,769	14	£18,922	14	£21,365	14	£24,708
	Ene 2	Credits awarded based on HLP achieved with given fabric package	2	£0	2	£0	2	£0	2	£0
	Ene 3	>75% of internal light fittings dedicated energy efficient	2	£30	2	£40	2	£50	2	£60
	Ene 4	Internal tidy-dry	1	£15	1	£15	1	£15	1	£15
	Ene 5	Information on benefits of purchasing energy efficient white goods provided (houses) Efficient white goods included (flat)	2	£150	2	£150	2	£150	2	£150
	Ene 6	Cost of sensors, timers etc for external lighting	2	£45	2	£45	2	£45	2	£45
	Ene 7	Credits based on CO_2 emission reduction due to LZC technologies, cost included in Ene 1 costs	2	£0	2	£0	2	£0	2	£0
	Ene 8	Cycle storage not provided	0	£0	0	£0	0	£0	0	£0
	Ene 9	Home office fixtures provided in flat	1	£80	1	£80	1	£80	1	£80
Energy / CO_2 Totals			**26**	**£15,089**	**26**	**£19,252**	**26**	**£21,705**	**26**	**£25,058**
Water	Wat 1	Low flow fittings and greywater recycling system to achieve consumption of 80 litres/person/day	5	£1,750	5	£4,200	5	£4,200	5	£4,500
	Wat 2	Water butts included for block of flats and for houses	1	£0	1	£50	1	£50	1	£50
Water Totals			**6**	**£1,750**	**6**	**£4,250**	**6**	**£4,250**	**6**	**£4,550**

Materials	Mat 1	Assumed 12 zero cost credits (out of 15)	12	£0	12	£0	12	£0	12	£0
	Mat 2	Assumed 4 zero cost credits (out of 6)	4	£0	4	£0	4	£0	4	£0
	Mat 3	Assumed 1 zero cost credit (out of 3)	1	£0	1	£0	1	£0	1	£0
Materials Totals			**17**	**£0**	**17**	**£0**	**17**	**£0**	**17**	**£0**
Surface Water	Sur 1	Site-wide SUDS system cost of £1,100 split between all dwellings	2	£55.0	2	£55.0	2	£55.0	2	£55.0
	Sur 2	Assumed development is in an area of low flood risk	2	£0	2	£0	2	£0	2	£0
Surface Water Totals			**4**	**£55**	**4**	**£55**	**4**	**£55**	**4**	**£55**
Waste	Was 1	Internal storage for recyclable waste provided, assumed collection scheme exists	4	£25	4	£25	4	£25	4	£25
	Was 2	Assumed maximum credits could be achieved for no extra cost	2	£0	2	£0	2	£0	2	£0
	Was 3	Composting facilities provided (flats)	1	£30	1	£50	1	£50	1	£50
Waste Totals			**7**	**£55**	**7**	**£75**	**7**	**£75**	**7**	**£75**
Pollution	Pol 1	Zero cost credit	1	£0	1	£0	1	£0	1	£0
	Pol 2	Gas CHP meets requirement for 3 credits	3	£0	3	£0	3	£0	3	£0
Pollution Totals			**4**	**£0**	**4**	**£0**	**4**	**£0**	**4**	**£0**
Health & Well-Being	Hea 1	Assumed view of sky can be achieved at no E/O cost in all dwellings and that ADF of >1.5% in living rooms is met by default in detached house, extra glazing also included	3	£300	3	£300	3	£300	3	£150
	Hea 2	Detached house scores maximum credits by default, cost of sound testing in flat, terraced and semi-	4	£250	4	£200	4	£200	4	£0

		detached houses								
	Hea 3	Assumed zero cost credit	1	£0	1	£0	1	£0	1	£0
	Hea 4	Lifetime Homes standards met in houses	0	£0	0	£0	0	£0	0	£0
Health & Well-Being Totals			**8**	**£550**	**8**	**£500**	**8**	**£500**	**8**	**£150**
Manage-ment	Man 1	Home user guide provided, including information on site and surroundings	3	£25	£3	£25	£3	£25	£3	£25
	Man 2	Assumed zero cost credits	2	£0	2	£0	2	£0	2	£0
	Man 3	Procedures to cover four items in site management procedures	2	£50	£2	£50	£2	£50	£2	£50
	Man 4	Cost of measures to comply with secured by design principles in terraced and semi-detached houses	0	£0	0	£0	0	£0	0	£0
Management Totals			**7**	**£75**	**7**	**£75**	**7**	**£75**	**7**	**£75**
Ecology	Eco 1	Brownfield site, 1 credit by default	1	£0	1	£0	1	£0	1	£0
	Eco 2	Ecologist employed	1	£150	1	£150	1	£150	1	£150
	Eco 3	Credit only achieved if ecologist is employed	1	£0	1	£0	1	£0	1	£0
	Eco 4	Cost of increasing number of plant species	4	£15	4	£15	4	£15	4	£15
	Eco 5	No credits achieved	0	£0	0	£0	0	£0	0	£0
Ecology Totals			**7**	**£165**	**7**	**£165**	**7**	**£165**	**7**	**£165**
Total Code Credits			**86**		**86**		**86**		**86**	
Total Percentage Points Score			**84**		**84**		**84**		**84**	
Total Extra Over Cost			**£17,739**		**£24,372**		**£26,825**		**£30,128**	

Small Brownfield Development: Code Level 6										
Category	***Issue***	***Details of measures***	***Flat***		***Terraced house***		***Semi-detached***		***Detached***	
			Credits	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***
Energy / CO_2	Ene 1	Best fabric, community gas CHP, PV (3.2kW, 3.65kW, 4.25kW, 4.85kW for flat, terraced, semi, detached)	15	£24,894	15	£28,122	15	£32,037	15	£36,116
	Ene 2	Credits awarded based on HLP achieved with given fabric package	2	£0	2	£0	2	£0	2	£0
	Ene 3	>75% of internal light fittings dedicated energy efficient	2	£30	2	£40	2	£50	2	£60
	Ene 4	Internal tidy-dry	1	£15	1	£15	1	£15	1	£15
	Ene 5	Information on benefits of purchasing energy efficient white goods provided (houses) Efficient white goods included (flat)	2	£150	2	£150	2	£150	2	£150
	Ene 6	Cost of sensors, timers etc for external lighting	2	£45	2	£45	2	£45	2	£45
	Ene 7	Credits based on CO_2 emission reduction due to LZC technologies, cost included in Ene 1 costs	2	£0	2	£0	2	£0	2	£0
	Ene 8	Cycle storage not provided	0	£0	0	£0	0	£0	0	£0
	Ene 9	Home office fixtures provided in flats and detached houses	1	£80	1	£80	1	£80	1	£80
Energy / CO_2 Totals			**27**	**£25,214**	**27**	**£28,452**	**27**	**£32,377**	**27**	**£36,466**
Water	Wat 1	Low flow fittings and greywater recycling system to achieve consumption of 80 litres/person/day	5	£1,750	5	£4,200	5	£4,200	5	£4,500
	Wat 2	Water butts included for block of flats and for houses	1	£0	1	£50	1	£50	1	£50

Water Totals			**6**	**£1,750**	**6**	**£4,250**	**6**	**£4,250**	**6**	**£4,550**
Materials	Mat 1	Assumed 12 zero cost credits (out of 15)	12	£0	12	£0	12	£0	12	£0
	Mat 2	Assumed 4 zero cost credits (out of 6)	4	£0	4	£0	4	£0	4	£0
	Mat 3	Assumed 1 zero cost credit (out of 3)	1	£0	1	£0	1	£0	1	£0
Materials Totals			**17**	**£0**	**17**	**£0**	**17**	**£0**	**17**	**£0**
Surface Water	Sur 1	Site-wide SUDS system cost of £1,100 split between all dwellings	2	£55.0	2	£55.0	2	£55.0	2	£55.0
	Sur 2	Assumed development is in an area of low flood risk	2	£0	2	£0	2	£0	2	£0
Surface Water Totals			**4**	**£55**	**4**	**£55**	**4**	**£55**	**4**	**£55**
Waste	Was 1	Internal storage for recyclable waste provided, assumed collection scheme exists	4	£25	4	£25	4	£25	4	£25
	Was 2	Assumed maximum credits could be achieved for no extra cost	2	£0	2	£0	2	£0	2	£0
	Was 3	Composting facilities provided	1	£30	1	£50	1	£50	1	£50
Waste Totals			**7**	**£55**	**7**	**£75**	**7**	**£75**	**7**	**£75**
Pollution	Pol 1	Zero cost credit	1	£0	1	£0	1	£0	1	£0
	Pol 2	Gas CHP meets requirement for 3 credits	3	£0	3	£0	3	£0	3	£0
Pollution Totals			**4**	**£0**	**4**	**£0**	**4**	**£0**	**4**	**£0**
Health & Well-Being	Hea 1	Assumed view of sky can be achieved at no E/O cost in all dwellings and that ADF of >1.5% in living rooms is met by default in detached house, extra glazing also included	3	£300	3	£300	3	£300	3	£150
	Hea 2	Detached house scores maximum credits by default, cost of sound testing in flat, terraced and semi-	4	£250	4	£200	4	£200	4	£0

		detached houses								
	Hea 3	Assumed zero cost credit	1	£0	1	£0	1	£0	1	£0
	Hea 4	Lifetime Homes standards met E/O cost for lift included for flats (assumed lift not standard in this small development)	4	£650	4	£1,235	4	£1,235	4	£1,235
Health & Well-Being Totals			**12**	**£1,200**	**12**	**£1,735**	**12**	**£1,735**	**12**	**£1,385**
Manage-ment	Man 1	Home user guide provided, including information on site and surroundings	3	£25	£3	£25	£3	£25	£3	£25
	Man 2	Assumed zero cost credits	2	£0	2	£0	2	£0	2	£0
	Man 3	Procedures to cover four items in site management procedures	2	£50	£2	£50	£2	£50	£2	£50
	Man 4	Cost of measures to comply with secured by design principles in terraced and semi-detached houses	0	£0	0	£0	0	£0	0	£0
Management Totals			**7**	**£75**	**7**	**£75**	**7**	**£75**	**7**	**£75**
Ecology	Eco 1	Brownfield site, 1 credit by default	1	£0	1	£0	1	£0	1	£0
	Eco 2	Ecologist employed	1	£150	1	£150	1	£150	1	£150
	Eco 3	Credit only achieved if ecologist is employed	1	£0	1	£0	1	£0	1	£0
	Eco 4	Cost of increasing number of plant species	4	£15	4	£15	4	£15	4	£15
	Eco 5	No credits achieved	0	£0	0	£0	0	£0	0	£0
Ecology Totals			**7**	**£165**	**7**	**£165**	**7**	**£165**	**7**	**£165**
Total Code Credits			**91**		**91**		**91**		**91**	
Total Percentage Points Score			**90**		**90**		**90**		**90**	
Total Extra Over Cost			**£28,514**		**£34,807**		**£38,732**		**£42,771**	

Table 58: E/O costs and credits by issue: Strategic development

Strategic Development: Code Level 1										
Category	***Issue***	***Details of measures***	***Flat***		***Terraced house***		***Semi-detached***		***Detached***	
			Credits	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***
Energy / CO_2	Ene 1	Good fabric	1	£215	1	£118	1	£186	1	£243
	Ene 2	Credits awarded based on HLP achieved with given fabric package	2	£0	1	£0	0	£0	0	£0
	Ene 3	>75% of internal light fittings dedicated energy efficient (flat)	2	£30	1	£20	1	£20	0	£0
	Ene 4	Internal tidy-dry	1	£15	1	£15	1	£15	1	£15
	Ene 5	Information on benefits of purchasing energy efficient white goods provided	1	£5	1	£5	1	£5	1	£5
	Ene 6	One zero cost credit assumed for ensuring all external light fittings are energy efficient	1	£0	1	£0	1	£0	1	£0
	Ene 7	No LZC technologies employed	0	£0	0	£0	0	£0	0	£0
	Ene 8	Cycle storage not provided	0	£0	0	£0	0	£0	0	£0
	Ene 9	Home office fixtures not provided	0	£0	0	£0	0	£0	0	£0
Energy / CO_2 Totals			**8**	**£265**	**6**	**£158**	**5**	**£226**	**4**	**£263**
Water	Wat 1	Assumed achieving 110 litres/person/day is zero cost	2	£0	2	£0	2	£0	2	£0
	Wat 2	Water butts included for blocks of flats	1	£0	0	£0	0	£0	0	£0
Water Totals			**3**	**£0**	**2**	**£0**	**2**	**£0**	**2**	**£0**
Materials	Mat 1	Assumed 12 zero cost credits (out of 15)	12	£0	12	£0	12	£0	12	£0
	Mat 2	Assumed 4 zero cost credits (out of 6)	4	£0	4	£0	4	£0	4	£0
	Mat 3	Assumed 1 zero cost credit (out of	1	£0	1	£0	1	£0	1	£0

		3)								
Materials Totals			**17**	**£0**	**17**	**£0**	**17**	**£0**	**17**	**£0**
Surface Water	Sur 1	Site-wide SUDS system cost of £1,100 split between all dwellings	2	£0.2	2	£0.2	2	£0.2	2	£0.2
	Sur 2	Assumed development is in an area of low flood risk	2	£0	2	£0	2	£0	2	£0
Surface Water Totals			**4**	**£0**	**4**	**£0**	**4**	**£0**	**4**	**£0**
Waste	Was 1	Internal storage for recyclable waste provided in terraced and detached houses, assumed collection scheme exists	0	£0	4	£25	4	£25	4	£25
	Was 2	Assumed maximum credits could be achieved for no extra cost	2	£0	2	£0	2	£0	2	£0
	Was 3	Composting facilities not provided	0	£0	0	£0	0	£0	0	£0
Waste Totals			**2**	**£0**	**6**	**£25**	**6**	**£25**	**6**	**£25**
Pollution	Pol 1	Zero cost credit	1	£0	1	£0	1	£0	1	£0
	Pol 2	High efficiency gas boiler meets requirement for 3 credits	3	£0	3	£0	3	£0	3	£0
Pollution Totals			**4**	**£0**	**4**	**£0**	**4**	**£0**	**4**	**£0**
Health & Well-Being	Hea 1	Assumed view of sky can be achieved at no E/O cost in all dwellings and that ADF of >1.5% in living rooms is met by default in detached house	1	£0	1	£0	1	£0	2	£0
	Hea 2	Detached house scores maximum credits by default	0	£0	0	£0	0	£0	4	£0
	Hea 3	Assumed zero cost credit	1	£0	1	£0	1	£0	1	£0
	Hea 4	Lifetime Homes standards not met	0	£0	0	£0	0	£0	0	£0
Health & Well-Being Totals			**2**	**£0**	**2**	**£0**	**2**	**£0**	**7**	**£0**
Manage-ment	Man 1	Home user guide provided, including information on site and	3	£0	£3	£0	£3	£0	£3	£0

		surroundings								
	Man 2	Assumed zero cost credits	2	£0	2	£0	2	£0	2	£0
	Man 3	Procedures to cover four items in site management procedures	2	£0	£2	£0	£2	£0	£2	£0
	Man 4	Credits not sought	0	£0	0	£0	0	£0	0	£0
Management Totals			**7**	**£0**	**7**	**£0**	**7**	**£0**	**7**	**£0**
Ecology	Eco 1	Greenfield site, no credits gained	0	£0	0	£0	0	£0	0	£0
	Eco 2	Ecologist not employed	0	£0	0	£0	1	£100	0	£0
	Eco 3	Credit only achieved if ecologist is employed	0	£0	0	£0	1	£0	0	£0
	Eco 4	Credits only available if ecologist is employed	0	£0	0	£0	4	£15	0	£0
	Eco 5	No credits achieved	0	£0	0	£0	0	£0	0	£0
Ecology Totals			**0**	**£0**	**0**	**£0**	**6**	**£115**	**0**	**£0**
Total Code Credits			**47**		**48**		**53**		**51**	
Total Percentage Points Score			**36**		**36**		**42**		**39**	
Total Extra Over Cost			**£265**		**£184**		**£367**		**£289**	

Strategic Development: Code Level 2										
Category	***Issue***	***Details of measures***	***Flat***		***Terraced house***		***Semi-detached***		***Detached***	
			Credits	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***
Energy / CO_2	Ene 1	Better fabric, 0.05kW PV (flats)	2	£1,358	2	£1,292	3	£705	3	£626
	Ene 2	Credits awarded based on HLP achieved with given fabric package	2	£0	2	£0	1	£0	1	£0
	Ene 3	>75% of internal light fittings dedicated energy efficient (flat, terraced), >40% in semi and detached houses	2	£30	2	£40	2	£50	1	£20
	Ene 4	Internal tidy-dry	1	£15	1	£15	1	£15	1	£15
	Ene 5	Information on benefits of purchasing energy efficient white goods provided	1	£5	1	£5	1	£5	1	£5
	Ene 6	One zero cost credit assumed for ensuring all external light fittings are energy efficient	1	£0	1	£0	1	£0	1	£0
	Ene 7	Insufficient contribution from LZC technologies	0	£0	0	£0	0	£0	0	£0
	Ene 8	Cycle storage not provided	0	£0	0	£0	0	£0	0	£0
	Ene 9	Home office fixtures not provided	0	£0	0	£0	0	£0	0	£0
Energy / CO_2 Totals			**9**	**£1,408**	**9**	**£1,352**	**9**	**£775**	**8**	**£666**
Water	Wat 1	Assumed achieving 110 litres/person/day is zero cost	2	£0	2	£0	2	£0	2	£0
	Wat 2	Water butts included for blocks of flats	1	£0	0	£0	0	£0	0	£0
Water Totals			**3**	**£0**	**2**	**£0**	**2**	**£0**	**2**	**£0**
Materials	Mat 1	Assumed 12 zero cost credits (out of 15)	12	£0	12	£0	12	£0	12	£0
	Mat 2	Assumed 4 zero cost credits (out of	4	£0	4	£0	4	£0	4	£0

		6)								
	Mat 3	Assumed 1 zero cost credit (out of 3)	1	£0	1	£0	1	£0	1	£0
Materials Totals			**17**	**£0**	**17**	**£0**	**17**	**£0**	**17**	**£0**
Surface Water	Sur 1	Site-wide SUDS system cost of £1,100 split between all dwellings	2	£0.2	2	£0.2	2	£0.2	2	£0.2
	Sur 2	Assumed development is in an area of low flood risk	2	£0	2	£0	2	£0	2	£0
Surface Water Totals			**4**	**£0**	**4**	**£0**	**4**	**£0**	**4**	**£0**
Waste	Was 1	Internal storage for recyclable waste provided, assumed collection scheme exists	4	£25	4	£25	4	£25	4	£25
	Was 2	Assumed maximum credits could be achieved for no extra cost	2	£0	2	£0	2	£0	2	£0
	Was 3	Composting facilities not provided	0	£0	0	£0	0	£0	0	£0
Waste Totals			**6**	**£25**	**6**	**£25**	**6**	**£25**	**6**	**£25**
Pollution	Pol 1	Zero cost credit	1	£0	1	£0	1	£0	1	£0
	Pol 2	High efficiency gas boiler meets requirement for 3 credits	3	£0	3	£0	3	£0	3	£0
Pollution Totals			**4**	**£0**	**4**	**£0**	**4**	**£0**	**4**	**£0**
Health & Well-Being	Hea 1	Assumed view of sky can be achieved at no E/O cost in all dwellings and that ADF of >1.5% in living rooms is met by default in detached house	1	£0	1	£0	1	£0	2	£0
	Hea 2	Detached house scores maximum credits by default	0	£0	0	£0	0	£0	4	£0
	Hea 3	Assumed zero cost credit	1	£0	1	£0	1	£0	1	£0
	Hea 4	Lifetime Homes standards met in flats	0	£0	0	£0	0	£0	0	£0
Health & Well-Being Totals			**2**	**£0**	**2**	**£0**	**2**	**£0**	**7**	**£0**

Manage-ment	Man 1	Home user guide provided, including information on site and surroundings	3	£0	£3	£0	£3	£0	£3	£0
	Man 2	Assumed zero cost credits	2	£0	2	£0	2	£0	2	£0
	Man 3	Procedures to cover four items in site management procedures	2	£0	£2	£0	£2	£0	£2	£0
	Man 4	Credits not sought	0	£0	0	£0	0	£0	0	£0
Management Totals			**7**	**£0**	**7**	**£0**	**7**	**£0**	**7**	**£0**
Ecology	Eco 1	Greenfield site, no credits gained	0	£0	0	£0	0	£0	0	£0
	Eco 2	Ecologist employed	1	£100	1	£100	1	£100	1	£100
	Eco 3	Credit only achieved if ecologist is employed	1	£0	1	£0	1	£0	1	£0
	Eco 4	Cost of increasing number of plant species	4	£15	4	£15	4	£15	4	£15
	Eco 5	No credits achieved	0	£0	0	£0	0	£0	0	£0
Ecology Totals			**6**	**£115**	**6**	**£115**	**6**	**£115**	**6**	**£115**
Total Code Credits			**58**		**57**		**57**		**61**	
Total Percentage Points Score			**49**		**47**		**47**		**52**	
Total Extra Over Cost			**£1,549**		**£1,493**		**£916**		**£807**	

Strategic Development: Code Level 3										
Category	***Issue***	***Details of measures***	***Flat***		***Terraced house***		***Semi-detached***		***Detached***	
			Credits	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***
Energy / CO_2	Ene 1	Good fabric, ASHP[21]	5	£1,323	5	£1,150	5	£1,739	6	£1,796
	Ene 2	Credits awarded based on HLP achieved with given fabric package	2	£0	1	£0	0	£0	0	£0
	Ene 3	>75% of internal light fittings dedicated energy efficient	2	£30	2	£40	2	£50	2	£60
	Ene 4	Internal tidy-dry	1	£15	1	£15	1	£15	1	£15
	Ene 5	Information on benefits of purchasing energy efficient white goods provided	1	£5	1	£5	1	£5	1	£5
	Ene 6	One zero cost credit assumed for ensuring all external light fittings are energy efficient, E/O cost for sensors, timers etc	2	£45	2	£45	2	£45	1	£0
	Ene 7	No credits achieved	0	£0	0	£0	0	£0	0	£0
	Ene 8	Cycle storage not provided	0	£0	0	£0	0	£0	0	£0
	Ene 9	Home office fixtures not provided	0	£0	0	£0	0	£0	0	£0
Energy / CO_2 Totals			**13**	**£1,418**	**12**	**£1,255**	**11**	**£1,854**	**11**	**£1,876**
Water	Wat 1	Cost of low flow fittings etc to achieve 105 litres/person/day	3	£200	3	£200	3	£200	3	£240
	Wat 2	Water butts included for blocks of flats and for houses	1	£0	1	£50	1	£50	1	£50
Water Totals			**4**	**£200**	**4**	**£250**	**4**	**£250**	**4**	**£290**
Materials	Mat 1	Assumed 12 zero cost credits (out of 15)	12	£0	12	£0	12	£0	12	£0

[21] Note that the E/O cost of this house-by-house Ene1 option differs slightly from the results for the small brownfield development. This is due to different offset benefits for avoiding the need for a gas connection between brownfield and greenfield sites.

	Mat 2	Assumed 4 zero cost credits (out of 6)	4	£0	4	£0	4	£0	4	£0
	Mat 3	Assumed 1 zero cost credit (out of 3)	1	£0	1	£0	1	£0	1	£0
Materials Totals			**17**	**£0**	**17**	**£0**	**17**	**£0**	**17**	**£0**
Surface Water	Sur 1	Site-wide SUDS system cost of £1,100 split between all dwellings	2	£0.2	2	£0.2	2	£0.2	2	£0.2
	Sur 2	Assumed development is in an area of low flood risk	2	£0	2	£0	2	£0	2	£0
Surface Water Totals			**4**	**£0**	**4**	**£0**	**4**	**£0**	**4**	**£0**
Waste	Was 1	Internal storage for recyclable waste provided, assumed collection scheme exists	4	£25	4	£25	4	£25	4	£25
	Was 2	Assumed maximum credits could be achieved for no extra cost	2	£0	2	£0	2	£0	2	£0
	Was 3	Composting facilities not provided	1	£30	0	£0	0	£0	0	£0
Waste Totals			**7**	**£55**	**6**	**£25**	**6**	**£25**	**6**	**£25**
Pollution	Pol 1	Zero cost credit	1	£0	1	£0	1	£0	1	£0
	Pol 2	ASHP is electrically powered, credits not achieved	0	£0	0	£0	0	£0	0	£0
Pollution Totals			**1**	**£0**	**1**	**£0**	**1**	**£0**	**1**	**£0**
Health & Well-Being	Hea 1	Assumed view of sky can be achieved at no E/O cost in all dwellings and that ADF of >1.5% in living rooms is met by default in detached house extra glazing included in terraced and semi	3	£300	3	£300	3	£300	2	£0
	Hea 2	Detached house scores maximum credits by default, cost of sound testing in terraced and semi	0	£0	3	£100	3	£100	4	£0
	Hea 3	Assumed zero cost credit	1	£0	1	£0	1	£0	1	£0
	Hea 4	Lifetime Homes standards met in flats	0	£0	0	£0	0	£0	0	£0

Health & Well-Being Totals			**4**	**£300**	**7**	**£400**	**7**	**£400**	**7**	**£0**
Manage-ment	Man 1	Home user guide provided, including information on site and surroundings	3	£0	£3	£0	£3	£0	£3	£0
	Man 2	Assumed zero cost credits	2	£0	2	£0	2	£0	2	£0
	Man 3	Procedures to cover four items in site management procedures	2	£0	£2	£0	£2	£0	£2	£0
	Man 4	Credits not sought	0	£0	0	£0	0	£0	0	£0
Management Totals			**7**	**£0**	**7**	**£0**	**7**	**£0**	**7**	**£0**
Ecology	Eco 1	Greenfield site, no credits gained	0	£0	0	£0	0	£0	0	£0
	Eco 2	Ecologist employed	1	£100	1	£100	1	£100	1	£100
	Eco 3	Credit only achieved if ecologist is employed	1	£0	1	£0	1	£0	1	£0
	Eco 4	Cost of increasing number of plant species	4	£15	4	£15	4	£15	4	£15
	Eco 5	No credits achieved	0	£0	0	£0	0	£0	0	£0
Ecology Totals			**6**	**£115**	**6**	**£115**	**6**	**£115**	**6**	**£115**
Total Code Credits			**63**		**64**		**63**		**63**	
Total Percentage Points Score			**57**		**58**		**57**		**57**	
Total Extra Over Cost			**£2,088**		**£2,046**		**£2,645**		**£2,307**	

Strategic Development: Code Level 4										
Category	***Issue***	***Details of measures***	***Flat***		***Terraced house***		***Semi-detached***		***Detached***	
			Credits	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***
Energy / CO_2	Ene 1	Better fabric, ASHP, PV for flats (0.4kW), terraced (0.35kW), semi(0.25kW)	8	£4,266	8	£5,888	8	£6,512	8	£4,619
	Ene 2	Credits awarded based on HLP achieved with given fabric package	2	£0	2	£0	2	£0	1	£0
	Ene 3	>75% of internal light fittings dedicated energy efficient	2	£30	2	£40	2	£50	2	£60
	Ene 4	Internal tidy-dry	1	£15	1	£15	1	£15	1	£15
	Ene 5	Information on benefits of purchasing energy efficient white goods provided	1	£5	2	£150	2	£150	2	£150
	Ene 6	Cost of sensors, timers etc for external lighting	2	£45	2	£45	2	£45	2	£45
	Ene 7	Credits based on CO_2 reduction due to LZC technologies, cost included in Ene 1	2	£0	1	£0	0	£0	0	£0
	Ene 8	Cycle storage not provided	0	£0	0	£0	0	£0	0	£0
	Ene 9	Home office fixtures not provided	0	£0	0	£0	1	£80	1	£80
Energy / CO_2 Totals			**18**	**£4,361**	**18**	**£6,138**	**18**	**£6,852**	**17**	**£4,969**
Water	Wat 1	Cost of low flow fittings etc to achieve 105 litres/person/day	3	£200	3	£200	3	£200	3	£240
	Wat 2	Water butts included for blocks of flats and for houses	1	£0	1	£50	1	£50	1	£50
Water Totals			**4**	**£200**	**4**	**£250**	**4**	**£250**	**4**	**£290**
Materials	Mat 1	Assumed 12 zero cost credits (out of 15)	12	£0	12	£0	12	£0	12	£0
	Mat 2	Assumed 4 zero cost credits (out of	4	£0	4	£0	4	£0	4	£0

		6)								
	Mat 3	Assumed 1 zero cost credit (out of 3)	1	£0	1	£0	1	£0	1	£0
Materials Totals			**17**	**£0**	**17**	**£0**	**17**	**£0**	**17**	**£0**
Surface Water	Sur 1	Site-wide SUDS system cost of £1,100 split between all dwellings	2	£0.2	2	£0.2	2	£0.2	2	£0.2
	Sur 2	Assumed development is in an area of low flood risk	2	£0	2	£0	2	£0	2	£0
Surface Water Totals			**4**	**£0**	**4**	**£0**	**4**	**£0**	**4**	**£0**
Waste	Was 1	Internal storage for recyclable waste provided, assumed collection scheme exists	4	£25	4	£25	4	£25	4	£25
	Was 2	Assumed maximum credits could be achieved for no extra cost	2	£0	2	£0	2	£0	2	£0
	Was 3	Composting facilities provided (flats)	1	£30	1	£50	1	£50	1	£50
Waste Totals			**7**	**£55**	**7**	**£75**	**7**	**£75**	**7**	**£75**
Pollution	Pol 1	Zero cost credit	1	£0	1	£0	1	£0	1	£0
	Pol 2	ASHP is electrically powered, credits not achieved	0	£0	0	£0	0	£0	0	£0
Pollution Totals			**1**	**£0**	**1**	**£0**	**1**	**£0**	**1**	**£0**
Health & Well-Being	Hea 1	Assumed view of sky can be achieved at no E/O cost in all dwellings and that ADF of >1.5% in living rooms is met by default in detached house extra glazing also included	3	£300	3	£300	3	£300	3	£150
	Hea 2	Detached house scores maximum credits by default, cost of sound testing in terraced and semi	4	£250	4	£200	4	£200	4	£0
	Hea 3	Assumed zero cost credit	1	£0	1	£0	1	£0	1	£0
	Hea 4	Lifetime Homes standards met in flat, semi and detached houses	0	£0	0	£0	0	£0	4	£1,235

Health & Well-Being Totals			**8**	**£550**	**8**	**£500**	**8**	**£500**	**12**	**£1,385**
Manage-ment	Man 1	Home user guide provided, including information on site and surroundings	3	£0	£3	£0	£3	£0	£3	£0
	Man 2	Assumed zero cost credits	2	£0	2	£0	2	£0	2	£0
	Man 3	Procedures to cover four items in site management procedures	2	£0	£2	£0	£2	£0	£2	£0
	Man 4	Cost of measures to meet secured by design principles in terraced and semi-detached houses	0	£0	0	£0	0	£0	0	£0
Management Totals			**7**	**£0**	**7**	**£0**	**7**	**£0**	**7**	**£0**
Ecology	Eco 1	Greenfield site, no credits gained	0	£0	0	£0	0	£0	0	£0
	Eco 2	Ecologist employed	1	£100	1	£100	1	£100	1	£100
	Eco 3	Credit only achieved if ecologist is employed	1	£0	1	£0	1	£0	1	£0
	Eco 4	Cost of increasing number of plant species	4	£15	4	£15	4	£15	4	£15
	Eco 5	No credits achieved	0	£0	0	£0	0	£0	0	£0
Ecology Totals			**6**	**£115**	**6**	**£115**	**6**	**£115**	**6**	**£115**
Total Code Credits			**72**		**72**		**72**		**75**	
Total Percentage Points Score			**68**		**68**		**68**		**71**	
Total Extra Over Cost			**£5,281**		**£7,079**		**£7,793**		**£6,835**	

Strategic Development: Code Level 5										
Category	***Issue***	***Details of measures***	***Flat***		***Terraced house***		***Semi-detached***		***Detached***	
			Credits	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***
Energy / CO_2	Ene 1	Best fabric, MVHR, BM block heating (flats), BM boilers (houses), PV (0.75kW, 1.05kW, 1.25kW, 1.6kW)	14	£13,593	14	£20,459	14	£22,742	14	£25,722
	Ene 2	Credits awarded based on HLP achieved with given fabric package	2	£0	2	£0	2	£0	2	£0
	Ene 3	>75% of internal light fittings dedicated energy efficient	2	£30	2	£40	2	£50	2	£60
	Ene 4	Internal tidy-dry	1	£15	1	£15	1	£15	1	£15
	Ene 5	Information on benefits of purchasing energy efficient white goods provided	2	£150	2	£150	2	£150	2	£150
	Ene 6	Cost of sensors, timers etc for external lighting	2	£45	2	£45	2	£45	2	£45
	Ene 7	Credits based on CO_2 reduction due to LZC technologies, cost included in Ene 1	2	£0	2	£0	2	£0	2	£0
	Ene 8	Cycle storage not provided	2	£200	2	£650	2	£650	0	£0
	Ene 9	Home office fixtures not provided	1	£80	1	£80	1	£80	1	£80
Energy / CO_2 Totals			**28**	**£14,113**	**28**	**£21,439**	**28**	**£23,732**	**26**	**£26,072**
Water	Wat 1	Low flow fittings and greywater recycling to achieve consumption of 80 litres/person/day	5	£1,750	5	£4,200	5	£4,200	5	£4,500
	Wat 2	Water butts included for blocks of flats and for houses	1	£0	1	£50	1	£50	1	£50
Water Totals			**6**	**£1,750**	**6**	**£4,250**	**6**	**£4,250**	**6**	**£4,550**
Materials	Mat 1	Assumed 12 zero cost credits (out of 15)	12	£0	12	£0	12	£0	12	£0

	Mat 2	Assumed 4 zero cost credits (out of 6)	4	£0	4	£0	4	£0	4	£0
	Mat 3	Assumed 1 zero cost credit (out of 3)	1	£0	1	£0	1	£0	1	£0
Materials Totals			**17**	**£0**	**17**	**£0**	**17**	**£0**	**17**	**£0**
Surface Water	Sur 1	Site-wide SUDS system cost of £1,100 split between all dwellings	2	£0.2	2	£0.2	2	£0.2	2	£0.2
	Sur 2	Assumed development is in an area of low flood risk	2	£0	2	£0	2	£0	2	£0
Surface Water Totals			**4**	**£0**	**4**	**£0**	**4**	**£0**	**4**	**£0**
Waste	Was 1	Internal storage for recyclable waste provided, assumed collection scheme exists	4	£25	4	£25	4	£25	4	£25
	Was 2	Assumed maximum credits could be achieved for no extra cost	2	£0	2	£0	2	£0	2	£0
	Was 3	Composting facilities provided (flats and detached houses)	1	£30	1	£50	1	£50	1	£50
Waste Totals			**7**	**£55**	**7**	**£75**	**7**	**£75**	**7**	**£75**
Pollution	Pol 1	Zero cost credit	1	£0	1	£0	1	£0	1	£0
	Pol 2	NO_x emissions too high to achieve credits with biomass heating	0	£0	0	£0	0	£0	0	£0
Pollution Totals			**1**	**£0**	**1**	**£0**	**1**	**£0**	**1**	**£0**
Health & Well-Being	Hea 1	Assumed view of sky can be achieved at no E/O cost in all dwellings and that ADF of >1.5% in living rooms is met by default in detached house extra glazing also included	3	£300	3	£300	3	£300	3	£150
	Hea 2	Detached house scores maximum credits by default, cost of sound testing in other dwellings	4	£250	4	£200	4	£200	4	£0
	Hea 3	Assumed zero cost credit	1	£0	1	£0	1	£0	1	£0
	Hea 4	Lifetime Homes standards met	4	£650	0	£0	0	£0	4	£1,235

Health & Well-Being Totals			**12**	**£1,200**	**8**	**£500**	**8**	**£500**	**12**	**£1,385**
Manage-ment	Man 1	Home user guide provided, including information on site and surroundings	3	£0	£3	£0	£3	£0	£3	£0
	Man 2	Assumed zero cost credits	2	£0	2	£0	2	£0	2	£0
	Man 3	Procedures to cover four items in site management procedures	2	£0	£2	£0	£2	£0	£2	£0
	Man 4	Cost of measures to meet secured by design principles in terraced and semi-detached houses	0	£0	2	£515	2	£515	0	£0
Management Totals			**7**	**£0**	**9**	**£515**	**9**	**£515**	**7**	**£0**
Ecology	Eco 1	Greenfield site, no credits gained	0	£0	0	£0	0	£0	0	£0
	Eco 2	Ecologist employed	1	£100	1	£100	1	£100	1	£100
	Eco 3	Credit only achieved if ecologist is employed	1	£0	1	£0	1	£0	1	£0
	Eco 4	Cost of increasing number of plant species	4	£15	4	£15	4	£15	4	£15
	Eco 5	No credits achieved	0	£0	0	£0	0	£0	0	£0
Ecology Totals			**6**	**£115**	**6**	**£115**	**6**	**£115**	**6**	**£115**
Total Code Credits			**88**		**86**		**86**		**86**	
Total Percentage Points Score			**88**		**85**		**85**		**85**	
Total Extra Over Cost			**£17,234**		**£26,895**		**£29,187**		**£32,197**	

Strategic Development: Code Level 6										
Category	***Issue***	***Details of measures***	***Flat***		***Terraced house***		***Semi-detached***		***Detached***	
			Credits	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***	***Credits***	***E/O Cost***
Energy / CO_2	Ene 1	Best fabric, MVHR, BM CHP, PV (2.2kW, 2.45kW, 2.65kW, 3.1kW)	15	£23,375	15	£26,655	15	£29,054	15	£32,532
	Ene 2	Credits awarded based on HLP achieved with given fabric package	2	£0	2	£0	2	£0	2	£0
	Ene 3	>75% of internal light fittings dedicated energy efficient	2	£30	2	£40	2	£50	2	£60
	Ene 4	Internal tidy-dry	1	£15	1	£15	1	£15	1	£15
	Ene 5	Energy efficient white goods provided	2	£150	2	£150	2	£150	2	£150
	Ene 6	Cost of sensors, timers etc for external lighting	2	£45	2	£45	2	£45	2	£45
	Ene 7	Credits based on CO_2 reduction due to LZC technologies, cost included in Ene 1	2	£0	2	£0	2	£0	2	£0
	Ene 8	Cycle storage provided	2	£200	2	£650	2	£650	2	£900
	Ene 9	Home office fixtures included	1	£80	1	£80	1	£80	1	£80
Energy / CO_2 Totals			**29**	**£23,895**	**29**	**£27,635**	**29**	**£30,044**	**29**	**£33,782**
Water	Wat 1	Low flow fittings and greywater recycling to achieve consumption of 80 litres/person/day	5	£1,750	5	£4,200	5	£4,200	5	£4,500
	Wat 2	Water butts included for blocks of flats and for houses	1	£0	1	£50	1	£50	1	£50
Water Totals			**6**	**£1,750**	**6**	**£4,250**	**6**	**£4,250**	**6**	**£4,550**
Materials	Mat 1	Assumed 12 zero cost credits (out of 15)	12	£0	12	£0	12	£0	12	£0
	Mat 2	Assumed 4 zero cost credits (out of 6)	4	£0	4	£0	4	£0	4	£0

	Mat 3	Assumed 1 zero cost credit (out of 3)	1	£0	1	£0	1	£0	1	£0
Materials Totals			**17**	**£0**	**17**	**£0**	**17**	**£0**	**17**	**£0**
Surface Water	Sur 1	Site-wide SUDS system cost of £1,100 split between all dwellings	2	£0.2	2	£0.2	2	£0.2	2	£0.2
	Sur 2	Assumed development is in an area of low flood risk	2	£0	2	£0	2	£0	2	£0
Surface Water Totals			**4**	**£0**	**4**	**£0**	**4**	**£0**	**4**	**£0**
Waste	Was 1	Internal storage for recyclable waste provided, assumed collection scheme exists	4	£25	4	£25	4	£25	4	£25
	Was 2	Assumed maximum credits could be achieved for no extra cost	2	£0	2	£0	2	£0	2	£0
	Was 3	Composting facilities provided (flats and detached houses)	1	£30	1	£50	1	£50	1	£50
Waste Totals			**7**	**£55**	**7**	**£75**	**7**	**£75**	**7**	**£75**
Pollution	Pol 1	Zero cost credit	1	£0	1	£0	1	£0	1	£0
	Pol 2	NO_x emissions too high to achieve credits with biomass as main fuel	0	£0	0	£0	0	£0	0	£0
Pollution Totals			**1**	**£0**	**1**	**£0**	**1**	**£0**	**1**	**£0**
Health & Well-Being	Hea 1	Assumed view of sky can be achieved at no E/O cost in all dwellings and that ADF of >1.5% in living rooms is met by default in detached house extra glazing also included	3	£300	3	£300	3	£300	3	£150
	Hea 2	Detached house scores maximum credits by default, cost of sound testing in other dwellings	4	£250	4	£200	4	£200	4	£0
	Hea 3	Assumed zero cost credit	1	£0	1	£0	1	£0	1	£0
	Hea 4	Lifetime Homes standards met	4	£650	4	£1,235	4	£1,235	4	£1,235
Health & Well-Being Totals			**12**	**£1,200**	**12**	**£1,735**	**12**	**£1,735**	**12**	**£1,385**

Manage-ment	Man 1	Home user guide provided, including information on site and surroundings	3	£0	£3	£0	£3	£0	£3	£0
	Man 2	Assumed zero cost credits	2	£0	2	£0	2	£0	2	£0
	Man 3	Procedures to cover four items in site management procedures	2	£0	£2	£0	£2	£0	£2	£0
	Man 4	Cost of measures to meet secured by design principles	2	£450	2	£515	2	£515	2	£650
Management Totals			**9**	**£450**	**9**	**£515**	**9**	**£515**	**9**	**£650**
Ecology	Eco 1	Greenfield site, no credits gained	0	£0	0	£0	0	£0	0	£0
	Eco 2	Ecologist employed	1	£100	1	£100	1	£100	1	£100
	Eco 3	Credit only achieved if ecologist is employed	1	£0	1	£0	1	£0	1	£0
	Eco 4	Cost of increasing number of plant species	4	£15	4	£15	4	£15	4	£15
	Eco 5	No credits achieved	0	£0	0	£0	0	£0	0	£0
Ecology Totals			**6**	**£115**	**6**	**£115**	**6**	**£115**	**6**	**£115**
Total Code Credits			**91**		**91**		**91**		**91**	
Total Percentage Points Score			**91**		**91**		**91**		**91**	
Total Extra Over Cost			**£27,465**		**£34,325**		**£36,735**		**£40,558**	

Table 59: E/O cost (in 2009) as £/m^2 of floor area and as a percentage of baseline build costs (cost of building dwelling to Part L 2006): Small Brownfield

Code Level	Flat			Terraced house			Semi-detached house			Detached house		
	E/O cost		%	E/O cost		%	E/O cost		%	E/O cost		%
	(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)	
Minimum cost options (based on E/O cost for whole development)												
1	£315	£5	0.5%	£228	£3	0%	£356	£4	0%	£313	£3	0.3%
2	£1,673	£27	3%	£1,617	£22	2%	£1,040	£12	1%	£971	£8	1%
3	£2,463	£40	4%	£2,420	£33	3%	£3,019	£34	3%	£2,681	£23	3%
4	£5,611	£92	9%	£7,363	£101	9%	£8,142	£93	9%	£6,029	£51	6%
5	£17,739	£291	30%	£24,372	£334	28%	£26,825	£305	29%	£30,128	£255	30%
6	£28,514	£467	48%	£34,807	£477	40%	£38,732	£440	41%	£42,771	£362	43%
Maximum cost (based on E/O cost for whole development)												
1	£315	£5	0.5%	£228	£3	0%	£356	£4	0%	£313	£3	0.3%
2	£1,673	£27	3%	£1,617	£22	2%	£1,040	£12	1%	£971	£8	1%
3	£6,737	£110	11%	£7,520	£103	9%	£9,277	£105	10%	£3,651	£31	4%
4	£11,508	£189	19%	£16,365	£224	19%	£17,922	£204	19%	£19,219	£163	19%
5	£17,013	£279	28%	£26,674	£365	31%	£28,967	£329	31%	£32,627	£276	33%
6	£27,562	£452	46%	£37,109	£508	43%	£40,506	£460	43%	£44,685	£379	45%

Table 60: E/O cost (in 2009) as £/m^2 of floor area and as a percentage of baseline build costs (cost of building dwelling to Part L 2006): City Infill

Code Level	Flat			Terraced house			Semi-detached house			Detached house		
	E/O cost		%	E/O cost		%	E/O cost		%	E/O cost		%
	(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)	
Minimum cost options (based on E/O cost for whole development)												
1	£290	£5	0.5%	-	-	-	-	-	-	-	-	-
2	£1,773	£29	3%	-	-	-	-	-	-	-	-	-
3	£2,763	£45	5%	-	-	-	-	-	-	-	-	-
4	£5,888	£97	10%	-	-	-	-	-	-	-	-	-
5	£16,134	£264	27%	-	-	-	-	-	-	-	-	-
6	£26,909	£441	45%	-	-	-	-	-	-	-	-	-
Maximum cost (based on E/O cost for whole development)												
1	£290	£5	0.5%	-	-	-	-	-	-	-	-	-
2	£1,773	£29	3%	-	-	-	-	-	-	-	-	-
3	£7,062	£116	12%	-	-	-	-	-	-	-	-	-
4	£11,658	£191	20%	-	-	-	-	-	-	-	-	-
5	£17,308	£284	29%	-	-	-	-	-	-	-	-	-
6	£27,857	£457	47%	-	-	-	-	-	-	-	-	-

Table 61: E/O cost (in 2009) as £/m^2 of floor area and as a percentage of baseline build costs (cost of building dwelling to Part L 2006): Medium Urban (mixed)

Code Level	Flat			Terraced house			Semi-detached house			Detached house		
	E/O cost		%	E/O cost		%	E/O cost		%	E/O cost		%
	(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)	
Minimum cost options (based on E/O cost for whole development)												
1	£257	£4	0.4%	£170	£2	0%	£258	£3	0%	£270	£2	0.3%
2	£1,555	£25	3%	£1,499	£21	2%	£892	£10	1%	£813	£7	1%
3	£2,345	£38	4%	£2,002	£27	2%	£2,901	£33	3%	£2,513	£21	3%
4	£5,438	£89	9%	£7,190	£98	8%	£7,969	£91	9%	£5,856	£50	6%
5	£17,567	£288	29%	£24,200	£332	28%	£26,653	£303	29%	£29,955	£254	30%
6	£19,580	£321	33%	£26,550	£364	31%	£28,392	£323	30%	£31,232	£265	31%
Maximum cost (based on E/O cost for whole development)												
1	£257	£4	0.4%	£170	£2	0%	£258	£3	0%	£270	£2	0.3%
2	£1,555	£25	3%	£1,499	£21	2%	£892	£10	1%	£813	£7	1%
3	£6,574	£108	11%	£7,352	£101	9%	£9,059	£103	10%	£3,493	£30	3%
4	£11,241	£184	19%	£15,947	£218	18%	£17,504	£199	19%	£19,051	£161	19%
5	£16,840	£276	28%	£26,501	£363	31%	£28,794	£327	31%	£32,454	£275	32%
6	£27,390	£449	46%	£36,936	£506	43%	£40,333	£458	43%	£44,512	£377	45%

Table 62: E/O cost (in 2009) as £/m^2 of floor area and as a percentage of baseline build costs (cost of building dwelling to Part L 2006): Medium Urban (flats)

Code Level	Flat			Terraced house			Semi-detached house			Detached house		
	E/O cost		%	E/O cost		%	E/O cost		%	E/O cost		%
	(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)	
Minimum cost options (based on E/O cost for whole development)												
1	£236	£4	0.4%	-	-	-	-	-	-	-	-	-
2	£1,555	£25	3%	-	-	-	-	-	-	-	-	-
3	£2,174	£36	4%	-	-	-	-	-	-	-	-	-
4	£5,299	£87	9%	-	-	-	-	-	-	-	-	-
5	£15,616	£256	26%	-	-	-	-	-	-	-	-	-
6	£17,654	£289	30%	-	-	-	-	-	-	-	-	-
Maximum cost (based on E/O cost for whole development)												
1	£236	£4	0.4%	-	-	-	-	-	-	-	-	-
2	£1,555	£25	3%	-	-	-	-	-	-	-	-	-
3	£6,544	£107	11%	-	-	-	-	-	-	-	-	-
4	£11,115	£182	19%	-	-	-	-	-	-	-	-	-
5	£16,815	£276	28%	-	-	-	-	-	-	-	-	-
6	£27,364	£449	46%	-	-	-	-	-	-	-	-	-

Table 63: E/O cost (in 2009) as £/m^2 of floor area and as a percentage of baseline build costs (cost of building dwelling to Part L 2006): Large Urban (mixed)

Code Level	Flat			Terraced house			Semi-detached house			Detached house		
	E/O cost		%	E/O cost		%	E/O cost		%	E/O cost		%
	(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)	
Minimum cost (based on E/O cost for whole development)												
1	£250	£4	0.4%	£164	£2	0%	£252	£3	0%	£264	£2	0.3%
2	£1,549	£25	3%	£1,493	£20	2%	£886	£10	1%	£807	£7	1%
3	£2,338	£38	4%	£1,996	£27	2%	£2,895	£33	3%	£2,507	£21	3%
4	£6,363	£104	11%	£6,205	£85	7%	£6,581	£75	7%	£6,467	£55	6%
5	£16,640	£273	28%	£23,212	£318	27%	£25,583	£291	27%	£28,794	£244	29%
6	£23,212	£381	39%	£29,919	£410	35%	£32,392	£368	35%	£36,035	£305	36%
Maximum cost (based on E/O cost for whole development)												
1	£250	£4	0.4%	£164	£2	0%	£252	£3	0%	£264	£2	0.3%
2	£1,549	£25	3%	£1,493	£20	2%	£886	£10	1%	£807	£7	1%
3	£6,568	£108	11%	£7,346	£101	8%	£9,052	£103	10%	£3,487	£30	3%
4	£11,234	£184	19%	£15,941	£218	18%	£17,497	£199	19%	£19,044	£161	19%
5	£16,834	£276	28%	£26,495	£363	31%	£28,787	£327	31%	£32,447	£275	32%
6	£27,383	£449	46%	£36,930	£506	43%	£40,326	£458	43%	£44,505	£377	45%

Table 64: E/O cost (in 2009) as £/m^2 of floor area and as a percentage of baseline build costs (cost of building dwelling to Part L 2006): Large Urban (flats)

Code Level	Flat			Terraced house			Semi-detached house			Detached house		
	E/O cost		%	E/O cost		%	E/O cost		%	E/O cost		%
	(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)	
Minimum cost (based on E/O cost for whole development)												
1	£230	£4	0.4%	-	-	-	-	-	-	-	-	-
2	£1,549	£25	3%	-	-	-	-	-	-	-	-	-
3	£2,168	£36	4%	-	-	-	-	-	-	-	-	-
4	£4,293	£70	7%	-	-	-	-	-	-	-	-	-
5	£14,690	£241	25%	-	-	-	-	-	-	-	-	-
6	£21,287	£349	36%	-	-	-	-	-	-	-	-	-
Maximum cost (based on E/O cost for whole development)												
1	£230	£4	0.4%	-	-	-	-	-	-	-	-	-
2	£1,549	£25	3%	-	-	-	-	-	-	-	-	-
3	£6,538	£107	11%	-	-	-	-	-	-	-	-	-
4	£11,109	£182	19%	-	-	-	-	-	-	-	-	-
5	£16,809	£276	28%	-	-	-	-	-	-	-	-	-
6	£27,358	£448	46%	-	-	-	-	-	-	-	-	-

Table 65: E/O cost (in 2009) as £/m^2 of floor area and as a percentage of baseline build costs (cost of building dwelling to Part L 2006): Small Infill

Code Level	Flat			Terraced house			Semi-detached house			Detached house		
	E/O cost		%	E/O cost		%	E/O cost		%	E/O cost		%
	(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)	
Minimum cost (based on E/O cost for whole development)												
1	-	-	-	£353	£5	0%	£431	£5	0%	£288	£2	0.3%
2	-	-	-	£1,837	£25	2%	£1,260	£14	1%	£1,091	£9	1%
3	-	-	-	£2,295	£31	3%	£2,994	£34	3%	£2,651	£22	3%
4	-	-	-	£7,408	£101	9%	£8,152	£93	9%	£7,194	£61	7%
5	-	-	-	£27,254	£373	32%	£29,547	£336	32%	£32,557	£276	33%
6	-	-	-	£37,689	£516	44%	£41,086	£467	44%	£45,515	£386	46%
Maximum cost (based on E/O cost for whole development)												
1	-	-	-	£353	£5	0%	£431	£5	0%	£288	£2	0.3%
2	-	-	-	£1,837	£25	2%	£1,260	£14	1%	£1,091	£9	1%
3	-	-	-	£7,590	£104	9%	£9,397	£107	10%	£3,771	£32	4%
4	-	-	-	£16,240	£222	19%	£17,797	£202	19%	£19,189	£163	19%
5	-	-	-	£29,117	£399	34%	£31,570	£359	34%	£35,593	£302	36%
6	-	-	-	£39,552	£542	46%	£43,477	£494	47%	£47,651	£404	48%

Table 66: E/O cost (in 2009) as £/m^2 of floor area and as a percentage of baseline build costs (cost of building dwelling to Part L 2006): Small Greenfield

Code Level	Flat			Terraced house			Semi-detached house			Detached house		
	E/O cost		%	E/O cost		%	E/O cost		%	E/O cost		%
	(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)	
Minimum cost (based on E/O cost for whole development)												
1	£320	£5	0.5%	£233	£3	0%	£333	£4	0%	£318	£3	0.3%
2	£1,620	£27	3%	£1,564	£21	2%	£987	£11	1%	£878	£7	1%
3	£2,160	£35	4%	£2,117	£29	2%	£2,716	£31	3%	£2,378	£20	2%
4	£5,353	£88	9%	£7,150	£98	8%	£7,864	£89	8%	£6,906	£59	7%
5	£17,305	£284	29%	£26,966	£369	31%	£29,259	£332	31%	£32,269	£273	32%
6	£27,654	£453	46%	£37,401	£512	43%	£40,798	£464	44%	£45,227	£383	45%
Maximum cost (based on E/O cost for whole development)												
1	£320	£5	0.5%	£233	£3	0%	£333	£4	0%	£318	£3	0.3%
2	£1,620	£27	3%	£1,564	£21	2%	£987	£11	1%	£878	£7	1%
3	£6,984	£114	12%	£7,467	£102	9%	£9,224	£105	10%	£3,598	£30	4%
4	£11,205	£184	19%	£16,062	£220	19%	£17,619	£200	19%	£18,916	£160	19%
5	£21,781	£357	36%	£28,829	£395	33%	£31,282	£355	34%	£35,305	£299	35%
6	£32,556	£534	55%	£39,264	£538	45%	£43,189	£491	46%	£47,363	£401	47%

Table 67: E/O cost (in 2009) as £/m^2 of floor area and as a percentage of baseline build costs (cost of building dwelling to Part L 2006): Small Edge of Town

Code Level	Flat			Terraced house			Semi-detached house			Detached house		
	E/O cost		%	E/O cost		%	E/O cost		%	E/O cost		%
	(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)	
Minimum cost (based on E/O cost for whole development)												
1	-	-	-	£353	£5	0%	£431	£5	0%	£288	£2	0.3%
2	-	-	-	£1,837	£25	2%	£1,260	£14	1%	£1,091	£9	1%
3	-	-	-	£2,295	£31	3%	£2,994	£34	3%	£2,651	£22	3%
4	-	-	-	£7,408	£101	9%	£8,152	£93	9%	£7,194	£61	7%
5	-	-	-	£27,254	£373	32%	£29,547	£336	32%	£32,557	£276	33%
6	-	-	-	£37,689	£516	44%	£41,086	£467	44%	£45,515	£386	46%
Maximum cost (based on E/O cost for whole development)												
1	-	-	-	£353	£5	0%	£431	£5	0%	£288	£2	0.3%
2	-	-	-	£1,837	£25	2%	£1,260	£14	1%	£1,091	£9	1%
3	-	-	-	£7,590	£104	9%	£9,397	£107	10%	£3,771	£32	4%
4	-	-	-	£16,240	£222	19%	£17,797	£202	19%	£19,189	£163	19%
5	-	-	-	£29,117	£399	34%	£31,570	£359	34%	£35,593	£302	36%
6	-	-	-	£39,552	£542	46%	£43,477	£494	47%	£47,651	£404	48%

Table 68: E/O cost (in 2009) as £/m^2 of floor area and as a percentage of baseline build costs (cost of building dwelling to Part L 2006): Medium Edge of Town

Code Level	Flat			Terraced house			Semi-detached house			Detached house		
	E/O cost		%	E/O cost		%	E/O cost		%	E/O cost		%
	(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)	
Minimum cost (based on E/O cost for whole development)												
1	£269	£4	0.4%	£187	£3	0%	£370	£4	0%	£292	£2	0.3%
2	£1,552	£25	3%	£1,496	£20	2%	£919	£10	1%	£810	£7	1%
3	£2,092	£34	4%	£2,049	£28	2%	£2,648	£30	3%	£2,310	£20	2%
4	£5,285	£87	9%	£7,082	£97	8%	£7,796	£89	8%	£6,838	£58	7%
5	£17,237	£283	29%	£26,898	£368	31%	£29,191	£332	31%	£32,201	£273	32%
6	£24,076	£395	40%	£31,247	£428	36%	£33,089	£376	35%	£36,179	£307	36%
Maximum cost (based on E/O cost for whole development)												
1	£269	£4	0.4%	£187	£3	0%	£370	£4	0%	£292	£2	0.3%
2	£1,552	£25	3%	£1,496	£20	2%	£919	£10	1%	£810	£7	1%
3	£6,916	£113	12%	£7,399	£101	9%	£9,156	£104	10%	£3,530	£30	4%
4	£11,137	£183	19%	£15,994	£219	18%	£17,551	£199	19%	£18,848	£160	19%
5	£20,793	£341	35%	£27,780	£381	32%	£30,151	£343	32%	£34,083	£289	34%
6	£31,568	£518	53%	£38,215	£523	44%	£42,058	£478	45%	£46,141	£391	46%

Table 69: E/O cost (in 2009) as £/m^2 of floor area and as a percentage of baseline build costs (cost of building dwelling to Part L 2006): Large Edge of Town

Code Level	Flat			Terraced house			Semi-detached house			Detached house		
	E/O cost		%	E/O cost		%	E/O cost		%	E/O cost		%
	(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)	
Minimum cost (based on E/O cost for whole development)												
1	£265	£4	0.4%	£184	£3	0%	£367	£4	0%	£289	£2	0.3%
2	£1,549	£25	3%	£1,493	£20	2%	£916	£10	1%	£807	£7	1%
3	£2,088	£34	3%	£2,046	£28	2%	£2,645	£30	3%	£2,307	£20	2%
4	£5,282	£87	9%	£7,079	£97	8%	£7,793	£89	8%	£6,835	£58	7%
5	£17,234	£283	29%	£26,895	£368	31%	£29,187	£332	31%	£32,197	£273	32%
6	£27,712	£454	46%	£34,619	£474	40%	£37,092	£421	40%	£40,985	£347	41%
Maximum cost (based on E/O cost for whole development)												
1	£265	£4	0.4%	£184	£3	0%	£367	£4	0%	£289	£2	0.3%
2	£1,549	£25	3%	£1,493	£20	2%	£916	£10	1%	£807	£7	1%
3	£6,913	£113	12%	£7,396	£101	9%	£9,152	£104	10%	£3,527	£30	4%
4	£11,134	£183	19%	£15,991	£219	18%	£17,547	£199	19%	£18,844	£160	19%
5	£20,790	£341	35%	£27,777	£381	32%	£30,148	£343	32%	£34,079	£289	34%
6	£31,564	£517	53%	£38,212	£523	44%	£42,055	£478	45%	£46,137	£391	46%

Table 70: E/O cost (in 2009) as £/m^2 of floor area and as a percentage of baseline build costs (cost of building dwelling to Part L 2006): Strategic

Code Level	Flat			Terraced house			Semi-detached house			Detached house		
	E/O cost		%	E/O cost		%	E/O cost		%	E/O cost		%
	(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)		(£)	(£/m^2)	
Minimum cost (based on E/O cost for whole development)												
1	£265	£4	0.4%	£184	£3	0%	£367	£4	0%	£289	£2	0.3%
2	£1,549	£25	3%	£1,493	£20	2%	£916	£10	1%	£807	£7	1%
3	£2,088	£34	3%	£2,046	£28	2%	£2,645	£30	3%	£2,307	£20	2%
4	£5,281	£87	9%	£7,079	£97	8%	£7,793	£89	8%	£6,835	£58	7%
5	£17,234	£283	29%	£26,895	£368	31%	£29,187	£332	31%	£32,197	£273	32%
6	£27,465	£450	46%	£34,325	£470	40%	£36,735	£417	39%	£40,558	£344	41%
Maximum cost (based on E/O cost for whole development)												
1	£265	£4	0.4%	£184	£3	0%	£367	£4	0%	£289	£2	0.3%
2	£1,549	£25	3%	£1,493	£20	2%	£916	£10	1%	£807	£7	1%
3	£6,913	£113	12%	£7,396	£101	9%	£9,152	£104	10%	£3,527	£30	4%
4	£11,134	£183	19%	£15,991	£219	18%	£17,547	£199	19%	£18,844	£160	19%
5	£20,790	£341	35%	£27,777	£381	32%	£30,148	£343	32%	£34,079	£289	34%
6	£31,564	£517	53%	£38,212	£523	44%	£42,055	£478	45%	£46,137	£391	46%