The Code for Sustainable Homes simply explained

REVISED JANUARY 2010

NHBC Foundation

Housing research & development in partnership with BRE Trust

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FOREWORD

Launched in December 2006, the Code for Sustainable Homes called for a step change in the way new homes are designed and constructed, and introduced a 1 to 6 star rating system to communicate their overall sustainability performance. In May 2008 a mandatory requirement was introduced for all new-build homes in England to be rated against the Code and be issued with a certificate.

Many housing developers, particularly larger builders and those developing social homes, are becoming increasingly familiar with the Code and are quickly developing their expertise. Others have not yet built homes to comply with the Code and for them the prospect of getting to grips with the Code for Sustainable Homes Technical Guide may be somewhat daunting (the current version is around 300 pages long).

Starting at page 1 of the Code Technical Guide and working your way through to the end may not prove the easiest or most effective way to get to grips with the issues. *The Code for Sustainable Homes simply explained* proposes an alternative approach and, by using it, readers will benefit from the knowledge of others who are already further up the learning curve.

This guide distils the experience gained from a large number of Code assessments and advises designers and builders on a strategic way through. It highlights the interaction between the various issues and suggests how they can be addressed in the most practical way and most cost-effectively. Throughout, it includes a variety of key points and other useful information.

It is important that the current severe recession does not provide an excuse for sustainability to be overlooked by an increasingly challenged house-building industry. It is hoped that, building on a growing range of material from the NHBC Foundation, *The Code for Sustainable Homes simply explained* will be an invaluable resource that will help encourage the transition towards sustainable new homes.

Rt. Hon. Nick Raynsford MP

Chairman, NHBC Foundation

REVISED EDITION

This edition of *The Code for Sustainable Homes simply explained* has been revised to include details of the requirements of the *Water Efficiency Calculator for New Dwellings* which was issued in May 2009 and to improve clarity on surface water run-off. Text has been replaced on the following pages:

Page 24, third, fourth and fifth paragraphs of section 7.2

Page 25, the Top Tips box

Page 28, first, second and third paragraphs of section 7.5.

ABOUT THE NHBC FOUNDATION

The NHBC Foundation was established in 2006 by the NHBC in partnership with the BRE Trust. Its purpose is to deliver high-quality research and practical guidance to help the industry meet its considerable challenges.

Since its inception, the NHBC Foundation's work has focused primarily on the sustainability agenda and the challenges of the government's 2016 zero carbon homes target. Research has included a review of microgeneration and renewable energy techniques and the groundbreaking research on zero carbon and what it means to homeowners and housebuilders.

The NHBC Foundation is also involved in a programme of positive engagement with government, development agencies, academics and other key stakeholders, focusing on current and pressing issues relevant to the industry.

Further details on the latest output from the NHBC Foundation can be found at www.nhbcfoundation.org.

NHBC Foundation Advisory Board

The work of the NHBC Foundation is guided by the NHBC Foundation Advisory Board, which comprises:

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EXECUTIVE SUMMARY

The Code for Sustainable Homes is the standard by which new homes in England, Wales and Northern Ireland are now being judged for their green credentials. The Code covers a wide range of environmental issues: energy and carbon dioxide emissions, water usage, materials, surface water run-off, waste (site and household), pollution, health and well-being, site management, ecology and land use. Homes are assessed at the design stage and post construction. Each dwelling has its own assessment, and if it meets the required criteria, then it is awarded a certificate, ranging from Level 1 to Level 6, depending on performance. This guide looks primarily at how to achieve Levels 3 and 4 as these are currently (2009) the levels most commonly specified.

Achieving Code compliance at any level presents a significant challenge, particularly since there are mandatory issues that need to be addressed. The highest levels need significant changes to conventional construction approaches, mainly due to the stringent requirements for reducing carbon dioxide emissions. Until recently, renewable-energy technologies and other low-emission technologies (eg combined heat and power [CHP] systems) were only found on homes owned by the keenest of environmentalists. Now, in 2009, these are a common feature of developments built to meet Level 3 and are effectively unavoidable at higher levels.

Although meeting the higher levels will never be easy, by planning ahead and taking a more strategic approach, developers can take every opportunity for improving the performance of their dwellings without needing to resort to 'bolt-on technologies'. There are concerns that these may not be cost-effective and that customers may not perceive them as adding value. In fact, with a combination of good design and imagination, many of the credits and mandatory minimum performance standards can be met without any additional cost at all. If considered in a holistic way, developments can be created that are both environmentally and socially sustainable, and financially viable.

This guide takes a strategic approach to the Code, looking at how the different issues interact and considers which are given the most weighting. It tackles issues, not in the order laid out in the *Code for Sustainable Homes Technical Guide* (which can be downloaded from the Communities and Local Government website[1]), but in nine groups of credits that have an impact on one another:

1. easy-win, stand-alone credits
2. site: ecology and flooding
3. construction and supply chain management
4. potable water, greywater and rainwater use, and sustainable drainage systems (SUDS)
5. space and design layouts
6. specifying materials
7. Secured by Design – windows, doors and external lights
8. building fabric and balconies
9. energy sources, internal lighting and Dwelling Emission Rate (DER).

If dwellings are specifically designed to meet the requirements of the Code, they will be more robust, as they will depend more on the building fabric to deliver the performance over the whole lifetime rather than on less-established technologies, which may require replacement from time to time. As such, developers who learn to design and build in this way will be in a stronger position to develop Code Level 5 and 6 houses in the future.

GLOSSARY

CHP	Combined heat and power
DER	Dwelling Emission Rate
GWP	Global Warming Potential
HLP	Heat Loss Parameter
HQI	Housing Quality Indicator
LZC technologies	Low and zero-carbon technologies
PV	Photovoltaic
SUDS	Sustainable Drainage Systems
TER	Target Emission Rate

1 Introduction

1.1 Background

The Code for Sustainable Homes is part of the government's programme to improve the sustainability of new dwellings, in particular with a view to national targets for reducing carbon dioxide emissions, but taking a more holistic approach by considering a wide range of environmental and social impacts of new homes.

The Code is based on the established EcoHomes assessment method,[2] but it includes mandatory requirements in many areas, with particularly stringent requirements for reducing carbon dioxide emissions and water consumption, and setting new aspirational levels well beyond 'EcoHomes Excellent'. Another significant difference is that dwellings are assessed individually, both before and after construction, so making conformance to design specification vital.

The Code has six performance levels – Level 1 to Level 6. From 1 May 2008 a mandatory requirement was introduced for all new homes in England to be rated against the Code and be issued with a certificate. There is, however, no requirement to reach a specific level and a 'nil-rating' certificate can be issued if a Code assessment is not carried out. Publicly funded homes and those built on publicly owned land normally have to achieve a rating of at least Level 3.

Although this guide is primarily concerned with Code Levels 3 and 4, the higher levels will be referred to occasionally. It is designed to be read in conjunction with the *Code for Sustainable Homes Technical Guide*.[1]

Note that the Technical Guide is updated at regular intervals – the version that applies will be the one currently in force when the development is registered with the BRE[3] or Stroma.[4] This guide (NF15) is based on the October 2008 version published by Communities and Local Government.[1]

1.2 How does the Code work?

The Code assesses the new dwelling against nine categories (see Table 1), each of which is allocated a number of credits and a weighting factor (or percentage point contribution to the overall score). Within each category a number of different issues are addressed.

TABLE 1

Code for Sustainable Homes categories

	Category	Issue	Number of credits	Weighting factor (%)
1	Energy and CO_2 emissions	Ene 1: DER (m) Ene 2: Building fabric Ene 3: Internal lighting Ene 4: Drying space Ene 5: Energy-labelled white goods Ene 6: External lighting Ene 7: LZC technologies Ene 8: Cycle storage Ene 9: Home office	29	36.4
2	Water	Wat 1: Indoor water use (m) Wat 2: External water use	6	9.0
3	Materials	Mat 1: Environmental impact of materials (m) Mat 2: Responsible sourcing of materials – basic building elements Mat 3: Responsible sourcing of materials – finishing elements	24	7.2
4	Surface water run-off	Sur 1: Management of surface water run-off from developments (m) Sur 2: Flood risk	4	2.2
5	Waste	Was 1: Storage of non-recyclable waste and recyclable household wastes (m) Was 2: Construction site waste management (m) Was 3: Composting	7	6.4
6	Pollution	Pol 1: Global warming potential of insulants Pol 2: NO_x emissions	4	2.8
7	Health and well-being	Hea 1: Daylighting Hea 2: Sound insulation Hea 3: Private space Hea 4: Lifetime Homes (m at Level 6 only)	12	14.0
8	Management	Man 1: Home user guide Man 2: Considerate Constructors Scheme Man 3: Construction site impacts Man 4: Security	9	10.0
9	Ecology	Eco 1: Ecological value of site Eco 2: Ecological enhancement Eco 3: Protection of ecological features Eco 4: Change in ecological value of site Eco 5: Building footprint	9	12.0

m: includes a mandatory element

As indicated in Table 1, some of the categories contain mandatory minimum standards that must be achieved for different Code levels as well as optional credits that can be used to build up a total score (for Code Levels 3–6 see Further Information on page 3).

FURTHER INFORMATION

Mandatory and optional scores for Code Levels 3–6

	Code Level 3			Code Level 4			Code Level 5			Code Level 6		
	Mandatory requirements	Credits	Points	Mandatory requirements	Credits	Points	Mandatory requirements	Credits	Points	Mandatory requirements	Credits	Points
Ene 1: Energy	Percentage improvement of DER over TER: ≥25%	5	6.276	Percentage improvement of DER over TER: ≥44%	8	10.041	Percentage improvement of DER over TER: ≥100%	14	17.572	Zero carbon	15	18.828
Ene 2: Building fabric	N/A	N/A	0	N/A	N/A	0	N/A	N/A	0	HLP ≤0.8 W/m^2K	2	2.510
Wat 1: Indoor water use	≤105 litres/ person/day	3	4.500	≤105 litres/ person/day	3	4.500	≤80 litres/ person/day	5	7.500	≤80 litres/ person/day	5	7.500
Mat 1: Materials specification	3 out of 5 elements to be A+ to D*	0	0	3 out of 5 elements to be A+ to D*	0	0	3 out of 5 elements to be A+ to D*	0	0	3 out of 5 elements to be A+ to D*	0	0
Sur 1: Surface water run-off	Peak run-off to not increase*	0	0	Peak run-off to not increase*	0	0	Peak run-off to not increase*	0	0	Peak run-off to not increase*	0	0
Was 1: Storage of non-recyclable waste and recyclable household waste	Space for household waste*	0	0	Space for household waste*	0	0	Space for household waste*	0	0	Space for household waste*	0	0
Was 2: Site Waste Management Plan	SWMP to be used*	0	0	SWMP to be used*	0	0	SWMP to be used*	0	0	SWMP to be used*	0	0
Hea 4: Lifetime Homes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Compliance	4	4.667
Mandatory points	–	–	**10.776**	–	–	**14.541**	–	–	**25.072**	–	–	**33.505**
Total points required for Level	–	–	**57.000**	–	–	**68.000**	–	–	**84.000**	–	–	**90.000**
Optional points required for Level	–	–	**46.224**	–	–	**53.459**	–	–	**58.928**	–	–	**56.495**

* Full details in the *Code for Sustainable Homes Technical Guide.*[1]

1.3 Project planning for the Code

To comply with the Code requirements in a cost-effective way, the assessment criteria need to be considered early in the design stage. 'Brainstorming' the Code and energy requirements early and seeking advice from a suitably knowledgeable source is likely to pay dividends later, as a small amount of planning at concept stage before the site layout is finalised could avoid cost-effective opportunities being ruled out.

Site factors such as ecological value and flood risk will affect the score, so these need to be taken into account even before purchase of the site, when considering the financial impact of Code compliance.

Before the site layout is finalised, consider how the development can maximise its performance. For example, if dwellings can be orientated to have living areas facing south, free passive solar energy will benefit the dwellings in winter, and afford the opportunity to provide shading to prevent overheating in summer. Facing living areas away from due south can still provide passive solar gain but external shading will be more difficult. Unshaded south-facing roofs will provide the opportunity for installing solar renewable energy technologies. (See section 12 for more on this issue. Further Information: Strategies to avoid overheating – 1 Shading.) Even if the final design does not include these technologies, it provides flexibility to change the energy strategy and, looking beyond the confines of the Code assessment, allows owners to fit these technologies at some stage in the future. Similarly, with some imaginative masterplanning, designing the site layout to allow the daylighting criteria of the Code to be met for all dwellings may not involve any additional cost at this point, and can provide an improved living environment for future residents. Certainly, if it is not considered at this stage it is likely to be much more difficult, or even impossible, to achieve later on. Internal layouts are also crucial and will need careful consideration as the design progresses, but there will be more leeway if the availability of daylight to the dwelling has been maximised.

It is vital at this stage that a hydrological consultant or engineer prepares a flood risk assessment to show that at least the mandatory requirement of Sur 1 (Management of surface water run-off from developments) will be met, ie that the peak rate of run-off into watercourses is no greater for the developed site than it was for the pre-developed site. If this mandatory requirement is not achieved, the dwellings will not be able to achieve any Code rating.

Siting dwellings to allow existing features of ecological value (eg mature trees) to be retained may again provide flexibility to achieve more credits, as well as providing a selling point and attractive site features for residents. Providing space for a communal plant room and deliveries of biomass fuel allows the option of a communal heating system powered by renewable energy to be considered (an option which may be more economical than other alternatives). Again, this option may not actually be pursued, but in the developing renewable energy sector, changes can happen very quickly, so it is a benefit to be able to adapt the strategy and also take advantage of new markets where cost savings could be made.

Before any work commences on site, there are a number of essential tasks to ensure that the Code rating is optimised. These include:

- Employing a qualified Code assessor to advise on whether measures are being implemented correctly.
- Implementing a Site Waste Management Plan (SWMP). During the construction phase this is a mandatory requirement, and if work has commenced before a suitable one is in place it could rule out achieving even Code Level 1.
- Registering for the Considerate Constructors Scheme, which is relatively highly weighted within the Code.
- Undertaking a baseline ecological survey, as confirming an improvement of ecological value, is also highly weighted.

If these are not considered at this stage, then they will have to be substituted by other Code options that may be more expensive later on.

Achieving the maximum use of the building footprint, perhaps by making provision for the roof space to be habitable, is best considered at the early design stage to ensure that the specific Code criteria are met.

Lifetime Homes (a standard covering accessibility and adaptability of homes to suit residents' changing needs) is heavily weighted, and every opportunity should be taken to meet the requirements if possible. This will certainly be easier to integrate early in the design process rather than later.

Flexibility to take on new ideas and adapt the design and specification is key to achieving a good Code rating. For example, innovative construction methods are not necessarily required to achieve a high level of the Code, but they are worth considering as they could be a cost-effective way to improve the score in several areas (eg through reducing impacts during the construction phase, minimising energy use, and careful sourcing of materials), with possible additional benefits such as a reduced time spent on site.

There is an advantage in aiming for credits that can be verified in advance of the post-construction review which are not dependent on the quality of workmanship or work methods in order to be achieved. For example, there can be a very high level of confidence that specifying a suitable private external space will result in the associated credit being achieved at the post-construction stage. However, if relying on a high standard of performance for say airtightness, the result cannot be determined until after testing has been undertaken at the very latest stage of construction. If the results of testing prove to be unfavourable, this is too late to easily find alternative credits, so costly remediation work could be the only option (possibly with no guarantee of success).

Similarly, specifying materials with a high *Green Guide (*The *Green Guide to specification*)[5] rating is quite straightforward, if their suitability is confirmed prior to construction. However, the responsible sourcing of materials (in particular, specifying timber and timber products from documented legal and third-party certified sources) is more difficult to get right as it relies on strictly enforced supply-chain management and there are many opportunities during the construction process for errors to be made.

There are more detailed issues to consider too: rainwater butts are easy to specify, although there must be an appropriate place for the downpipe; cycle storage in the rear garden will need direct access from the road; and waste storage requires space. These are often considered to be more superficial aspects of the design, but in fact building design and site layout are crucial to all of these issues. Even consultation with the police on Secured by Design (a crime prevention initiative)[6] should be carried out from the earliest stages, to ensure that the requirements can be met.

There is a benefit to developers of aiming slightly higher than is necessary to achieve their target Code rating, in case some credits are lost during construction (this is sometimes called 'slippage'). But taking an intelligent approach to this does allow some 'value engineering' to take place, so features could be omitted unless they were found to be needed at a later stage. For example, a rainwater butt could be added to the building to gain credits lost elsewhere, even after the first post-construction assessment, as long as space has been allowed for it.

Building to Levels 3 and 4 of the Code provides an opportunity for developers to gain experience of the measures involved before progressing to the higher levels which are going to be required in the future.

In summary, for successful Code-compliant dwellings, the key issues that should be considered are as follows:

- Maximising the site-based credits when buying land for development, looking at:
  - ecological value
  - flood risk.

- The early appointment, before any design work has been carried out, of:
  - a Code assessor
  - an energy assessor.
- An energy feasibility study to establish the best sources of energy for the dwellings, including any need for renewable technologies.
- Planning for Lifetime Homes, and its impact on dwelling layouts.
- The early consultation of the police architectural liaison officer or crime prevention design officer.
- The early appointment, before any site work has been carried out, of a 'suitably qualified ecologist'.
- The early commissioning of a flood risk and drainage assessment report as part of the design process.
- Consideration of the orientation and positioning of dwellings to maximise potential for:
  - passive solar design, and installation of renewable technologies, such as solar panels
  - daylighting
  - protecting any ecological features.
- Registering for the Considerate Constructors Scheme before site work starts.
- Establishing a SWMP before work commences.
- Allowing for slippage in credit scores, in particular in those credits that are subject to post-construction testing. The most important tests, where failure to perform to design would have serious consequences, are:
  - airtightness (potentially affecting Ene 1, Ene 2 and, indirectly, Ene 7)
  - auditing of documentation to confirm responsible sourcing of materials (Mat 2 and Mat 3).
  - sound testing of separating walls and floors (affecting Hea 2) when Robust Details are not used.

These issues will be explored in greater depth later in this guide.

2 A strategic route through the Code

2.1 Credit choices and weightings

The seemingly most obvious way of working through the Code might be to begin with the Energy section and work though to Ecology at the end. This is, however, unlikely to deliver optimum results.

It would be more productive to take a strategic approach, looking first at the mandatory elements, those elements which can be incorporated at low cost at an early stage in the design, and where elements interact. This will help to ensure that the most cost-effective and practical route is chosen while, if possible, actually increasing the value and desirability of the end-product.

The first step is to consider which issues have mandatory minimum performance standards that must be met. We have already identified issues with mandatory elements within the Code, but there will also be site-specific issues with credits that need to be obtained to satisfy 'other requirements' that apply to the development. These might be Housing Corporation[7] Design and Quality Recommendations, English Partnerships[8] requirements or local planning requirements, such as a 'Merton Rule'-type requirement or similar (see section 3). These performance standards set the basic requirements for what credits must be achieved and then the additional credits required for each Code level are selected at the discretion of the developer.

Developers are likely to choose these discretionary credits on the basis of a range of different priorities, including minimum capital cost, maximum perceived added value to the end user, compatibility with current construction methods and supply chains, timescale, corporate targets, and community considerations. These will also vary considerably from one site to another. Whichever strategy is adopted, it is worth remembering that some credits achieve more percentage points than others (see Fig. 1).

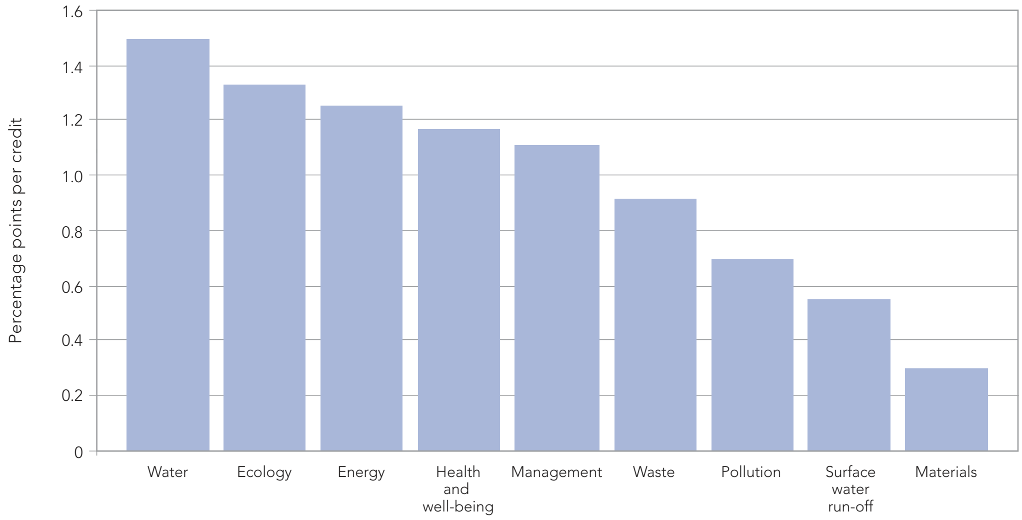


Figure 1 Approximate number of percentage points per credit.

Based on these weighting factors, credits in the Water, Ecology, Energy, Health and well-being, and Management sections might, at first sight, all seem well worth considering, while credits for Materials and Surface water run-off seem less attractive. However, the relationship is not so simple, as the measures required to achieve these credits vary in their cost and practicality, and indeed vary from site to site. Therefore building up the score will be an iterative process, beginning by considering those credits that can be achieved with most confidence and those that will be achieved due to site factors (these will typically be Ecology or Surface water run-off credits). Then, based on the number of points needed to achieve the required Code level, the remaining credits can be selected, based on their cost, practicality and weighting, until the score is achieved.

2.2 Credit interactions

Many credits are interconnected, in that they can impact on one another both positively and negatively, and this interaction should be considered. This is explored later in sections 4 to 12.

2.3 Potential pitfalls

Addressing the issues in the Code should improve the sustainability of a development, but there could be negative impacts in other areas if care is not taken.

The financial impact of measures with high capital cost will usually be quite obvious, but attention should be paid to hidden costs such as installation, and fluctuating prices due to steeply rising demand in immature markets with limited supply.

Measures that need extra space such as the use of soakaways, passive solar design, biomass heating systems, or Lifetime Homes, can have significant impacts on the site layout so these need to be considered from an early stage if they are to be incorporated effectively (this is explored further in section 8).

Some measures are technically more difficult, such as rainwater harvesting or greywater recycling, but it has been shown that environmental assessment schemes such as BREEAM (Building Research Establishment Environmental Assessment Method) and EcoHomes have encouraged manufacturers to develop products and systems in the past. A simple example is the range of recycling bins specified to meet EcoHomes and Code requirements that are now available. New products are likely to be introduced in the future in response to the Code.

Some credits are site-dependent and may be unachievable in some cases, eg most of the Ecology credits (Eco 1, Eco 3 and Eco 4) and Flood risk (Sur 2).

The measures required to achieve some credits may increase the maintenance burden for the builder, landlord or home owner. This is likely to have ongoing cost implications, and may even be a disincentive for potential homebuyers. Moreover, if certain measures are not maintained correctly, this could have an adverse effect on the sustainability performance of the dwelling. Examples of such issues include:

- Installing microgeneration technology in preference to adopting fabric measures such as improved thermal insulation, airtightness and reduced thermal bridging. If, following the installation of suitable fabric measures, microgeneration is required, specifiers should consider using systems and installers that have been certified under the Microgeneration Certification Scheme[9] to give them greater confidence with regard to performance and reliability.
- Considering carefully the need to specify a mechanical ventilation system, if a natural ventilation system would be sufficient. Natural ventilation systems, including passive stack ventilation, have minimal maintenance requirements and may be simpler for occupants to use correctly. In some cases, however, mechanical ventilation systems may be specified to provide acceptable air quality, security or noise control. Heat recovery may be needed to reduce carbon dioxide emissions, in order to achieve the required Dwelling Emission Rate (DER) and/or Heat Loss Parameter (HLP) (see sections 11 and 12).
- Considering carefully whether rainwater or greywater recycling systems need to be specified for Code Level 3 and 4 dwellings, if water-efficient fittings and low-water-use white goods will provide an acceptable outcome. There may be ongoing maintenance issues and energy requirements associated with these systems.

Some innovations could have health and safety implications under the Construction (Design and Management) (CDM) Regulations.[10] Products must be fit for purpose, which means that they must not only work, but work safely without exposing the end user, or those installing them, to unacceptable risks. These include risks to health, safety and the environment and, of particular relevance when specifying for Code compliance, risks associated with inspection, maintenance and cleaning during use.[11]

2.4 Case studies

Examples of case studies with credit scores for a variety of scenarios are shown for Code Levels 3 and 4 in Appendix 2.

3 Site-specific mandatory and recommended requirements

As well as the mandatory requirements for the different Code levels, as specified in the *Code for Sustainable Homes Technical Guide*,[1] the Homes and Communities Agency (HCA) (through its English Partnerships and Housing Corporation Standards) and many local authorities have their own requirements and preferences for issues covered by the Code.

3.1 HCA English Partnerships' Quality Standards

The HCA English Partnerships' Quality Standards[12] lay out mandatory requirements, some of which overlap with or relate to Code criteria (see Table 2).

Once the mandatory credits have been added together the optional points can be collected by picking up credits where possible from heavily weighted sections of the Code, such as:

- Ene 2: Building fabric
- Ene 3: Internal lighting
- Ene 4: Drying space
- Ene 5: Energy-labelled white goods
- Ene 6: External lighting
- Ene 9: Home office
- Hea 1: Daylighting (perhaps only 1 credit)
- Hea 3: Private space
- Man 1: Home user guide
- Man 2: Considerate Constructors Scheme
- Man 3: Construction site impacts

HCA English Partnerships also has a requirement with regard to minimising overheating[13] and this will influence site layout, construction materials, glazing, shading and ventilation specifications.

TABLE 2

HCA English Partnerships' Quality Standards

	Mandatory requirements		Credits	Points (%)
Code for Sustainable Homes	Minimum Level 3	Ene 1	5	6.27
		Wat 1	3	4.50
Mat 1: Environmental impact of materials	A+, A, B or C rated constructions only (ratings from BRE's *Green Guide*)[5]		2	0.60
Was 2: Site Waste Management Plan	System, targets and sorting for construction waste		2	1.82
Hea 2: Sound insulation	Minimum of 5 dB better than Building Regulations		3	3.50
Hea 4: Lifetime Homes	Compliant		4	4.66
Man 4: Security	Secured by Design: Parts 1 and 2[6]		2	2.22
Mandatory points				23.57
Total required points for Level 3				57.00
Optional points required to achieve Level 3 (rounded up)				33.44

All final scores in the Code are rounded down to the nearest whole percentage[14]

3.2 HCA Housing Corporation Design and Quality Standards

The HCA Housing Corporation Design and Quality Standards[15] work slightly differently. This document specifies Code Level 3 and then asks for compliance with Secured by Design. Other aspects of the Code are encouraged by awarding points in the Housing Quality Indicator (HQI) methodology and calculator. These are shown along with the mandatory elements in Table 3.

As with the HCA English Partnerships case, once the mandatory credits have been added together the optional points can be collected by picking up credits where possible from heavily weighted sections.

TABLE 3

HCA Housing Corporation Design and Quality Standards

	Mandatory requirements and measures achieving HQI points		Credits	Points (%)
Code for Sustainable Homes	Minimum Level 3	Ene 1	5	6.27
		Wat 1	3	4.50
Ene 8: Cycle storage	Compliant with Code requirements		2	2.51
Wat 2: External water consumption	For example, supply system to collect rainwater for irrigation		1	1.50
Sur 2: Flood risk	Low annual probability of flooding		2	1.10
Hea 1: Daylighting	Compliant with Code requirements		3	3.50
Hea 4 Lifetime Homes	Compliant		4	4.66
Man 2: Considerate Constructors Scheme	Achieving at least 32.0 points (at least 3.0 in each section)		2	2.22
Man 4: Security	Secured by Design: Parts 1 and 2[6]		2	2.22
Mandatory points and measures achieving HQI points				28.48
Total required points for Level 3				57.00
Optional points required to achieve Level 3 (rounded up)				28.53

All final scores in the Code are rounded down to the nearest whole percentage[16]

3.3 Merton Rule and similar requirements: low- and zero-carbon technology

The Merton Rule[17] is named after the London Borough of Merton which first used it in 2003. Merton Rule-type requirements[18] are used by local planning authorities, including the Greater London Authority, to require developers to install renewable energy or low-emission technologies. These rules, in various forms, have been adopted by many local authorities and, with the Planning and Energy Bill (which requires councils to set targets for decentralised energy production) receiving Royal Assent in November 2008, their application is likely to become even more widespread.[19] They specify that developments need to provide a percentage (typically between 10 and 25%) of predicted energy requirements, or achieve a reduction of carbon dioxide emissions, through the use of renewable or low-emission technologies. The technologies permitted by local authorities to meet these requirements will vary.

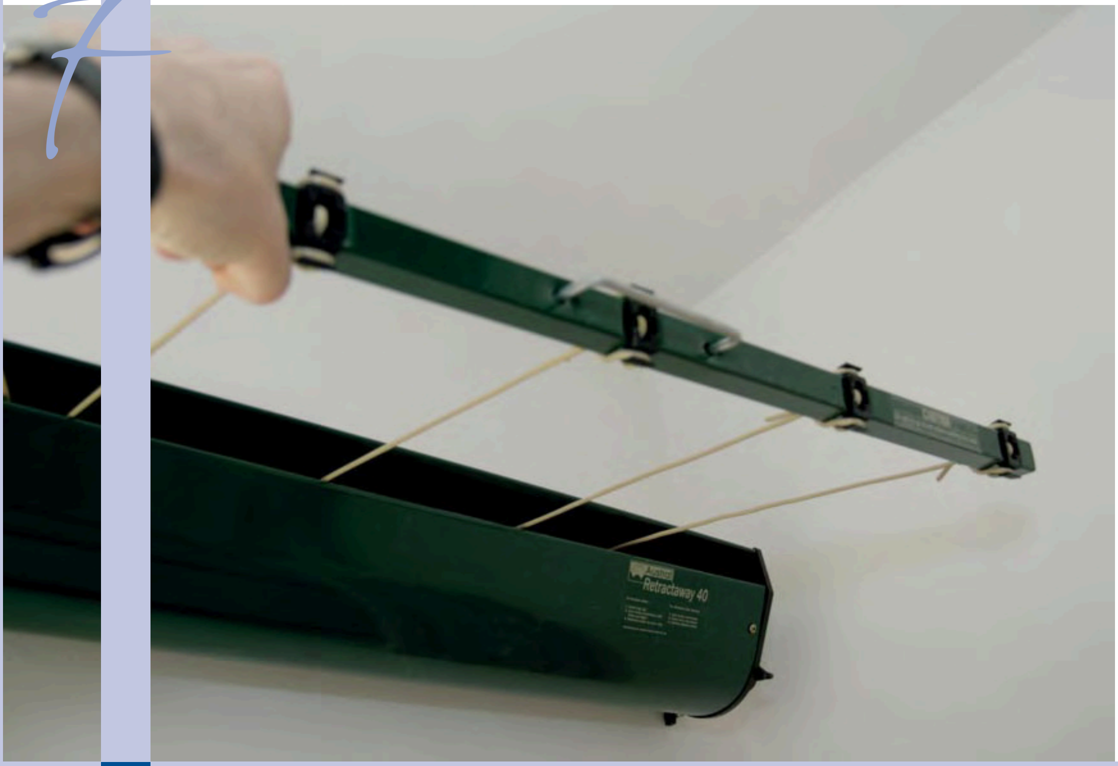
This potentially relates to issue Ene 7 of the Code (and also Ene 1 since it is likely to improve DERs – see section 12). In Ene 7, 1 credit is achieved for reducing total carbon dioxide emissions by 10% by specifying suitable low- and zero-carbon (LZC) technologies, and 2 credits for reducing total carbon dioxide emissions by 15%. For Code Level 4 and certainly for Code Level 5, at least 2 credits will normally be achieved for Ene 7, just through meeting the mandatory requirements of Ene 1. For Code Level 3, renewables are not always necessary (see case studies in Appendix 1 and 2).

It should be noted that the way in which the Merton Rule-type requirements assess the use of renewables is often different from the method used in the Code and that local authorities may have a variety of other similar requirements for developments. For example, the Code considers gas-fired Combined Heat and Power (CHP) as an LZC technology suitable for Ene 7. While many local authorities will encourage or even insist on CHP for appropriate developments, they may not allow it to contribute to the renewable energy requirements.

3.4 The Environment Agency policy towards sustainable drainage

The Environment Agency has a primary policy key objective to establish sustainable drainage systems (SUDS) as "normal drainage practice where appropriate for all new developments in England and Wales".[20] Local authorities are adopting SUDS as a planning requirement for many new developments, particularly those on greenfield sites. Measures can be incorporated into smaller infill sites, but as soakaways and similar methods will often be ruled as unsuitable, meeting the requirements can be a lot more expensive due to the provision of on-site storage requirements.

This directly affects the Code issue Sur 1 (see section 7) but can overlap with Wat 2 External water use and the Ecology section.



4 Easy-win, stand-alone credits

TABLE 4

Credits that do not impact other credits

Category	Issue	Credits	Approx. points/credit	Percentage of overall points
Ene 4	Drying space	1	1.255	1.25
Ene 5	Energy-labelled white goods	2	1.255	2.51
Was 3	Composting	1	0.914	0.91
Man 1	Home user guide	3	1.111	3.33
Total				8.00

There are a few simple credits that have little or no effect on any of the others and can give 8% of the total points available (see Table 4).

4.1 Drying space

Ene 4 Drying space requires an internal drying line (eg a drying line over a bath, with suitable ventilation) or external equivalent (eg a rotary dryer).

4.2 Energy-efficient white goods

To obtain the full 2 credits for energy-efficient white goods (Ene 4) requires the specification of 'A+' fridges and freezers (ratings are for energy efficiency as specified by the EU Energy-efficiency labelling scheme), 'A'-rated washing machines and dishwashers and 'B'-rated tumble dryers (or instead of a tumble dryer, a 'B'-rated washer dryer or providing information on the EU Energy-efficiency labelling scheme). If developers are supplying white goods with their dwellings anyway, then energy-efficient white goods are generally easy to source with only a small price premium, although special requirements such as built-in appliances may severely restrict the choice available. Alternatively, one credit can be achieved simply by supplying information on the EU Energy-efficiency Labelling Scheme. When supplying white goods it is also sensible to consider their water consumption (see section 7).

TOP TIPS

Energy-efficient white goods

There are a variety of ways of achieving credits for Ene 5, and this can cause some confusion, particularly around how to achieve the maximum 2 credits. The table below gives a summary.

	Scenario	Credits awarded
1	▪ Only an 'A+'-rated fridge and freezer or fridge-freezer have been provided	1
2	▪ 'A+'-rated fridge and freezer or fridge-freezer have been provided Information on the EU Energy Efficiency Labelling Scheme for white goods is provided to each dwelling	1
3	Information on the EU Energy Efficiency Labelling Scheme for white goods is provided to each dwelling	1
4	▪ 'A+'-rated fridge and freezer or fridge-freezer ▪ 'A'-rated washing machine have been provided Information on the EU Energy Efficiency Labelling Scheme for white goods is provided to each dwelling	1
5	▪ 'A+'-rated fridge and freezer or fridge-freezer ▪ 'A'-rated washing machine and an 'A'-rated dishwasher have been provided, but no washer dryer or tumble dryer Information on the EU Energy Efficiency Labelling Scheme for white goods is provided to each dwelling	2
6	▪ 'A+'-rated fridge and freezer or fridge-freezer ▪ 'A'-rated washing machine ▪ 'B'-rated (or better) tumble dryer, or a 'B'-rated (or better) washer dryer ▪ 'A'-rated dishwasher have been provided Information on the EU Energy Efficiency Labelling Scheme for white goods is not required for dwellings	2
7	▪ 'A'-rated washing machine and an 'A'-rated dishwasher have been provided Information on the EU Energy Efficiency Labelling Scheme for white goods is required for each dwelling	1

4.3 Composting

The composting credit (Was 3) is particularly easy to obtain if the dwelling has its own garden. In this case a composting bin can be installed, although consideration will have to be given to access for people with disabilities. In flats, the credit can be more difficult, but can still be achieved if the local authority (or other management agency) runs a composting service or kitchen waste collection service. Many local authorities already do this and more are likely to do so in the future to meet government targets.

4.4 Home user guide

A lot of the information needed for a home user guide, meeting the requirements of Man 1, will be provided for the Code assessor anyway so it just needs to be collated into a single document. The additional information needed about the local area can easily be found on the web, in local newspapers and/or in parish magazines. It should also contain details of the procedures for obtaining the guide in alternative formats, including foreign languages, Braille, large print or audio cassette/CD.

5 Site credits: ecology and flooding

TABLE 5

Ecology and flooding credits

Category	Issue	Credits	Approx. points/credit	Percentage of overall points
Sur 4	Flood risk	2	0.550	1.11
Eco 1	Ecological value of site	1	1.333	1.33
Eco 2	Ecological enhancement	1	1.333	1.33
Eco 3	Protection of ecological features	1	1.333	1.33
Eco 4	Change in ecological value of site	4	1.333	5.33
Total				**10.43**

Ecology and flooding credits are mostly site dependent and are absolutely vital when making decisions about how to tackle the rest of the Code since they account for over 10% of the total points available (see Table 5).

Flood risk (Sur 2) is not entirely dependent on the initial condition of the site, but is still best placed in this section as the location of the site significantly affects the likely performance. Two credits can be awarded automatically if the site is situated in a site confirmed to be of low annual probability of flooding (Zone 1).

Sites with medium and high annual probability of flooding (Zones 2 and 3) can still obtain one credit if the finished ground-floor level of the dwellings is at least 600 mm above the design flood level of the flood zone or if there are new or existing defences and the Environment Agency confirms that the flood risk can be downgraded to medium or low.

TOP TIPS

Green and brown roofs

Green and brown roofs can provide a two-fold benefit when trying to improve the Code score. First, they can form part of a SUDS, helping to reduce the rate of surface water run-off. Second, they can increase the ecological value of the site, which is of particular interest when opportunities for enhancement measures at ground level are limited.

There are several options for green roofs, which range from 'intensive', such as roof gardens, to 'extensive', such as sedum roofs. One of the risks of green roofs is that in very hot and dry summers the plant cover has been known to die, so they do need be monitored.

A brown roof is not generally pre-planted with vegetation. It could be covered in something like rubble or gravel, which might contain small self-seeded plants for bio-diversity and/or to attract birds. Brown roofs have the advantage that they are using a waste product as the substrate and therefore potentially reduce waste disposal costs.

It is recommended that green/brown roofs should come as complete systems and are not made up of individual components or materials. They should be installed by a contractor approved by the roof membrane manufacturer. Examples of green roofs can be found in chapter 7.1 of the NHBC standards.[21]

No credits are awarded for Sur 2 if the site is built on against the recommendation of the Environment Agency or if a flood defence scheme for the site would reduce the performance of floodplains elsewhere.

In summary, if the site is in Zone 1 then these two credits are easily obtained. However, in the very unlikely event that planning permission to build in Zones 2 or 3 has been granted, the extra cost entailed in raising the ground floors for an extra 1 credit (for less than 0.6% points) will be considerable, but of course there are wider implications to consider here.

Eco 1 encourages the development of land of low ecological value. Eco 4 rewards minimising any reduction (or increasing) in the ecological value of the site.
Both Eco 1 and (to a lesser extent) Eco 4 are dependent on having a site of poor ecological value in the first place and if this is the case then these credits are well worth pursuing. For a Code assessor to be able to designate a site to be of low ecological value, it needs to be a redeveloped site with virtually no vegetation. Other sites can be considered of low ecological value, but only with confirmation from a 'suitably qualified ecologist', who must visit the site at a suitable time of year and, crucially, prior to any construction work commencing. For maximum points to be obtained in Eco 4, native species or wildlife-friendly planting will have to be considered and this will generally be following the recommendations of the ecologist. The area of this planting is crucial for the credits to be achieved. In order to fit this into small sites, it may be worth considering matrix or cellular paving with grass in the voids or the more expensive option of a green roof. Bearing this in mind, it would be wise if wishing to score well in this area to call the ecologist in at the earliest concept design stage. Both of these solutions could help with SUDS (Sur 1) – see section 7.

TOP TIPS

Trees

When do trees have a 'low ecological value'?

Trees make a valuable contribution to the local ecology around homes, being able to support a wide variety of wildlife. However, existing trees can provide a challenge as they may prevent optimum use of the site, and removing trees of ecological value could prevent a credit being achieved in the Code for Eco 3.

Commonly, trees are automatically classified as having a low ecological value for the Code assessment if they are less than 1 m in height and with a trunk less than 100 mm in diameter. A suitably qualified ecologist can confirm that other trees are of low ecological value and may be removed, for example if they are dead or diseased, or are immature or an introduced species which support little wildlife. However, of course, tree preservation orders may be in place, which will supersede any recommendations of the ecologist.

Planting new trees

If choosing to plant trees to achieve credits for Eco 2 or Eco 4, it would be preferable to choose those which are more drought resistant. An additional aspect to consider is that trees that are native to the UK will often support more species than overseas varieties.

Irrespective of the initial condition of the site, an additional credit can always be obtained for ecological enhancement (Eco 2). A suitably qualified ecologist will need to produce a list of key and additional recommendations on how to enhance the site. Thirty per cent of the additional recommendations have to be adopted. Many of the ecologist's recommendations may be inexpensive and could include planting recommendations, sustainable horticultural techniques (eg avoiding the use of peat), and providing boxes for birds, bats or insects.

Eco 3 enables a credit to be achieved for protecting the site's ecological features, including trees and large shrubs. If the work on site does not affect any ecological features at all, then Eco 3 is obtained by default. Not all trees have a high ecological value, so where some do need to be removed, it may be worth consulting a suitably qualified ecologist to see if the credit can be achieved. Where features remain and are protected in accordance with the Code requirements (which typically follow British Standard requirements[22]), then completion of Eco 3 could be used to comply with one of the key requirements of the Considerate Constructors Scheme (Man 2 – see section 6).

TOP TIPS

Typical ecological enhancement suggestions

Ecology can be enhanced by several means that are possible to integrate into a typical residential development. In simple cases this can include installing bat and/or bird boxes, and planting a variety of vegetation around the home in plant beds or boxes, to increase the attractiveness of the site to wildlife.

Other means include installing green façades and walls which can incorporate twining plants, such as honeysuckle, clematis and wisteria, around a trellis or similar. A space between the trellis and wall is normally recommended to create space for birds and insects to shelter.

Green/brown roofs and cellular paving can also be used to increase the variety of vegetation and wildlife on site as well as potentially providing part of a SUDS solution (see section 7).

It should be noted that only plant species are counted as part of Eco 4 (Change in ecological value of the site), but that both plant and measures for animal species could be included within the recommendations of the ecologist's report for Eco 2 (Ecological enhancement).

Cellular or matrix paving

Cellular paving incorporates hollow spaces or cells in which vegetation, such as grass, can grow. This vegetation supports insects and other invertebrates on which birds and other animals feed. The paving is used for driveways and for SUDS that help reduce surface water run-off.

Cellular paving systems are most often made from concrete or high-density plastic and are easy to lay and replace. Concrete systems utilise laid cellular slabs or are cast in place on site, while plastic systems are produced in mats which interlock when laid. Cellular paving needs to support design loads, including loading from vehicles, without any detrimental effect on the vegetation.

6 Construction and supply chain management

TABLE 6

Construction and supply chain management credits

Category	Issue	Credits	Approx. points/credit	Percentage of overall points
Was 2	Construction site waste management	2	0.914	1.82
Man 2	Considerate Constructors Scheme	2	1.111	2.22
Man 3	Construction site impacts	2	1.111	2.22
Mat 2	Responsible sourcing of materials – basic building elements	6	0.300	1.80
Mat 3	Responsible sourcing of materials – finishing elements	3	0.300	0.90
Total				8.96

6.1 Construction and supply chain management credits

These construction management credits are (see Table 6) relatively easy to achieve on larger sites where their administration and costs can be spread over more dwellings. For smaller sites these may be more difficult, at least until developers become more familiar with the requirements. Credits for Construction site impacts (Man 3) are probably the most straightforward to obtain and are worth pursuing for the majority of developments.

6.2 Considerate Constructors Scheme (Man 2)

The Considerate Constructors Scheme[23] was set up in 1997 to improve the image of the industry. The scheme has eight sections:

1. Considerate (to those using the area around the site)
2. Environment
3. Cleanliness
4. Good neighbour
5. Respectful (to workforce)
6. Safe
7. Responsible
8. Accountable (awareness of the Considerate Constructors Scheme).

There are 41 key requirements spread over the above areas, as outlined in the 'monitors' checklist'.[24]

By fulfilling items (a), (c), (d) and (e) of construction site impacts (Man 3 – see section 6.3) (ie monitoring energy and water, and best practice policies for avoiding pollution of air and water), implementing a Site Waste Management Plan (SWMP) (Was 2) and protecting existing ecological features (Eco 3 – see section 5), this could help meet five of the most difficult key requirements of the Considerate Constructors Scheme.

6.3 Site impact management (Was 2 and Man 3)

Was 2 (Construction site waste management), Man 2 (Considerate Constructors Scheme) and Man 3 (Construction site impacts) are achieved through adopting best practice in site management.

Construction waste management (Was 2) involves the implementation of SWMPs in order to reduce waste and to divert from landfill such waste as is produced, in accordance with best practice. Guidance and templates can be found in the NHBC Foundation/WRAP publication: *Site waste management: Guidance and templates for effective site waste management plans.*[25] A best-practice SWMP, as defined in this document, will:

- Assign responsibility to a waste management champion who will be present on the site to implement the SWMP.
- Identify the types of waste to be generated.
- Identify waste management options.
- Achieve material waste segregation on or off site.
- Use key performance indicators (KPIs) relevant to the industry and project type for monitoring performance.
- Use appropriate and licensed waste management contractors and sites.
- Set a waste recovery target with the waste management contractor employed on the project.
- Set individual targets for waste types.
- Monitor, review and report waste and ensure continuous improvement.

FURTHER INFORMATION

Using off site/MMC systems to reduce waste

Recent work carried out by the BRE on the SmartLIFE project in Cambridgeshire on behalf of WRAP[26] looked at the waste generated by masonry, open-panel timber-framed and pre-insulated steel-framed constructions on houses that were of similar design. Figures for waste generated by the masonry construction on site were compared with the waste generated by the off site systems both on site and in the factory. The timber-framed house produced 11% less waste overall compared with the masonry construction, and the steel-framed house 22% less waste.

Waste management information

There has been considerable development in the field of waste management. Some waste management companies and material suppliers have been very innovative in their approaches – the recycling of waste plasterboard is just one high-profile example (see the WRAP website[27]).

The NHBC Foundation, in conjunction with WRAP, has produced a useful guide to this subject entitled *Site waste management: Guidance and templates for effective site waste management plans.*[25]

In addition, WRAP has produced two guidance documents for contractors and designers: *Achieving good practice waste minimisation and management and achieving effective waste minimisation.*[28]

BRE's SMARTwaste[29] auditing tool can help with SWMPs, ensuring legal compliance and best practice, and it is free to use.

Further information is available on SWMPs in the *Code for Sustainable Homes Technical Guide*[1] or from the Waste and Resources Action Programme (WRAP)[30] BRE, Envirowise[31] or the Department for Environment, Food and Rural Affairs (Defra). SWMPs are now compulsory in England on projects where the cost of construction is over £300 000 and therefore on all larger sites it makes sense to use them to their full extent by adopting best practice to obtain the 2 credits available.

The Construction site impacts (Man 3) credits seek to encourage the minimisation of other site impacts through site management procedures to cover either two to three items (for 1 credit) or four or more (for 2 credits) of the following:

(a) Monitor, report and set targets for CO_2 production or energy use arising from site activities.

(b) Monitor and report CO_2 or energy use arising from commercial transport to and from site.

(c) Monitor, report and set targets for water consumption from site activities.

(d) Adopt best-practice policies in respect of air (dust) pollution arising from site activities.

(e) Adopt best-practice policies in respect of water (ground and surface) pollution occurring on site.

(f) Ensure 80% of site timber (ie timber used only during the construction process – formwork, site hoardings etc.) is reclaimed, reused or responsibly sourced.

The monitoring required for items (a) and (b) is set out in the *Code for Sustainable Homes Technical Guide*[1]. It is simple but, particularly for monitoring of transport, can be laborious and as such could be difficult to adopt on small sites where relevant procedures are not in place.

Items (c) to (e) are much more straightforward to achieve. With regard to item (d), namely dust, only three best-practice issues are specifically raised in the Technical Guide: 'dust sheets', dampening the site in dry weather; and covers to skips. However, where further measures are advised in DTI/ BRE guidance, these must also be followed. With regard to item (e), water pollution, the Environment Agency guidelines in PPG 1, PPG 5 and PPG 6[32] must be followed – something that most developers will automatically want to do. The important aspect is to ensure that this is documented in a site-specific procedure: the credits cannot be achieved without the documentary evidence.

Item (f) for timber will be easier to achieve if practices and procedures to collate appropriate documentation are in place in order to obtain credits for responsible sourcing of construction materials (see Mat 2 and 3 below). However, temporary site timber is frequently not considered by such purchasing policies and the inclusion of items such as scaffolding planks makes compliance very difficult as most subcontractors will not have documentation to demonstrate that they are of reused timber (even though they typically will be).

As mentioned earlier, fulfilling items (a) (CO_2 monitoring on site), (c) (water use monitoring), (d) (air pollution best practice) and (e) (water pollution best practice) would contribute towards achieving compliance with three of the key requirements of the Considerate Constructors Scheme.[6]

6.4 Responsible sourcing (Mat 2 and Mat 3)

Responsible sourcing of materials – basic building elements (Mat 2) and finishing elements (Mat 3) – covers some very important sustainability issues such as timber from certified sustainable and legal sources, and suppliers and manufacturers with environmental management systems; however, they require rigorous enforcement of purchasing policies, may reduce the choice of suppliers and potentially increase costs, and are given very little weighting within the Code. This means that many developers choose to overlook these credits and make up their score elsewhere. In addition, compliance with the requirements must be demonstrated through documentary evidence, so even with a suitable purchasing policy in place it is possible to miss out on the expected credits if a subcontractor or supplier makes an error or fails to deliver to specification.

Where elements (roof, external wall, etc) are to contribute, 80% of the assessed materials must be responsibly sourced and 100% of the timber must be legally sourced.[33] Typical sourcing solutions include the requirement for a suitable environmental management system certificate (eg ISO 14001) or timber Chain of Custody documentation. This must be shown to be for the actual timber and timber products used on site, so suppliers must ensure that their invoices or equivalent confirm the required certification reference: certificates alone are insufficient.

The use of off site or modern methods of construction (MMC) could make this assessment easier because their specification will mean that the developer usually has fewer suppliers to manage. Many of these suppliers are now familiar with providing information on the responsible sourcing of the materials that they use.

7 Potable water, greywater and rainwater use, and SUDS

TABLE 7

Credits for water use and SUDS

Category	Issue	Credits	Approx. points/credit	Percentage of overall points
Wat 1	Indoor water use	5	1.500	7.50
Wat 2	External water use	1	1.500	1.50
Sur 1	Management of surface water run-off from developments	2	0.550	1.11
Total				**10.11**

7.1 Introduction

The Code's water category cannot be ignored as it contains mandatory elements, some of which are very challenging. However, some credits can be achieved at relatively low cost, are relatively easy to integrate into the design, and in the case of Wat 1 and Wat 2, are heavily weighted (which makes them useful if extra credits are required to top up the overall score). See Table 7 for a breakdown.

7.2 Minimising water usage and the specification of white goods

The Code specifies certain mandatory levels to be achieved for Wat 1; these are given in Table 8.

Less than 105 litres/person/day can be achieved by specifying lower water usage fittings without the need to specify greywater or rainwater recycling (see sections 7.3 and 7.4).

TABLE 8

Water consumption

Mandatory levels	Water consumption	Credits
Levels 1 and 2	≤120 litres/person/day	1
	≤110 litres/person/day	2
Levels 3 and 4	≤105 litres/person/day	3
	≤90 litres/person/day	4
Levels 5 and 6	≤80 litres/person/day	5

Some will question the acceptability of low flow-rate showers and small baths. And if these do not provide adequate performance, there is a risk that residents will later install their own fittings which could have a much higher flow rate, thus losing any benefit. Showerheads designed to deliver, what many would regard as adequate performance can now do so, with a flow-rate below 8 litres per minute. These usually modify the water flow using aeration or modulation to enhance its 'feel'. The flow of water from taps can also be aerated.

The NHBC Standards (effective from 1 May 2008, NHBC, Amersham, 2008) specify a minimum flow rate of 6 litres/min (for water pressures above 1.5 bar) for all taps. This flow rate is low enough for such taps to be considered as part of a specification to use 105 litres of potable water per person per day or less (the maximum for Code levels 3 and 4 – see Top Tips) for the May 2009 version of the Code.

Homes built to versions of the Code prior to the May 2009[1] update may have needed to use much lower flow rate taps to obtain similar overall usage rates but the new *Water Efficiency Calculator for New Dwellings* issued in May 2009 is less affected by the tap specification than earlier versions of the Code calculator. Taps with mid-flow water brakes, sometimes also called "click taps", were also specified in the past specifically with the Code in mind, as the maximum flow rate of the lower range could be used in the old water calculator. This is no longer the case and where such taps are specified, the maximum flow rate of the higher range now has to be used, although these taps could still be an effective way to reduce water consumption in practice.

FURTHER INFORMATION

Legionella

When fitting low-flow taps there can be an increased legionella risk if the relevant guidelines are not followed. Water in conventional 15 and 22 mm pipes may be kept at a warm ambient temperature for a long time if the turnover of water is low. This creates a potential environment for legionella and similar bacteria to multiply. Spray outlets, designed to give the illusion of there being more water present, can then create atomised droplets which could be inhaled and infect vulnerable people. These risks are reduced by appropriate pipe layouts, including minimising pipe runs, small-bore insulated pipework and relatively high-use sentinel fittings (a sentinel fitting is the last fitting in a pipe run), such as with any WC. Under the Code, risk assessments for legionella are now required.

The Health and Safety Executive supplies relevant guidance.[34]

Where flow restrictors have been fitted to taps, great care needs to be taken to ensure that they have been installed and set correctly, and still provide an adequate flow since variation in site water pressure may result in the delivered flow rate (which the Code is based on) being different from that which was designed.

Very small bath sizes may be a more problematic issue, although it is possible at Code Levels 3 to 4 to avoid having to use the smallest ones without the need to adopt recycling or harvesting of water.

A rainwater or greywater recycling system used for flushing WCs can be specified in order to allow higher flow rates on taps etc, so developers need to balance the preferences of their customers against increased capital cost and maintenance requirements.

TOP TIPS

Although the May 2009 update of the *Code for Sustainable Homes Technical Guide*[1] does not generally make major changes to the criteria, there is a significant change with respect to the calculation of internal water consumption, as the *Water Efficiency Calculator for New Dwellings* is now used instead of the previous Code-specific calculation method.

The Water Efficiency Calculator for New Dwellings is the government's national calculation method for the assessment of water efficiency in new dwellings, in support of new building regulations and the Code for Sustainable Homes May 2009 version. Due to the impacts of user behaviour, it is not intended to relate directly to the actual water use in the home, but to provide a benchmark assessment of the typical consumption of a fitting specification. It is not a tool for the design of water supply or drainage systems.

To determine the impact of the new calculation method, the *Water Efficiency Calculator for New Dwellings* has been used on a typical home being built to achieve Code Level 3, and it has been found that the requirements may in some cases be less onerous when compared with previous versions of the *Code for Sustainable Homes Technical Guide*. Alternatively, additional credits could be achievable for the same specification.

A typical specification for internal water-consuming items, which would meet the relevant mandatory requirements of Code Level 3 for the *Code for Sustainable Homes Technical Guide* (May 2009 version), is as follows (all values quoted as defined in the Code guidance):

- WC dual-flush: 4 litre full-flush volume, 2.6 litre part-flush volume
- Wash-hand basin: maximum 6 litres/min (as quoted by manufacturer)
- Shower: flow rate maximum 9 litres/min
- Bath: 150 litre capacity to overflow
- Kitchen taps: maximum 6 litres/min (as quoted by manufacturer)
- Washing machines and dishwashers: default values used as not specified
- No rainwater harvesting or greywater recycling.

The above specification yields a calculated internal water consumption of 104.7 litres/person/day, thereby meeting the mandatory Wat 1 requirement for Code Levels 3 and 4 of 105 litres of water/person/day (and achieving the associated 3 credits).

Using the previous water calculation method would give a water consumption of 128.6 litres/person/day, which would achieve no credits at all.

A wide range of white goods now have water consumption levels lower than the default values used in the Code's water calculator (eg a 43-litre/use washing machine is calculated to reduce household water consumption by 2.04 litres/person/day, compared to the default value used when a machine is not specified). This could allow the specification of other items to be relaxed. To further reduce the water use of white goods as shown in the water calculator, small load capacity white goods can be specified. These may then be used more frequently, but the water calculator does not take this into account, although it would impact the end user and their water consumption. The Waterwise website[35] has information on water-efficient washing machines and dishwashers.

TOP TIPS

Getting the water calculation right for white goods

Great care needs to be taken to provide the appropriate information to your Code assessor so that they use the correct values in the water calculator for white goods. For washing machines this will be the 60°C cotton wash in accordance with BS EN 60456,[37] and for a dishwasher it will be the water use for a cycle in accordance with BS EN 50242.[38]

Even with the efforts already mentioned to minimise water use, greywater recycling and rainwater harvesting will in practice be necessary to obtain 5 credits in Wat 1 (ie the mandatory requirement for Code Level 5 and above). It should be noted that very few greywater or rainwater systems have obtained BBA (British Board of Agrément) or BRE product certification. There is a new British Standard for rainwater harvesting systems[39] but none currently exists for greywater systems.

7.3 Greywater recycling

Greywater recycling has a key advantage over rainwater recycling in that the water is more consistently available for use as it does not depend on rainfall. Greywater can be collected from showers, baths and basins and used for the WC. As a result, the amount of mains potable water that can be saved through using greywater is limited by the water requirement for flushing, but as WCs use a high proportion of total potable water consumption, this reduction is still significant. It may sound obvious, but greywater may have a grey hue and residents will need to be prepared for this. Other colours are possible if water is collected from kitchen and utility room sinks (eg coffee and tea residues) and more serious problems may occur if sinks are used for less benign activities, such as washing paint brushes. This contamination would be less likely if the greywater came only from baths and showers, as is generally specified.

Greywater needs to be treated, if it is to be of suitable quality for WC flushing and to avoid the development of legionella and other bacteria. If greywater reuse is to be pursued, consideration should be given to communal systems that can be maintained by an outside contractor. But low-maintenance self-contained units for single dwellings are starting to come on to the market.

FURTHER INFORMATION

Examples of greywater recycling systems

There are a variety of greywater recycling technologies that can be installed either within the dwelling or communally. These differ in how they treat the water. The most conventional systems use chlorine treatment (eg Brac[40]), others use the submerged aerated filter system or membrane treatment systems, while others use gravity separation (eg Polypipe Ecoplay[41]).

Gravity separation systems are stand-alone systems, designed to be installed in individual dwellings. Typically, the system will take water from showers, baths and, optionally, basins, and store it in a tank, eg above where the cistern would normally be. In the first tank, any light solid contaminants are skimmed off from the top and heavier materials sink to the bottom. The cleaner water from the middle of the tank is transferred to a second storage tank to use for flushing. The light solids and the contaminated water containing the heavier material go directly to waste. If the toilet is not used for a long period, the tanks are automatically flushed out with mains water.

7.4 Rainwater recycling and water butts

Rainwater recycling systems collect rainwater run-off and store it, normally in underground tanks, on site. After filtration, the water can then be used to flush WCs, supply washing machines[42] (contributing to Wat 1) or irrigate the garden (contributing to Wat 2). Although rainwater recycling systems are generally simpler than greywater systems, there is still a need for occasional basic maintenance.

Installing a water butt will not contribute to reducing water use internally (Wat 1), but it is usually the easiest way to achieve the 1 credit available in Wat 2 (External water use). Water butts are simple and cost-effective to install for detached and semi-detached dwellings, although flats and terraced housing may not have sufficient space and/or downpipes unless their provision is designed in from the earliest stage.

TOP TIPS

Water butts

A simple way to obtain the Wat 2 credit is to install a water butt to collect rainwater from the roof for watering the garden.

A butt requires installation on a firm flat base which is capable of supporting its fully laden weight. They are typically around 200 litres in capacity, made of plastic and come in a variety of styles. All require overflows to be installed to redirect water into the downpipe or another drainage system when full. The capacity of butts can be increased by providing more than one butt around the garden area or by connecting butts together, if a larger-volume butt is not suitable. The water butt needs to be located on a stand to allow easy dispensing of water into a watering can. A secure removable cover is required to prevent debris falling into the water and prevent access to children, while the removable lid allows access for cleaning. Finding the space and suitable downpipe for a butt attached to detached and semi-detached dwellings is usually straightforward, but can be more difficult with terraces and flats.

If a more elaborate system is installed that collects rain from the roof and/or the paved areas, has an outside tap and the rainwater can be recycled internally, not only will it contribute to Wat 2, but also to Wat 1. If designed correctly it may even contribute to Sur 1 (Reduction of surface rainwater run-off from the site). See Further Information: Rainwater harvesting – permeable paving

Special care needs to be taken when specifying roofing materials, gullies, downpipes etc. for rainwater recycling. Gullies should be enclosed to minimise contamination and all materials need to be colourfast (which excludes some forms of timber cladding), non-rusting and free-draining.

FURTHER INFORMATION

Rainwater harvesting: permeable paving

Permeable paving can be an effective means of attenuating surface water run-off in both high and low flood-risk areas. When it rains, the water filters through the permeable pavement, or substrate such as gravel into an underground holding tank. After the rain subsides, the collected water is gradually released into a local watercourse or infiltrates the ground through a soakaway. If some of the water is stored for a longer period, the water can be used for applications in the dwelling for which non-potable water is suitable, including flushing the WC and for the washing machine. This would reduce potable water use, which has the potential to help gain credits in Wat 1, while also improving drainage and possibly gaining credits in Sur 1.

On the Hanson EcoHouse on the BRE Innovation Park, water from the roof downpipes goes directly onto the Formpave permeable paving. Some of the water is stored and used for flushing the WCs. The trench dug for the paving also provides a location for the external coils of the ground source heat pump, which provides a source of heat for use in the dwelling. The house scored maximum credits for Sur 1 and calculated water savings of 24 litres/day.

Rainwater and washing machines

Rainwater can be used in some washing machines but not in others. Great care should be taken to check this with the manufacturer since it could invalidate guarantees.

7.5 Surface water run-off

Surface water run-off is covered by Sur 1 of the Code. There is a mandatory requirement for Code-compliant dwellings, in all versions of the *Code for Sustainable Homes Technical Guide*[1] issued to date, that both the peak rate of run-off and the predicted volume of run-off from the site is no greater post-development than it was pre-development.

Full details of the requirements can be found in the relevant *Code for Sustainable Homes Technical Guide* but, in particular, note that cost and logistics are not considered a suitable technical reason for avoiding these requirements. Also, attenuation measures which reduce the peak rate of run-off only by delaying discharge from the site, such as holding tanks, balancing ponds and hydrobrakes, do not generally meet the volume requirement – these typically do not reduce the overall volume of run-off. Only in circumstances where there is evidence of suitable technical reasons may the amount of residual additional rainwater volume (ie that which cannot be prevented from being discharged) be reduced following a hierarchy of options detailed in the *Code for Sustainable Homes Technical Guide*.[1]

For both rate and volume of run-off, an allowance for climate change must also be made in accordance with current best practice (eg Planning Policy Statement 25, CLG, 2006 www.communities.gov.uk/documents/planningandbuilding/pdf/planningpolicy statement25.pdf).

In all cases, the drainage consultant needs to have prepared sufficient calculations to provide supporting information regarding peak run-off rates and additional volume of run-off – these must follow the relevant Code methodology. For derelict sites which have no run-off to sewers or watercourses, provided the site has been derelict for five years or less, the pre-development discharge can be calculated for the previous site's use. Also, a special case may occasionally be referable to BRE, where there are unique characteristics of the catchment which require a different approach to attenuation. However, the general assumption should be that the above requirements will apply. The significance of these requirements means that they should be considered and addressed with advice from a suitably qualified drainage consultant at the earliest possible design stage.

Up to 2 credits can then be awarded for either installing a SUDS system that ensures no discharge to the watercourse for rainfall depths of up to 5 mm, or establishing an agreement for the operation and maintenance of the SUDS system. Both these options will require specialist advice. CIRIA has produced a number of useful publications on SUDS which are obtainable from its website,[43] of which *The SUDS Manual*[44] is but one.

Although sometimes the cheaper option, in other circumstances SUDS systems can be rather expensive. However, they are frequently a mandatory requirement of planning permission and, if designed correctly, they may allow cost-effective achievement of additional credits in other sections of the Code, for example:

- by planting grass into matrix or cellular paving to achieve credits for Eco 4 (Change in ecological value of site) – see section 5, or,
- by installing a rainwater harvesting system for credits under Wat 1 (Internal potable water) and Wat 2 (External potable water), although the differing requirements of rainwater storage and attenuation of run-off are not always easy to incorporate.

Permeable paving is usually specified for the attenuation of surface water run-off. However, it can also be used to provide a supply for a rainwater recycling system. Further information on using permeable paving can be found in Interpave's *Responsible rainwater management around the home – using pre-cast concrete paving.*[45]

Where SUDS are outside the curtilage of the dwelling, their long-term maintenance and adoption will always need to be considered in conjunction with the appropriate authority early on in the design process.

8 Space and design layouts

TABLE 9

Credits for space and design layouts

Category	Issue	Credits	Approx. points/credit	Percentage of overall points
Hea 4	Lifetime Homes	4	1.167	4.66
Ene 8	Cycle storage	2	1.255	2.51
Was 1	Storage of non-recyclable waste and recyclable household waste	4	0.914	3.65
Eco 5	Building footprint	2	1.333	2.67
Hea 1	Daylighting	3	1.255	3.50
Ene 9	Home office	1	1.255	1.25
Total				18.24

The layouts of the dwellings, can, with thought, help achieve up to 18% of the Code (see Table 9).

8.1 Space requirements of credits (Hea 4, Ene 8 and Was 1)

The developer will need to consider the cost of land when considering pursuing some credits. Lifetime Homes (Hea 4) and Cycle storage (Ene 8) are both measures that demand significant space, which could mean that fewer dwellings can be built. Waste recycling (Was 1) also has some space requirements.

Lifetime Homes[46] (Hea 4), which is mandatory at Code Level 6, requires more space due to increased doorway and corridor widths, additional car parking area and wider paths from car parking etc.

The space required for 2 credits for Cycle storage (Ene 8) is:

- 1 cycle: 2 × 0.75 m (one-bedroom and studio dwellings)
- 2 cycles: 2 × 1.5 m (two- and three-bedroom dwellings)
- 4 cycles: 2 × 2.5 m (four-bedroom dwellings and larger).

Alternatively, cycles can be hung on a rack, but they must be capable of being taken down independently. Cycle storage can normally be accommodated in the back gardens of houses if there is direct access to the road, but cycle storage can be difficult to provide for terraced houses and flats. When cycle storage facilities are combined with waste storage, care must be taken to ensure that the requirements of both are met and that accessibility is not compromised.

In the Code there are a number of options allowed for the internal storage of household waste (Was 1). The most likely solutions for the maximum 4 credits are with a suitable local authority collection scheme (minimum fortnightly collection) where recyclable household waste is either sorted:

- after collection – in which case there is space for at least one 30-litre internal bin
- before collection – in which case there is space for three internal bins (none smaller than 7 litres) with a total capacity of at least 30 litres.

These requirements may have an effect on the size of some smaller kitchens.

Where there is no kerbside collection of material for recycling, a storage area for three external recycling bins is needed.

On high-rise developments, the mandatory requirements of the Code for waste storage can be very onerous, so developers should check the British Standard requirements[47] and their local authority planning department's waste policy when planning layouts.

8.2 Building footprint (Eco 5) and increasing build density

There is scope to increase the efficiency of footprint use if designing house types from scratch. Achieving 1 credit will require a *net internal floor area:net internal ground floor area* of 2.5:1 for houses and 3:1 for flats. Achieving 2 credits will require ratios of 3:1 and 4:1 respectively.

It should be noted that:

- this is calculated across the whole development and that all the dwellings will receive the same credit score
- external buildings such as a permanent bin store or a garage contribute to the footprint of the buildings, but not to the floor area.

Specifying an additional storey or a room in the roof can be a way of achieving this credit.

FURTHER INFORMATION

Building footprint

To achieve the full 2 credits for Eco 5 (Building footprint) in the Code, houses need to achieve a ratio of *net internal floor area:net internal ground floor area* of at least 3:1, which can be a challenge when there are planning restrictions on the number of storeys. However, obtaining the credits can help to increase land utilisation through minimising the area taken up by the dwelling.

A prime example of this are the semi-detached Sigma houses developed by the Stewart Milne Group for the BRE's Innovation Park. These obtain the maximum 2 credits for Eco 5 and have been shown to potentially achieve a density of 45 units per hectare.

8.3 Orientation and positioning of dwellings and their windows: the effect on the daylighting (Hea 1) and home office (Ene 9) credits

Imaginative design can make a significant difference to achieving the maximum 3 credits available for good daylighting (Hea 1). Most house designs can probably achieve 1 credit quite easily with minimum or no modification through achieving a 1.5% daylight factor in living rooms, dining rooms, studies and any designated home office space. It is recommended that default values in the calculations are replaced with actual values where possible, for example the glass transmission factor, which should be obtained from the window manufacturer.

Kitchens require a greater daylight factor (2%) for a second credit. For the third credit, 80% of the working plane in kitchens, living rooms, dining rooms and studies (including the designated home office space – see Ene 9 below) must have a view of the sky. The primary means of achieving this is through the placing and orientation of dwellings and optimising the internal layout, but the sky view can also be improved by raising the head of windows, increasing the glazed area and the use of rooflights.

Lifetime Homes also affects window size: it requires that living room window glazing should start no more than 800 mm above floor level.

Some houses are being designed with the living areas upstairs. This improves daylighting to these areas, as there is likely to be less impact from external obstructions to the view of the sky. Where living areas are on the top storey, it also allows an option for rooflights. This 'inverted design' has the added advantage of bedrooms being located on lower floors where they will be cooler in hot summers (see section 12).

There is a risk that increasing the amount of glazing will have a negative impact on the thermal performance of the building. However, provided that consideration is given to the orientation and the performance of glazing units (eg BFRC[48] A-rated or high-performance triple glazing) then including larger areas of glazing will not usually be a problem. Indeed when this glazing is considered correctly, ie to face south to make use of passive solar gain, the building's thermal performance may be improved. It is important in any project, however, that the summer overheating risk is carefully considered.

8.4 Home office (Ene 9)

The other, non-daylighting, requirements for a home office (Ene 9) are usually easy to satisfy. For larger dwellings it is relatively easy to accommodate a home office in a secondary bedroom, but it does require power and telephone points (one telephone point with confirmation of connection to broadband, or otherwise two telephone points). It must be remembered that a wireless connection does not meet the requirements of the Code.

The office must be in a suitable room. In small dwellings (two or fewer bedrooms), there is a lot of flexibility with regard to the suitability of rooms, with only bathrooms being unacceptable. In larger dwellings (three bedrooms or more), living rooms, kitchens and master bedrooms are also unacceptable.

9 Specifying materials

TABLE 10

Materials credits

Category	Issue	Credits	Approx. points/credit	Percentage of overall points
Mat 1	Environmental impact of materials (*Green Guide*)	15	0.300	4.50
Pol 1	GWP of insulants	1	0.700	0.70
Total				5.20

9.1 Introduction

For most generic methods of low-rise construction a good score of around 13 out of 15 credits (3% points) for Mat 1 (Environmental impact of materials) can be achieved if the issue is considered at the design stage (see Table 10). However, materials used for high-rise construction methods such as concrete frame are not likely to perform so well. The mandatory levels set by the Code and by third parties such as the Homes and Communities Agency and some local authorities can cause problems, in particular for high-rise construction.

Achieving the 1 credit (0.7% points) available for Pol 1 (Global warming potential [GWP] of insulants) should be possible for all developments (see Table 10).

9.2 Environmental impact of materials (Mat 1)

It is important to consider the environmental impact of the materials that will be specified in the five main elements of the building – roof, external walls, internal walls (including separating walls), upper and ground floors (including separating floors) and windows.

The *Green Guide*[5] provides a rating of A+, A, B, C, D or E for construction types for each element. The Code specifies a mandatory level of 100% of three out of the five key elements being A+ to D rated. On some sites, additional, stricter requirements may apply, eg the Homes and Communities Agency English Partnerships' Quality Standards specifies A+ to C for all elements.

FURTHER INFORMATION

Example: *Green Guide* ratings

For some of the more common build practices, *Green Guide* ratings are shown in Table 11.

TABLE 11

Green Guide ratings

Element	Rating
Roof	
Timber-trussed rafters and joists with insulation, roofing underlay, counterbattens, battens and concrete interlocking tiles	A+
External walls	
Brickwork outer leaf, insulation, aircrete blockwork inner leaf, cement mortar, plaster, paint	A+
Brickwork outer leaf, insulation, aircrete blockwork inner leaf, cement mortar, plasterboard on battens, paint	A+
Cement-rendered aircrete blockwork outer leaf, insulation, superlightweight solid blockwork inner leaf, cement mortar, plaster, paint	A+
Cement-rendered aircrete blockwork cavity wall, insulation, cement mortar, plasterboard on battens, paint	A+
Fair-face solid blockwork outer leaf, insulation, timber frame, vapour control layer, plasterboard on battens, paint	A+
Brickwork outer leaf, insulation, aircrete blockwork inner leaf, cement mortar, plasterboard on battens, paint	A+
Internal walls	
Timber stud, OSB (oriented strand board) facing, paint	A+
Galvanised steel stud, plasterboard, paint	A
Aircrete blockwork with plaster, paint	A
Aircrete blockwork, plasterboard, paint	B
Dense blockwork with plaster, paint	B
Dense blockwork, plasterboard, paint	C
Ground floors	
Screeded in situ concrete slab, over insulation on polyethylene DPM laid on blinded virgin aggregate sub-base	D
Structural topping on beam and extruded polystyrene (HFC blown) block flooring	B
Upper floors	
Chipboard decking on timber I joists	A+
Chipboard decking on timber joists	A+
Screeded beam and dense solid block flooring	C
Windows	
Durable hardwood window, double glazed, solvent-borne gloss paint (TWAS)[49]	A+
Preservative pre-treated softwood window, double glazed, water-based stain (non-TWAS)	A
Preservative pre-treated softwood window, double glazed, water-based stain (TWAS)	A+
PVC-U window with steel reinforcement, double glazed	A

More *Green Guide* ratings can be viewed online www.thegreenguide.org.uk.[50]

Note that ratings in the *Green Guide* are subject to change at any time, and reference should always be made to the latest online version. The version in force at the time of registration of the assessment will apply.

Elements you may wish to avoid: examples of E-graded constructions from the *Green Guide*

For compliance with the Code at all levels, no more than two elements are permitted to contain any E-grade construction types, as determined by the *Green Guide to specification* online.[50]

Examples of E-grade elements for low-rise construction are:

- Roof:
  - precast prestressed concrete hollow slab, with screed, mastic asphalt roofing, insulation, paving slabs.
- External walls:
  - imported Chinese granite-faced precast concrete sandwich panel, plaster skim, paint
  - sandstone-faced precast concrete sandwich panel, plaster skim, paint
  - UK slate rainscreen cladding and steel support, insulation, medium dense solid blockwork inner leaf, plasterboard and paint.
- Internal walls:
  - precast concrete panel (non-load-bearing, 150 mm) with plasterboard and paint.
- Upper floor:
  - chipboard decking on timber battens, grouted hollow precast reinforced slab flooring
  - screeded hollow precast reinforced slab.
- Ground floor:
  - screed on insulation laid on in situ concrete floor on polyethylene damp-proof membrane (DPM) on blinded virgin aggregate sub-base.
- Windows:
  - powder-coated aluminium window with softwood internal frame, double glazed, solvent-borne gloss paint internally.

The *Green Guide* ratings can be viewed at www.thegreenguide.org.uk.

The rating is based on a wide range of environmental impacts, but construction types with high embodied energy, eg due to a high mass of material or high transport requirements, will tend to perform poorly in the *Green Guide* and this has to be balanced against the advantages that such mass can potentially bring for thermal comfort in the summer.

9.3 Global warming potential of insulants (Pol 1)

This credit is aimed at reducing the GWP of the blowing agents used in the manufacture of foamed insulants. This can be an inexpensive and relatively easy credit to obtain simply through the specification of either non-foam insulants (eg mineral wool) or foamed insulants that use appropriate blowing agents.[1] Care will need to be taken to check the provenance of insulation in unexpected places, eg within doors, hot water cylinders and heat pumps.

10 Secured by Design – windows, doors and external lights

TABLE 12

Secured by Design credits

Category	Issue	Credits	Weighting	Points (%)
Man 4	Security	2	1.1	2.20
Ene 6	External lighting	2	1.3	2.50
Total				4.70

10.1 Introduction

Table 12 summarises the credits available from issues related to Secured by Design. These credits should be relatively easy to obtain if a police representative is consulted sufficiently early in the design process.

10.2 Windows and doors (Man 4)

To obtain the Security credits, the developer must consult with the police architectural liaison officer or crime prevention design officer and incorporate their recommendations with regard to conforming to section 2 of Secured by Design, Physical security from Secured by Design.[52] Evidence must be kept to demonstrate that this has occurred. This is relatively straightforward as it does not include site factors which may hinder achievement of the full Secured by Design award. Section 1 of Secured by Design is not covered within the Code, but may be required by the Homes and Communities Agency.

Secured by Design section 2 covers doors, windows, security lighting and alarms. Doors must comply with PAS 24-1[53] and downstairs windows must comply with BS 7950: 1997.[54]

Ancillary items such as locking systems, chains, limiters, viewers and letter plates are also specified.

Many companies, including those who import windows and doors from overseas, have Secured by Design-compliant products.

10.3 External lighting (Ene 6 and Man 4)

The Code criteria are set up so that there should be no conflict between achieving both the Security credits and the External lighting credits, because there is no restriction on the number of external light fittings, only that they are designed to be energy-efficient and adequately controlled.

Secured by Design requires that the security lighting covers all external doors, car parking and garage areas and some footpaths to dwellings. All luminaires must be designed to reduce light spillage and must have daylight cut-out sensors, with manual override.

To achieve 1 out of the 2 credits for External lighting (Ene 6), the space lighting fittings (as opposed to security lighting fittings) must be dedicated energy-efficient fittings. Credits cannot be awarded by default if no space lighting is installed. Internal and external communal lighting needs additional controls, such as push-button timers or PIR (passive infrared) sensors, but these should be straightforward to accommodate.

For the second credit, in addition to the energy-saving elements outlined in Secured by Design, all burglar security lights must have a maximum wattage of 150 W and be fitted with movement-detecting control (PIR). Where there are no such security lights, the second credit can be achieved by default.

It should be possible to obtain the maximum credits for Ene 6 and Man 4 on all sites.

11 Building fabric and balconies

TABLE 13

Building fabric and private space credits

Category	Issue	Credits	Approx. points/credit	Percentage of overall points
Hea 2	Sound insulation	4	1.167	4.66
Ene 2	Building fabric	2	1.255	2.51
Hea 3	Private space	1	1.167	1.16
Total				8.33

1.1 Introduction

Decisions about the building fabric have wide ramifications within the Code. Good decisions will not only enable most of the available 8 points to be obtained for the three items considered here, but could also result in more percentage points being achieved for Ene 1 Dwelling Emission Rate (DER), and even reduce the amount of renewable energy needed to achieve Ene 7, due to the reduction in total carbon dioxide emissions (see Section 12). See Table 13 for a breakdown of credits.

1.2 Sound insulation (Hea 2)

The sound insulation properties of different constructions vary considerably. The credits available are shown in Table 14.

Robust Details[56] that deliver a 5 dB improvement are available for separating walls, although there are only a few Robust Details for separating floors. More Robust Details are being developed. There are types of construction that do not have Robust Details but which can achieve the full 4 credits due to their good sound insulation performance. These are worth considering as 4 credits translate into 4.66% points due to the high weighting factor. Constructions without Robust Details have to be tested on site. This invites risk of failure due to variable workmanship and it is advisable to be cautious about forecasting their performance, particularly if the developer has no previous experience of them.

TABLE 14

Sound insulation credits

Insulation for:	Improvement on Building Regulations	Credits
Airborne sound	3 dB higher	1
Impact sound	3 dB lower	
Airborne sound	5 dB higher	3
Impact sound	5 dB lower	
Airborne sound	8 dB higher	4
Impact sound	8 dB lower	

TOP TIPS

A system which achieves maximum scores for sound insulation

There are a few MMC/off site system providers who can provide systems that claim to deliver the maximum credits for both separating walls and separating floors, although none of these is as yet registered as a 'Robust Detail' and they therefore need to be tested for sound transmission once constructed. The off site nature of such constructions gives greater confidence in the repeatability of their performance, although their installation on site can still compromise this performance (eg due to site-formed service penetrations).

11.3 Building fabric (Ene 2)

Credits are available for achieving a low Heat Loss Parameter (HLP) for the dwelling; these are shown in Table 15.

TABLE 15

Heat Loss Parameter (HLP) credits

HLP	Credits	Notes
≤1.30	1	
≤1.10	2	
≤0.80	2	Required for Level 6[56]

The HLP figure is calculated as part of the SAP (Standard Assessment Procedure) calculation for Part L1A of the Building Regulations. It is a measure of the heat loss through the building fabric, taking into account thermal bridges, ventilation and air leakage. It is easier to achieve a good HLP with compact build forms which have less exposed outside area, such as flats or mid-terrace dwellings. For less compact designs, such as detached dwellings and bungalows, the levels of airtightness and insulation will have to be stringently specified, and constructed with high-quality workmanship, to obtain the desired HLP.

TOP TIPS

Energy-efficient windows

Highly energy-efficient windows have been available in Scandinavia, Germany and Austria for some time. On the BRE Innovation Park, the highest-performing windows are manufactured in Scandinavia and have U-values of 0.8 W/m^2K or better. The PassivHaus standard also specifies 'solar heat-gain coefficients around 50%' to help limit unwanted solar gain in summer, although an important feature of PassivHaus design is that it uses passive solar design to minimise space heating demand in the winter. Energy-efficient windows and other products can be found online www.passivhaus.org.uk.[56]

A good HLP achieved by a high level of building fabric performance provides a sound base for meeting the DER target (Ene 1).

The HLP value of ≤0.80 required for Code Level 6 is a similar level to PassivHaus (see Further Information). Some designers and developers are considering adopting the PassivHaus levels of building fabric performance for Code Level 3 dwellings. This is because it is in some cases possible to achieve the energy requirements of Level 3 without specifying renewable technologies. However, meeting PassivHaus standards is particularly taxing with regard to thermal bridging and airtightness, both of which require great care with design details and work practices, and few UK builders currently have experience in constructing to this level of performance.

FURTHER INFORMATION

What is a PassivHaus?

The PassivHaus Standard is a voluntary space heating and primary energy standard developed in Germany in the 1990s. A dwelling built to this standard must require no more than 15 $kWh/m^2/year$ for space heating. A 2006 Part L (England and Wales) Building Regulations compliant dwelling would typically require around four times as much energy to heat it.

Houses built to the PassivHaus standard have a low HLP. The U-values of the heat-loss elements of the shell should not exceed 0.15 W/m^2K, the windows should not exceed 0.80 W/m^2K and the airtightness should not exceed 1 $m^3/(h.m^2)$ @ 50 Pa. Thermal bridging is minimised through the use of high-performance details for junctions between elements, although the availability of these details for UK construction methods will need to be improved if PassivHaus is to gain a wider uptake in this country.

The very low space heating requirement means that traditional wet radiator systems are not required and other systems such as warm air become more appropriate. Further details can be found online www.passivhaus.org.uk.[56]

Very high airtightness levels can be particularly difficult to achieve, and great attention to detail is required, both during the design and the construction stages, in order to obtain consistently good results.[57] It is advisable to conduct a preliminary airtightness test as soon as the building is weathertight, but prior to internal finishing. In cases where the desired level of airtightness has not been achieved, remedial work may be carried out by using sealants and fillers. However, this is time-consuming, not guaranteed to improve the airtightness substantially, and carries the risk of losing credits for Ene 1, Ene 2 and indirectly Ene 7 (renewables). It is even possible that emissions from the use of large quantities of additional sealants and fillers could lead to a deterioration in indoor air quality.

TOP TIPS

Achieving good airtightness

Airtightness work begins not on the construction site but on the drawing board. A thoroughly thought-out airtightness strategy starts at the original concept: an irregular-shaped building with many corners and other weak points, or without suitable space for services to be well integrated within the design, will be difficult to make airtight. But the work begins in earnest the moment detail drawings are being drafted. This includes defining a continuous airtightness barrier, planning mechanical and electrical (M&E) services to minimise the potential for air barrier penetrations, and choosing appropriate building products. Once on site, operatives should be educated about the importance of airtightness and how to achieve it. The site manager should also conduct thorough and frequent checks to ensure the airtightness strategy is being carried out.

Building up expertise and experience in airtightness will pay dividends when seeking compliance with higher levels of the Code. This is especially true for Code Level 6 where compliance with the mandatory HLP of ≤0.80 commonly requires the use of whole-house heat recovery systems and an airtightness ideally approaching 1 $m^3/(h.m^2)$ @ 50 Pa but certainly no greater than 3 $m^3/(h.m^2)$ @ 50 Pa (compared to a maximum of 10 $m^3/(h.m^2)$ @ 50 Pa required for Building Regulations). A developer/designer should consider carefully their track record in achieving these sorts of airtightness levels before relying on them within any design strategy. Special consideration should also be given to how the house is ventilated to avoid poor indoor air quality and moisture problems.[58]

11.4 Ventilation systems

For dwellings with airtightness of 5–7 $m^3/(h.m^2)$ @ 50 Pa, which would typically suit Code Level 3 and 4 dwellings, well-designed natural ventilation systems can offer a workable solution that could achieve at least 1 credit for Ene 2 (Building fabric), but still provide adequate ventilation to the dwelling. Ventilation in summer is particularly important to avoid overheating, and the flexibility to use natural ventilation in summer for this purpose is likely to be the most effective way to achieve suitably high flow rates of air through the dwelling.

Mechanical ventilation and heat recovery (MVHR) systems have the potential to significantly improve the HLP to enable the maximum 2 credits to be achieved in most cases. It is good practice for new build to only specify them in dwellings that are sufficiently airtight (ie 3 $m^3/(h.m^2)$ @ 50 Pa or better). In fact, it is recommended that very airtight buildings have MVHR to ensure good air quality, as it offers the advantage of continuous ventilation throughout the year, helping to minimise the risk of condensation and mould growth.

There are however a number of issues to consider when thinking of using MVHR.

FURTHER INFORMATION

Improving fabric thermal performance versus installing renewable energy technologies

To illustrate different ways of achieving the mandatory DER for Code Level 3, a semi- detached (89 m^2) house has been modelled using five different strategies (see Table 16).

TABLE 16

Possible strategies for achieving a DER suitable for Code Level 3

Specification		1. Building fabric only route without renewable energy technology	2. Relaxed airtightness to 5 m^3/(h.m^2) @ 50 Pa, window spec relaxed but still using EST Enhanced Construction Details	3. Relaxed airtightness to 5 m^3/(h.m^2) @ 50 Pa, window spec relaxed and now using Accredited Construction Details	4. Relaxed airtightness to 5 m^3/(h.m^2) @ 50 Pa, window spec relaxed and now using natural ventilation and Accredited Construction Details	5. Typical Part L compliant building + renewables to achieve Ene 1 requirements of Code Level 3
Fabric U-values (W/m^{2}K)	Roof	0.13				
	Walls	0.25				
	Ground floor	0.15			0.20	
	Windows	1.20 (g = 0.5)	1.80 (g = 0.63)	1.80 (g = 0.63)	1.80 (g = 0.63)	1.80 (g = 0.63)
	Doors	1.00 (insulated core)			2.85 (½ glazed solid door)	
	y-value (thermal bridging)	0.04 (EST best-practice Enhanced Construction Details)	0.04 (EST best-practice Enhanced Construction Details)	0.08 (Accredited Construction Details)	0.08 (Accredited Construction Details)	0.08 (Accredited Construction Details)
Ventilation	Airtightness (m^3/(h.m^2) @ 50 Pa)	3	5	5	5	7
	Ventilation system	MVHR 85% efficiency, 1 W/(l/s) specific fan power	MVHR 85% efficiency, 1 W/(l/s) specific fan power	MVHR 85% efficiency, 1 W/(l/s) specific fan power	Natural ventilation (extract fans with trickle vents)	Natural ventilation (extract fans with trickle vents)
Heating	Heating system	A-rated gas condensing boiler				
	Controls	Programmer, room thermostat, TRVs + a weather or load compensator			Programmer, room thermostat,TRVs only	
	Water heating	160-litre cylinder with 50 mm factory-applied insulation			160-litre cylinder with 38 mm factory-applied insulation	
	Secondary heating	10% electric (as assumed within Building Regulations)				
Renewables		n/a	3 m^2 of evacuated tube solar hot water	6 m^2 of evacuated tube solar hot water	6 m^2 of evacuated tube solar hot water + 2 modules of 180 W peak PV	6m^2 of evacuated tube solar hot water + 3 modules of 200 W peak PV
Energy-efficiency lighting		30% (as assumed within Building Regulations)				
CO_2 emissions	TER (kg/m^2/year)	23.00	23.00	23.00	23.00	23.00
	DER (kg/m^2/year)	17.18	17.00	17.26	16.53	17.01
	Improvement (%)	25.3	26.1	25.00	28.1	26.0
Energy-efficiency rating		85 (B)	85 (B)	85 (B)	87 (B)	87 (B)
Environmental impact rating		86 (B)	86 (B)	86 (B)	87 (B)	86 (B)
HLP		0.91	1.07	1.16	1.36	1.47
Running costs (£/year)		188	187	189	168	168

Notes to Table 16

- There is no real benefit in having more than 6 m^2 of solar hot water panels for a dwelling of this size, and once this has been reached it is best to use PV to provide any additional renewable energy requirements, as is the case above.
- In specification 5, three 200 Wp PV panels have been specified instead of specifying four modules of 180 Wp, as three higher-efficiency modules cost less than four modules of 180 Wp PV and yet still achieve the minimum Ene 1 Level 3 requirements.
- The U-values specified can be achieved using a variety of solutions including masonry and timber-frame. For details of the construction details used in the above specifications, go online to:
  - Accredited Construction Details www.planningportal.gov.uk/england/professionals/en/1115314255826.html[59] or
  - Energy Saving Trust Enhanced Construction Details www.energysavingtrust.org.uk/business/Business/Building-Professionals/Helpful-Tools/Enhanced-Construction-Details.[60]
- Standard construction details are not available for all build systems solutions in which case modelling may be required to assume this level of performance.

Some definitions

DER	Dwelling Emission Rate
EST	Energy Saving Trust
g	solar transmittance factor
PV	photovoltaic
TER	Target Emission Rate
Wp	Watt-peak.

- The Energy Efficiency rating (also known as the SAP rating) is based on the energy costs associated with space heating, water heating, ventilation and lighting, less cost savings from energy-generation technologies. It is adjusted for floor area so that it is independent of dwelling size for a given built form. The SAP rating is expressed on a scale of 1 to 100 – the higher the number the lower the costs (it can also be represented as a letter A to G, with A being the best).
- The Environmental Impact rating is based on the annual carbon dioxide emissions associated with space heating, water heating, ventilation and lighting, less the emissions saved by energy-generation technologies. It is adjusted for floor area so that it is essentially independent of dwelling size for a given built form. The Environmental Impact rating is expressed on a scale of 1 to 100 – the higher the number the better the standard (it can also be represented as a letter A to G, with A being the best).

At the design stage, the performance of potential MVHR systems should be checked on the Appendix Q list of SAP.[61] Results posted on this list are taken from tests in realistic configurations, rather than assumed default performance. The posted results are likely to be better than the default efficiencies otherwise used within SAP. This is especially true if the MVHR model has achieved the 'Energy Saving Recommended' standard.

It is vital that the space needed for ventilation systems and ductwork is considered and specified at the design stage and not left to be resolved on site. If ductwork routing is not adequately considered at the design stage, installation may be difficult and the performance of the system compromised. An installation checklist is available on the SAP Appendix Q website.[61] Points to watch out for are the use of flexible ducts[62] where rigid ducts were specified, increased length of duct runs, number of bends above that specified, and lack of insulation around ductwork. All of these can have a significant impact on the efficiency of the system and its potential to meet the ventilation requirements of the Building Regulations. Prefabricated solutions can be considered to reduce the risk of errors on site.

11.5 Balconies and private space (Hea 3)

In homes with private or large communal gardens with wheelchair access, the credits for private space are normally obtained. In other developments, such as flats, balconies with wheelchair access are often specified; the main consideration here is the size of the balcony (at least 1 m^2 per bedroom in the dwelling).

Balconies can have a detrimental effect on the performance of the fabric of the building, particularly if they penetrate it, causing problems with airtightness and thermal bridging. One solution is to use free-standing balconies. Care will need to be taken to prevent uninvited access to the upper floors particularly in cases where Secured by Design (section 1) is required.[63]

Balconies can provide shading to reduce the risk of overheating in summer (see section 12) but they also restrict the amount of daylighting, so a balance will need to be struck.

12 Energy sources, internal lighting and Dwelling Emission Rates

TABLE 17

Energy, lighting and Dwelling Emission Rate credits

Category	Issue	Credits	Approx. points/credit	Percentage of overall points
Pol 2	NO_x emissions	3	0.700	2.10
Ene 7	LZC technologies	2	1.255	2.51
Ene 3	Internal lighting	2	1.255	2.51
Ene 1	DER	15	1.255	18.82
Total				**25.94**

12.1 Introduction

This section deals with the energy sources, internal lighting and DERs; Table 17 gives a breakdown of the relevant credits.

The DER is the carbon dioxide emissions rate calculated according to Building Regulations Part L1A. It includes emissions due to space heating, water heating, pumps and fans, and lighting. To meet Criterion 1 of the Building Regulations, the DER must be less than the Target Emission Rate (TER), which is a calculated figure based on the dimensions of the dwelling. The TER depends on the fuel to be used.

Different fuels have different fuel factors. The TER is significantly less stringent for electric heating than for gas or renewable energy. However, it is still more difficult to achieve the TER with direct electric heating than it is with an efficient gas boiler.

When seeking to achieve a good DER it is good practice to aim first for a good HLP (see section 11). In addition to the HLP, a good DER requires an efficient heating/hot water system which ideally uses a low-carbon fuel.

12.2 Heating and hot water systems and the effect on NO_x (Pol 2)

There are a number of choices available for providing energy to the home, ranging from electric heaters to conventional gas boilers through to renewables. NO_x emissions are by-products of combustion which can lead to poor air quality. When it comes to scoring highly in Pol 2 (NO_x emissions), there appear to be only two primary alternatives (at least up to Code Level 5) for the main source of heat to achieve the maximum credits: a low NO_x gas boiler or a carefully specified gas-fired communal CHP system.

Compared to these two primary alternatives, biomass boilers tend to produce more NO_x and specifying them will probably lead to zero or possibly 1 credit. A significant problem at the time of writing is that many manufacturers of biomass boilers cannot provide details of their emissions, although this should change as demand grows for this information. Systems that run off 100% mains electricity, including ground source and air source heat pumps, are also going to obtain zero credits, since grid electricity is associated with NO_x emissions of approximately 1200 mg/kWh.

12.3 Contribution of low- and zero-carbon technologies (Ene 7)

At Code Level 4 or above it is likely that the two credits available for Ene 7 will be achieved, as renewable technologies will typically already be specified to achieve the Ene 1 requirements. The low- and zero-carbon (LZC) technologies must be those that are funded by the Low Carbon Building Programme[64] or similar, or designed and installed in a manner endorsed by an independent energy specialist. 'Green electricity' supplied through the National Grid is not eligible for the Ene 7 renewable credits. Any electricity generated on site by renewables is eligible, but the connection to the dwelling has to be through a private wire scheme (see Further Information on page 46) or it can potentially be connected to landlord areas for PV. Electricity generated by CHP can be either connected to the dwellings via a private wire scheme or fed into the National Grid.

FURTHER INFORMATION

Private wire schemes

A private wire is where electricity generated on site (eg by PVs, wind turbines or CHP plant) is available directly to the dwellings on the development. It is better from an environmental point of view, as transmission losses are reduced, but it also allows operators of communal energy systems to make them financially viable by selling the energy generated to residents, rather than to the national grid which has a very poor purchase rate. Private wire schemes are effectively limited to 1 MW for a single network, because the operators need to apply for a licence exemption for networks above that level of demand. This would typically serve 800–1000 dwellings.

Operators of private wire schemes must allow other energy suppliers access to the network otherwise they could possibly be in contravention of European trade law. The government is currently considering a ruling made in a German case. More information can be found online www.dentonwildesapte.com/assets/2/20667.pdf.

Developments with sufficient housing density, such as flats, could be heated communally using a new biomass boiler and/or gas-fired CHP.[65] Those located near an existing distribution network[66] could choose to use low-carbon heat from the network. (Biomass-fuelled CHP is a developing technology that could provide significant carbon dioxide savings in the future.)

If community heating systems are to be specified, it is usual for an Energy Services Company (ESCO) to be used to design, build, operate and/or manage the facilities. ESCOs often manage systems on behalf of local authorities or public bodies.[67, 68]

In terms of minimising maintenance burden and potential health and safety risks associated with maintenance, developers may want to be cautious about installing some renewables/low-carbon technologies (see section 2). But, if those issues are overcome, they may be chosen as a sales feature, or to comply with a 'Merton'-type rule (see section 3). Certainly, specifying LZC technologies has become increasingly common in the UK over the last few years. They are not always necessary for Code Level 3 houses (see section 11: Further information – Improving fabric thermal performance versus installing renewable energy technologies), but they are likely to be required both for Level 3 flats (unless the fabric specification is very high) and for all dwellings at Level 4. If LZC technologies are required then it may be worth trying to achieve the full 2 credits available.

Unless the site is in an exposed location, micro-wind turbines are unlikely to provide enough energy to contribute to Code requirements.[69]

FURTHER INFORMATION

Microgeneration and renewables

Further more detailed information,[70] including a guide for specifiers and installers,[71] can be obtained from the NHBC Foundation.

The report for CLG, *Cost Analysis of The Code for Sustainable Homes*[72] proposes some solutions and costs for Code Levels 3 and 4.

For Code Level 5 and 6 houses that use dedicated solar technologies, consideration may have to be given to adopting mono-pitch south-facing roofs in order to obtain enough roof area. This should be unnecessary for Code Levels 3 and 4 if the houses have a good building fabric specification, but flats will often have limited roof space and there will be a need to make optimum use of the area available.

TOP TIPS

Photovoltaics and solar thermal systems

PV and solar thermal panels can be effective technologies for reducing the DER of a dwelling.

Solar thermal panels (sometimes known as collectors) can provide a significant proportion of the hot water demands of a dwelling. However, these systems are subject to the law of diminishing returns. The larger the system, the lower the percentage of energy produced by the system that can be utilised. This is because in summer, a large solar collector will at times produce more energy than is consumed in the dwelling. Typically 3–4 m^2 is sufficient

PV panels generate electricity and are not subject to this law of diminishing returns, as long as they are connected to the national grid, as then any excess energy generated will be exported for use elsewhere and output will be directly proportional to the size of panel. However, if, as is usual, PVs are mounted on the roof, the area of suitable roof space available will restrict the total installation potential. (PVs can be mounted on vertical façades but their efficiency is significantly reduced.) The PV technology selected will also affect the area required; higher-efficiency modules, such as monocrystalline ones, will take up less space, but are more expensive. Systems dedicated to a single dwelling typically range from 1 to 4 kWp. If well designed, outputs of between 700 and 900 kWh/kWp per year can be achieved.

12.4 Internal lighting (Ene 3)

Dedicated energy-efficient light fittings are becoming easier to source, as they are required by the Building Regulations for at least 25% of fixed internal fittings. The maximum 2 credits are awarded for Ene 3 if 75% or more of the fixed internal light fittings are dedicated energy-efficient fittings (eg dedicated for compact fluorescent lamps with a two- or four-pin fitting).

For Code Levels 1 to 5, only 30% of the light fittings are assumed to be energy-efficient in SAP 2005 calculations[73] and therefore specifying further energy-efficient fittings will not improve the DER and hence the score for Ene 1. This assumption does not apply for Code Level 6 dwellings, where a designer can obtain benefit in Ene 1 by specifying up to 100% energy-efficient fittings.

12.5 Dwelling Emission Rate (Ene 1)

The credits awarded for DER depend on the improvement over the TER laid down in Part L1A (2006) of the Building Regulations (England and Wales). This is calculated by the SAP (Standard Assessment Procedure) method. The requirements for Code Level 3–6 dwellings are shown in Table 18.

TABLE 18

Dwelling Emission Rate credit scores (Levels 3–6)

Improvement of DER over TER (%)	Credits	Mandatory levels[74]
≥25	5	Level 3
≥31	6	
≥37	7	
≥44	8	Level 4
≥52	9	
≥60	10	
≥69	11	
≥79	12	
≥89	13	
≥100	14	Level 5
Zero carbon[75]	15	Level 6

Within the Code a zero-carbon home is one for which the net carbon emissions resulting from all anticipated energy use is zero or better. The elements, fittings and services within the remit of Building Regulations Part L1A must also have a 100% improvement of DER over TER and the dwelling must have a HLP of 0.8 W/m^2K or better. A full definition is given in *Code for Sustainable Homes Technical Guide*[1].

FURTHER INFORMATION

Capital costs for carbon dioxide emission compliance

In 2008 the Department for Communities and Local Government issued a consultation document on zero carbon entitled *Definition of Zero Carbon Homes and Non-Domestic Buildings – Consultation.*[76] Annex E of this document (page 95) contains capital costs for a combination of different technical solutions to reduce carbon dioxide emissions by respectively 25%, 44%, 70% and 100% over the current Building Regulations and for full zero carbon (as required for Level 6 of the Code). This useful resource can be found online.[77]

When working with the SAP method used for Building Regulations and Code carbon dioxide emission calculations, it is important to ensure that the current version is being used.[78]

Where dwellings emissions can be reduced further than the mandatory requirements, Ene 1 can be used to top up the number of points required for dwellings to achieve a particular Code level; this is most likely to happen when biomass or communal CHP systems are specified, where carbon dioxide emissions can be reduced further with minimal additional cost. But achieving more than around 10 credits can prove difficult, as additional credits above this are reliant on the installation of renewables which generate electricity to offset power consumption for lighting, pumps and ventilation fans (and appliances and cooking for maximum credits).

Designers/developers will also note that only 1 additional credit is presently achieved for moving from the Code Level 5 requirements of Ene 1 to the Code Level 6 zero-carbon requirements. So if Code Level 6 is not required, attempting this one last credit is definitely not going to be cost-effective.

Flats typically have a small external surface area and low heat loss compared to other build forms; because of this, improving the HLP often results in only a very small improvement in the DER. This is particularly true for mid-floor flats and others with a very small heat-loss area. North-facing dwellings or those with a high proportion of glazing can perform particularly poorly. In these cases, it may be beneficial to average out the results for the block; this is permitted for single-level flats with the same servicing strategy, which are defined as an 'energy group'.[79] Community heating with biomass boilers and/or gas CHP can be particularly suitable for flats because of the density of development, and ongoing management arrangements will typically be put in place as a matter of course. These can prove to be a very cost-effective way to improve the DER. Other accredited renewable technologies, in particular PVs, may be viable – the lower energy demands of flats compared to houses (due to the lower heat demand) requires a smaller area of panels.

The risk of overheating must always be addressed in building design. The potential for overheating can be minimised through a combination of reducing internal heat gains, external shading to control solar gains in the summer, good ventilation and appropriately located thermal mass. The key aims of the design should be to maximise thermal comfort for occupants and minimise the likelihood of mechanical cooling being installed subsequently. This should always be considered at the earliest possible design stage, with the aim of using passive solar energy for heating in the winter without causing excess overheating in the summer.

Example SAP results are shown in Appendix 1.

FURTHER INFORMATION

Strategies to avoid overheating: 1 Shading

Solar shading is an important factor for both avoiding summer overheating and for winter space heating (when shading could reduce the benefit from passive solar energy). There are several shading options available to designers. One is the incorporation of balconies or canopies above windows and glazed doors. If dimensioned correctly, they will provide shading of the windows below in the summer, when the sun is high in the sky. During winter, when the sun is low, they will allow sunlight into the building, helping reduce the space heating demand. But it is important to remember that orientation is vital – south-facing glazing can be shaded in this way, but if it faces east or west the sun will be low even in summer, so effective shading becomes very difficult. Deciduous trees are nature's version of the same concept, and can be used effectively in this way. External shutters are another option, which can be used to only allow solar heat to enter the building when it is needed. Their performance, however, will depend on occupant behaviour, unless they are connected to an automated control system. Insulating external shutters can add further benefits by reducing heat loss through windows during the night. It is important to note that internal shutters or other types of internal shading are not as effective at mitigating overheating, as they still allow the solar energy into the building.

When considering house layouts, it may also be worthwhile placing rooms that are important to keep cool, such as bedrooms, on the north side.

Strategies to avoid overheating: 2 Increasing thermal mass

Thermal mass has benefits with regard to avoiding overheating, as the absorption and release of heat from materials with a high thermal mass, such as concrete, can help to regulate internal temperatures when combined with a suitable ventilation strategy (eg night cooling). There are a number of ways of increasing the available thermal mass of a dwelling. The key to the effectiveness of thermal mass is that it should be accessible to the internal surfaces of the building.

One way is to use wet plaster onto blockwork walls instead of fixing plasterboard with dabs. Fixing plasterboard with dabs results in an insulation air gap being formed between the blockwork and the plasterboard, substantially reducing the effectiveness of the blockwork as a source of thermal mass. By using a plaster skim, the thermal mass of the blocks can be brought into play.

Precast concrete stairs and floors are also effective, but they should be tiled or left exposed, rather than covered in carpet or laminate flooring.

Heavy tiles will also add some thermal mass, regardless of the construction type.

Strategies to avoid overheating: 3 Secure ventilation

Natural ventilation is one of the most effective ways to prevent overheating, as long as windows have a sufficiently large opening area and the layout enables suitable cross-ventilation or avoids deep-plan rooms. It is good to simply be able to open windows, but they will need to be secure, particularly at ground level or where there is easy access. One way of achieving this is through the use of meshed and louvred vents and windows.

13 Designing for the Code or upgrading existing Part L (England and Wales) house designs

13.1 Introduction

Some developers and registered social landlords may not find it possible to design all dwellings from scratch to maximise the Code credits available, and would initially prefer to upgrade designs from their existing Part L compliant portfolio. This is likely to be more costly than designing from scratch, and some measures may not be possible to incorporate at all. This section considers the realistic scores that could be aimed for in each scenario.

The Code will be considered in the order and format outlined in the previous sections, showing indicative realistic maximum credit scores for both the new design and upgrade of Part L options. For simplicity, only houses are being considered in this section.

13.2 Easy-win, stand-alone credits

Table 19 gives a comparison of the easy-win, stand-alone credits for new and upgraded Part L dwellings. All of these credits should be available when upgrading existing house designs (assuming for Was 3 Composting that there is a garden).

TABLE 19

Comparison of easy-win, stand-alone credits for new and upgraded Part L dwellings

Category	Issue	Maximum credits	Achievable credit score	
			New dwelling design	Upgraded Part L dwellings
Ene 4	Drying space	1	1	1
Ene 5	Energy-efficient white goods	2	2	2
Was 3	Composting	1	1	1
Man 1	Home user guide	3	3	3

13.3 Site credits: ecology and flooding

Table 20 gives the credit scores for ecology and flooding. As these are site-specific they are not affected by the design of the dwelling. As previously discussed, Sur 2, Eco 1, Eco 3 and Eco 4 are very much site-dependent in terms of the likely performance. Eco 2 should be achievable on all developments.

TABLE 20

Ecology and flooding credits

Category	Issue	Maximum credits
Sur 2	Flood risk	2
Eco 1	Ecological value of site	1
Eco 2	Ecological enhancement	1
Eco 3	Protection of ecological features	1
Eco 4	Change in ecological value of site	4

13.4 Construction and supply chain management

Table 21 lists the credit scores that can be attained for construction and supply chain management. As outlined in section 6, these credits can be particularly taxing for small developers on small sites which do not have the required management procedures in place. In Table 21 it has been assumed that large sites are being considered and a high proportion of credits are achieved. The house design has no significant effect on the score, except for responsible sourcing of materials where a low proportion of timber and timber products in the construction can prevent the maximum credits being achieved (certified timber scores more points than other materials from manufacturers with an environmental management system). Therefore, for this exercise, fewer than the maximum credits available have been assumed to be achieved.

TABLE 21

Construction and supply chain management scores

Category	Issue	Maximum credits	Achievable credit score	
			New dwelling design	Upgraded Part L dwellings
Was 2	Construction site waste management	2	2	2
Man 2	Considerate Constructors Scheme	2	2	2
Man 3	Construction site impacts	2	2	2
Mat 2	Responsible sourcing of materials – basic building elements	6	4	4
Mat 3	Responsible sourcing of materials – finishing elements	3	2	2

13.5 Potable water, greywater and rainwater use, and SUDS

In view of the current absence of a wide range of certified systems, no British Standards for greywater use, and ongoing maintenance and energy requirements (although 4 or 5 credits can be achieved with these technologies as discussed in section 7), it may be preferred to aim only for 3 credits for Wat 1 through using water-efficient sanitaryware. However, these credits are highly weighted and worth considering for this reason (see Table 22).

TABLE 22

Credits for potable water, greywater and rainwater use, and Sustainable Drainage Systems

Category	Issue	Maximum credits	Achievable credit score	
			New dwelling design	Upgraded Part L dwellings
Wat 1	Internal potable water use	5	3 (4 or 5 if needed)	3 (4 or 5 if needed)
Wat 2	External water use	1	1	1
Sur 1	Reduction of surface water run-off from the site	2	2	2

It may be difficult to find room in an existing Part L compliant dwelling for an individual greywater recycling unit (particularly if the toilet cistern is below a window), but in flats communal units could be an option. Rainwater recycling from the roof or hard landscaping could be incorporated into a Part L compliant design along with robust SUDS solutions if considered early enough in the site layout.

13.6 Space and design layouts

This group of credits is particularly difficult to obtain for dwellings adapted from existing house types (see Table 23).

TABLE 23

Credit for space and design layouts

Category	Issue	Maximum credits	Achievable credit score	
			New dwelling design	Upgraded Part L dwellings
Hea 4	Lifetime Homes	4	0	0
Ene 8	Cycle storage	2	2	2
Was 1	Storage of non-recyclable waste and recyclable household waste	4	4	0
Eco 5	Building footprint	2	1	0
Hea 1	Daylighting	3	3	1
Ene 9	Home office	1	1	0

Unless Lifetime Homes is already specified in the design, it will be very difficult to adapt to meet all the requirements due to lack of space. The storage of waste bins in the kitchen and outside for Was 1 will take up space and although this can be accommodated in most new designs it will be more difficult to find space in the kitchen with smaller dwellings. External space is much easier to accommodate when a suitable kerbside collection is provided by the local authority.

Cycle storage (Ene 8) is relatively easy to obtain in houses with private gardens with direct access to the road, but will be more difficult with flats and terraced houses unless communal cycle storage has already been designed in (which is possible as many local authorities ask for this).

Credits for the building footprint (Eco 5) will be dependent on the existing design. Houses with at least three storeys or a room in the roof, and flats with at least four storeys, may achieve credits. Note that flats with three storeys are only likely to achieve a credit if there are no permanent communal storage areas (as these add to the footprint but not the habitable area).

Some existing dwellings may be able to obtain 1, 2 or even 3 credits for daylighting (Hea 1) depending on the site and internal layout. However, it is assumed that only 1 credit will be achieved as this is more likely. The requirement for a 1.50% daylight factor makes achieving the credit for a home office difficult and careful consideration of the internal layout and window size to the home office space (and to a lesser extent, the site layout) will be required.

13.7 Specifying materials

With few if any modifications to the design, it should be possible to score roughly the same number of credits for both Mat 1 and Pol 1 in a typical low-rise Part L compliant house as in a redesigned one, as long as there is flexibility in terms of the materials specification (see Table 24).

TABLE 24

Credits for specified materials

Category	Issue	Maximum credits	Achievable credit score	
			New dwelling design	Upgraded Part L dwellings
Mat 1	Environmental impact of materials (the *Green Guide*)	15	13	13
Pol 1	GWP of insulants	1	1	1

13.8 Secured by Design – windows, doors and external lights

It should be relatively easy to change the specification of existing windows, doors and external lights on existing house types to achieve these credits. Table 25 gives a breakdown.

TABLE 25

Credits for Secured by Design

Category	Issue	Maximum credits	Achievable credit score	
			New dwelling design	Upgraded Part L dwellings
Man 4	Security	2	2	2
Ene 6	External lighting	2	2	2

13.9 Building fabric and balconies

Most Part L houses should be able to be modified so that their separating walls achieve a performance at least 3 dB better than Part E requirements, and achieve 1 credit (see Table 26). However, this could require a change of construction type and take up some additional space. If it is not possible to use Robust Details, then testing can be undertaken and potentially achieve even better performance. As mentioned in more detail in section 11, some constructions not covered by Robust Details allow separating walls to achieve the full 4 credits, but only 3 credits have been assumed as developers may prefer to use Robust Details.

Detached dwellings automatically achieve 4 credits (see Table 26).

TABLE 26

Credits for building fabric and balconies

Category	Issue	Maximum credits	Achievable credit score	
			New dwelling design	Upgraded Part L dwellings
Hea 2	Sound insulation	4	4 (detached) 3 (otherwise)	4 (detached) 1 (otherwise)
Ene 2	Building fabric	2	2	0 or 1
Hea 3	Private space	1	1	1

Achieving additional credits for the separating floors between flats is likely to be more challenging as there are fewer Robust Details from which to choose.

If balconies are specified they should be free-standing to avoid thermal bridging and maintain airtightness, and this may require a change to the design. However, houses will generally have gardens so it is assumed that the Hea 3 Private space credit is achieved without the addition of balconies.

A house built to meet current Part L requirements would be unlikely to achieve any credits for Ene 2 Building fabric. It is assumed that 1 credit could be achieved for some dwellings if enough improvements could be made to the building fabric, eg through improving the specification of windows and doors, and better detailing and rigorous monitoring on site to improve airtightness. This will also depend on the type of dwelling, as detached dwellings tend to have a higher HLP and are difficult to improve to the required standard.

13.10 Energy sources, internal lighting and Dwelling Emission Rates

This subsection looks at the available options for improving the credit scores of existing dwellings in terms of energy sources, internal lighting and DER. Table 27 gives a breakdown.

TABLE 27

Credits for energy sources, internal lighting and Dwelling Emission Rates

Category	Issue	Maximum credits	Achievable credit score	
			New dwelling design	Upgraded Part L dwellings
Pol 2	NO_x emissions	3	3	0 (eg GSHP)
Ene 7	LZC technologies	2	0 (Level 3) 2 (Level 4)	0
Ene 3	Internal lighting	2	2	2
Ene 1	DER	15	Up to 10	Up to 8

Meeting the mandatory DER requirements of the Code is one of the most difficult aspects of upgrading an existing house design, assuming that the thermal performance of the building fabric is fixed and cannot be improved.

There are a number of solutions that can be explored to upgrade a Part L house without changing the fabric:

- A ground source heat pump. However, this may prove difficult in the case of small gardens, where there is restricted space available for the underground pipes; existing trees may also make the ground conditions unsuitable.
- An air source heat pump. However, the current SAP calculation method may not give this technology the required performance.
- A communal biomass boiler. However, this would have a significant ongoing maintenance requirement, and space will be needed for plant room, fuel storage and delivery.

In none of these cases are NO_x emission credits likely to be achieved, and for this reason in this exercise, no credits have been assumed.

If a ground source heat pump is specified, instead of say a gas boiler, a typical Part L compliant dwelling is likely to achieve the carbon dioxide emission requirements of Code Level 3.

For Code Level 4, it will be extremely difficult to achieve the 8 credits for Ene 1 (which is a mandatory requirement) unless biomass heating or a large quantity of renewables (eg solar thermal panels and PVs) are specified. The quantity of renewables can be reduced if insulation can be added to the building fabric, eg by fully filling cavities rather than using partial fill, or selecting insulation products with a better thermal performance. Improved U-values for doors and windows can help, in addition to specifying a more efficient heating system with best-practice controls, increasing insulation levels on hot water cylinders, and designing to a maximum air permeability of perhaps 5 $m^3/(m^2.h)$ @ 50 Pa (although this could be challenging – see section 11).

Where the thermal performance of the fabric is relatively poor, it will be harder to achieve credits for the reduction in emissions through the use of LZC technologies (Ene 7) as total emissions will be higher than they would be for a house with a good fabric. Biomass boilers could achieve credits due to their significant reduction of carbon dioxide emissions compared with standard gas systems.

13.11 Case studies

Example case studies showing how these scores would work out for example house types are shown in Appendices 2 (new designs) and 3 (upgrading Part L designs).

Although a Part L compliant house can feasibly be upgraded to achieve the energy category of the Code up to Level 4, the differences in the other credit scores (see Table 28) are of the order of 12–19 percentage points, making it virtually impossible to achieve Level 4 cost-effectively without achieving all the site-dependent credits. Because of this, a Level 4 example of an upgraded Part L house type is not shown.

TABLE 28

Approximate differences in available Code scores when aiming to achieve Level 4

Category		Maximum likely credit scores			% points difference
		New dwelling design	Upgrading Part L design	Difference	
Was 1	Waste storage	4	0	4	3.65
Eco 5	Building footprint	1	0	1	1.33
Hea 1	Daylighting	3	1	2	2.33
Ene 9	Home office	1	0	1	1.25
Pol 2	NO_x emissions	3	0	3	2.10
Ene 7	LZC technologies	0–2	0	0 or 2	0 or 2.51
Ene 1	DER	8–10	8	0–2	0–2.51
Hea 2	Sound insulation	4 (detached) 3 (otherwise)	4 (detached) or 1 (otherwise)	0 or 2	0 or 2.33
Ene 2	Building fabric	2	1	1	1.25
Total					**11.91–19.26**

APPENDIX 1

Example SAP result sheets

SAP sheets are shown in Tables 29 to 31 for a detached dwelling designed to meet Code Levels 3 and 4 and for an existing dwelling that has been upgraded from an existing Part L house type design to Code Level 3. The calculation sheets used in Tables 29 to 31 are SAP 2005 Version 9.81 (September 2007); however, you should refer to the current SAP 2005 (version 9.81/9.82, dated June 2008) at http://projects.bre.co.uk/sap2005/pdf/SAP2005_9-82.pdf.

TABLE 29

Detached dwelling designed to meet Code Level 3

SAP 2005 worksheet for new dwelling as designed (Version 9.81, September 2007): calculation of energy ratings (calculated by program Bresap version 4.42c)

1. Overall dwelling dimensions	Area (m^2)	Average storey height (m)	Volume (m^3)	SAP line nos
Ground floor	52.00	2.40	124.80	(1)
First floor	52.00	2.60	135.20	(2)
Total floor area	104.00			(5)
Dwelling volume (m^3)			260.00	(6)

2. Ventilation rate		m^3 per hour	ach	SAP line nos
Number of chimneys	0 × 40	0		(7)
Number of flues	0 × 20	0		(8)
Number of fans or passive vents	0 × 10	0		(9)
Number of flueless gas fires	0 × 40	0		(9a)
Infiltration due to chimneys, flues and fans			0.00	(10)
Pressure test	Yes			
Measured/design q50	3.0			
Infiltration rate			0.15	(19)
Number of sides sheltered	2			(20)
Shelter factor	0.85			(21)
Adjusted infiltration rate			0.13	(22)
Mechanical ventilation with heat recovery air change rate through system in-use efficiency percentage	 0.37 72			 (22a) (22b)
Effective air change rate			0.23	(25)

3. Heat losses and HLP	Area (m^2)	U-value (W/m^2K)	A × U (W/K)	SAP line nos
Doors	3.80	1.00	3.80	(26)
Windows	16.90	(1.20) 1.15	19.35	(27)
Ground floor	52.00	0.25	13.00	(28)
Walls	128.30	0.20	25.66	(29)
Roof	52.00	0.13	6.76	(30)
Total area of elements	**253.00**			(32)
Fabric heat loss			68.57	(33)
Thermal bridges (0.040 × total area)			10.12	(34)
Total fabric heat loss			**78.69**	(35)
Ventilation heat loss			**19.81**	(36)
Heat loss coefficient			98.50	(37)
HLP			0.95	(38)

4. Water heating energy requirements		kWh/year	SAP line nos
Energy content of heated water		2152	(39)
Distribution loss		380	(40)
Cylinder volume	160		(43)
Cylinder loss factor (kWh/litre/day)	0.0152		(44)
Volume factor	0.909		(44a)
Temperature factor	0.54		(44b)
Energy lost from cylinder in kWh/year (160 litres)		435	(47)
Primary circuit loss		360	(48)
Total		**3326**	(49a)
Solar input		0	(50)
Output from water heater		3326	(51)
Heat gains from water heating		1478	(52)

5. Internal gains	Watts	SAP line nos
Lights, appliances, cooking and metabolic	594	(53)
Reduction in lighting gains	-54	(53a)
Additional gains (Table 5a)	10	(53b)
Water heating	169	(54)
Total internal gains	**719**	(55)

6. Solar gains							
Orientation	Area	Flux	g	FF	Shading	Gains (W)	SAP line nos
East/West	0.9 × 16.90	48	0.72	0.70	0.77	283	(58)
Total						**283**	(65)
Total gains						1002	(66)
Gain/loss ratio						10.17	(67)
Utilisation factor						0.830	(68)
Useful gains						831	(69)

7. Mean internal temperature	°C	SAP line nos
Mean temperature of the living area	18.88	(70)
Temperature adjustment from Table 4e	0.00	(71)
Adjustment for gains	0.89	(72)
Adjusted living area temperature	19.77	(73)
Temperature difference between zones	1.41	(74)
Living area fraction	0.300	(75)
Rest-of-house area fraction	0.700	(76)
Mean internal temperature	18.78	(77)

8. Degree-days	°C	SAP line nos
Temperature rise from gains	8.44	(78)
Base temperature	10.34	(79)
Degree-days	1014.8	(80)

9a. Energy requirements			kWh/year	SAP line nos
Space heating requirement (useful)			2399	(81)
Fraction of heat from secondary system		0.00		(82)
Efficiency of main heating system		92.0		(83)
Efficiency of secondary heating system		0		(84)
Space heating fuel (main)			2608	(85)
Space heating fuel (secondary)			0	(85a)
Water heating requirement	3326			
Efficiency of water heater		92.0		(86)
Water heating fuel			3616	(86a)
Electricity for pumps and fans (heating pump 130, flue fan 45, mech vent fans 331)			506	(87)
Electricity for lighting (75% fixed LEL)			604	(87g)

10a. Fuel costs	kWh/year	p/k Wh	£/year	SAP line nos
Space heating – main system	2608	1.63	42.51	(88)
Space heating – secondary system	0	0.00	0.00	(89)
Water heating	3616	1.63	58.94	(91b)
Pump/fan energy cost	506	7.12	36.02	(92)
Electricity for lighting	604	7.12	42.98	(93)
Additional standing charges			34.00	(94)
Total energy cost			**214.43**	(97)

11a. SAP rating		SAP line nos
Energy cost deflator	0.91	(98)
Energy cost factor (ECF)	1.11	(99)
SAP value	84.53	(99a)
SAP rating	**85**	(100)
SAP band	B	

12a. Carbon dioxide emissions	Energy kWh/year	Emissions factor	Emissions kg/year	SAP line nos
Space heating, main – box (85)	2608	0.194	506	(101)
Space heating, secondary – box (85a)	0	0.422	0	(102)
Water heating – box (86a)	3616	0.194	701	(103)
Space and water heating			1207	(107)
Pumps and fans – box (87)	506	0.422	213	(108)
Electricity for lighting	604	0.422	255	(109)
Total kg/year			**1676**	(112)
			kg/m²/year	
CO_2 emissions per m²			**16.11**	(113)
EI value			84.93	(113a)
EI rating			**85**	(114)
EI band			B	

13a. Primary energy	Energy kWh/year	Primary factor	P.Energy kWh/year	SAP line nos
Space heating, main – box (85)	2608	1.15	2999	(101)
Space heating, secondary – box (85a)	0	2.80	0	(102)
Water heating – box (86a)	3616	1.15	4158	(103)
Space and water heating			**7157**	(107)
Pumps and fans – box (87)	506	2.80	1416	(108)
Electricity for lighting	604	2.80	1690	(109)
Primary energy kWh/year			**10263**	(112)
Primary energy kWh/m²/year			**99**	(113)

Worksheet calculated by:

Summary (SAP 2005 v 9.81):
SAP Rating: B 85
Emissions: B 85 1.7 tonnes/year
Primary energy: 99 kWh/m²/year

Fuel use:
Mains gas 6223 kWh
Standard tariff 1109 kWh

Emissions:
Space heating: 719 kg (including pumps and fans)
Water heating: 701 kg
Lighting: 255 kg

TABLE 30

Detached dwelling designed to meet Code Level 4

SAP 2005 worksheet for new dwelling as designed (Version 9.81, September 2007): calculation of energy ratings (calculated by program Bresap version 4.42c)

1. Overall dwelling dimensions	Area (m^2)	Average storey height (m)	Volume (m^3)	SAP line nos
Ground floor	52.00	2.40	124.80	(1)
First floor	52.00	2.60	135.20	(2)
Total floor area	104.00			(5)
Dwelling volume (m^3)			260.00	(6)
2. Ventilation rate		**m^3 per hour**	**ach**	**SAP line nos**
Number of chimneys	0 × 40	0		(7)
Number of flues	0 × 20	0		(8)
Number of fans or passive vents	0 × 10	0		(9)
Number of flueless gas fires	0 × 40	0		(9a)
Infiltration due to chimneys, flues and fans			0.00	(10)
Pressure test	Yes			
Measured/design q50	3.0			
Infiltration rate			0.15	(19)
Number of sides sheltered	2			(20)
Shelter factor	0.85			(21)
Adjusted infiltration rate			0.13	(22)
Mechanical ventilation with heat recovery air change rate through system in-use efficiency percentage	 0.37 72			 (22a) (22b)
Effective air change rate			0.23	(25)
3. Heat losses and HLP	**Area (m^2)**	**U-value (W/m^2K)**	**A × U (W/K)**	**SAP line nos**
Doors	3.80	1.00	3.80	(26)
Windows	16.90	(0.80) 0.78	13.10	(27)
Ground floor	52.00	0.20	10.40	(28)
Walls	128.30	0.20	25.66	(29)
Roof	52.00	0.13	6.76	(30)
Total area of elements	**253.00**			(32)
Fabric heat loss			59.72	(33)
Thermal bridges (0.040 × total area)			10.12	(34)
Total fabric heat loss			**69.84**	(35)
Ventilation heat loss			**19.81**	(36)
Heat loss coefficient			89.65	(37)
HLP			0.86	(38)

4. Water heating energy requirements			kWh/year	SAP line nos
Energy content of heated water			2152	(39)
Distribution loss			380	(40)
Cylinder volume		160		(43)
Cylinder loss factor (kWh/litre/day)		0.0115		(44)
Volume factor		0.909		(44a)
Temperature factor		0.54		(44b)
Energy lost from cylinder in kWh/year (160 litres)			124	(47)
Primary circuit loss			360	(48)
Total			**3015**	(49a)
Aperture area of solar panel		4.00		(H1)
Collector zero-loss efficiency	0.70			(H2)
Collector heat loss coefficient	1.80			(H3)
Collector performance ratio	2.57			(H4)
Annual solar radiation per m^2		1042		(H5)
Overshading factor		1.00		(H6)
Solar energy available		2918		(H7)
Solar/load ratio	1.153			(H8)
Solar utilisation factor		0.580		(H9)
Collector performance factor	2.57	0.787		(H10)
Dedicated solar storage volume	100			(H11)
Effective solar volume	118			(H13)
Daily hot water demand	119			(H14)
Volume ratio Veff/V	0.994			(H15)
Veff/V factor		0.999		(H16)
Solar input			-1329	(50)
Output from water heater			1686	(51)
Heat gains from water heating			1229	(52)

5. Internal gains	Watts	SAP line nos
Lights, appliances, cooking and metabolic	594	(53)
Reduction in lighting gains	-72	(53a)
Additional gains (Table 5a)	10	(53b)
Water heating	140	(54)
Total internal gains	**672**	(55)

6. Solar gains							
Orientation	Area	Flux	g	FF	Shading	Gains (W)	SAP line nos
East/West	16.90	48	0.50	–	0.77	312	(58)
Total						**312**	(65)
Total gains						985	(66)
Gain/loss ratio						10.98	(67)
Utilisation factor						0.806	(68)
Useful gains						793	(69)

7. Mean internal temperature	°C	SAP line nos
Mean temperature of the living area	18.88	(70)
Temperature adjustment from Table 4e	0.00	(71)
Adjustment for gains	0.97	(72)
Adjusted living area temperature	19.85	(73)
Temperature difference between zones	1.75	(74)
Living area fraction	0.300	(75)
Rest-of-house area fraction	0.700	(76)
Mean internal temperature	18.63	(77)

Table 30 (continued)

8. Degree-days			°C	SAP line nos
Temperature rise from gains			8.85	(78)
Base temperature			9.77	(79)
Degree-days			909.5	(80)

9a. Energy requirements			kWh/year	SAP line nos
Space heating requirement (useful)			1957	(81)
Fraction of heat from secondary system		0.10		(82)
Efficiency of main heating system		90.0		(83)
Efficiency of secondary heating system		72		(84)
Space heating fuel (main)			1957	(85)
Space heating fuel (secondary)			272	(85a)
Water heating requirement	1686			
Efficiency of water heater		90.0		(86)
Water heating fuel			1873	(86a)
Electricity for pumps and fans (heating pump 130, flue fan 45, mech vent fans 331, solar pump 75)			581	(87)
Electricity for lighting (100% fixed LEL)			483	(87g)
Energy saving/generation technologies				
PV generation 0.80 × 1.00 × 1042 × 1.00 =			-834	(87h)

10a. Fuel costs	kWh/year	p/k Wh	£/year	SAP line nos
Space heating – main system	1957	1.63	31.90	(88)
Space heating – secondary system	272	1.63	4.43	(89)
Water heating	1873	1.63	30.53	(91b)
Pump/fan energy cost	581	7.12	41.36	(92)
Electricity for lighting	483	7.12	34.38	(93)
Additional standing charges			34.00	(94)
Electricity generated – PVs	-834	6.41	-53.43	(95a)
Total energy cost			**123.16**	(97)

11a. SAP rating				SAP line nos
Energy cost deflator			0.91	(98)
Energy cost factor (ECF)			0.55	(99)
SAP value			92.31	(99a)
SAP rating			**92**	(100)
SAP band			A	

12a. Carbon dioxide emissions	Energy kWh/year	Emissions factor	Emissions kg/year	SAP line nos
Space heating, main – box (85)	1957	0.194	380	(101)
Space heating, secondary – box (85a)	272	0.422	53	(102)
Water heating – box (86a)	1873	0.194	363	(103)
Space and water heating			796	(107)
Pumps and fans – box (87)	581	0.422	245	(108)
Electricity for lighting	483	0.422	204	(109)
Electricity generated – PVs	-834	0.568	-473	(110)
Total kg/year			**771**	(112)
			$kg/m^2/year$	
CO_2 emissions per m^2			**7.42**	(113)
EI value			93.06	(113a)
EI rating			**93**	(114)
EI band			A	

13a. Primary energy	Energy kWh/year	Primary factor	P.Energy kWh/year	SAP line nos
Space heating, main – box (85)	1957	1.15	2250	(101)
Space heating, secondary – box (85a)	272	1.15	313	(102)
Water heating – box (86a)	1873	1.15	2154	(103)
Space and water heating			**4717**	(107)
Pumps and fans – box (87)	581	2.80	1626	(108)
Electricity for lighting	483	2.80	1352	(109)
Electricity generated – PVs	-834	2.80	-2334	
Primary energy kWh/year			**5362**	(112)
Primary energy kWh/m^2/year			**52**	(113)

Worksheet calculated by:

Summary (SAP 2005 v 9.81): SAP Rating: A 92
Emissions: A 93 0.8 tonnes/year
Primary energy: 52 kWh/m^2/year

Fuel use:
Mains gas 4102 kWh
Standard tariff 1064 kWh

Emissions:
Space heating: 677 kg (including pumps and fans)
Water heating: 363 kg
Lighting: 204 kg

TABLE 31

Existing dwelling upgraded from an existing Part L (England and Wales) house type design to Code Level 3

SAP 2005 worksheet for new dwelling as designed (Version 9.81, September 2007): calculation of energy ratings (calculated by program Bresap version 4.42c)

1. Overall dwelling dimensions	Area (m^2)	Average storey height (m)	Volume (m^3)	SAP line nos
Ground floor	52.00	2.40	124.80	(1)
First floor	52.00	2.60	135.20	(2)
Total floor area	104.00			(5)
Dwelling volume (m^3)			260.00	(6)

2. Ventilation rate		m^3 per hour	ach	SAP line nos
Number of chimneys	0 × 40	0		(7)
Number of flues	0 × 20	0		(8)
Number of fans or passive vents	0 × 10	0		(9)
Number of flueless gas fires	0 × 40	0		(9a)
Infiltration due to chimneys, flues and fans			0.00	(10)
Pressure test	Yes			
Measured/design q50	3.0			
Infiltration rate			0.15	(19)
Number of sides sheltered	2			(20)
Shelter factor	0.85			(21)
Adjusted infiltration rate			0.13	(22)
Mechanical ventilation with heat recovery air change rate through system in-use efficiency percentage	 0.37 46			 (22a) (22b)
Effective air change rate			0.33	(25)

3. Heat losses and HLP	Area (m^2)	U-value (W/m^2K)	A × U (W/K)	SAP line nos
Doors	3.80	1.00	3.80	(26)
Windows (1)	12.70	(1.30) 1.24	15.69	(27)
Windows (2)	4.20	(1.30) 1.24	5.19	(27)
Ground floor	52.00	0.20	10.40	(28)
Walls	128.30	0.25	32.08	(29)
Roof	52.00	0.13	6.76	(30)
Total area of elements	**253.00**			(32)
Fabric heat loss			73.92	(33)
Thermal bridges (0.08 × total area)			20.24	(34)
Total fabric heat loss			**94.16**	(35)
Ventilation heat loss			**28.13**	(36)
Heat loss coefficient			122.29	(37)
HLP			1.18	(38)

4. Water heating energy requirements		kWh/year	SAP line nos
Energy content of heated water		2152	(39)
Distribution loss		380	(40)
Cylinder volume	160		(43)
Cylinder loss factor (kWh/litre/day)	0.0152		(44)
Volume factor	0.909		(44a)
Temperature factor	0.54		(44b)
Energy lost from cylinder in kWh/year (160 litres)		435	(47)
Primary circuit loss		360	(48)
Total Solar input		**3326** 0	(49a) (50)
Output from water heater		3326	(51)
Heat gains from water heating		1478	(52)

5. Internal gains	Watts	SAP line nos
Lights, appliances, cooking and metabolic	594	(53)
Reduction in lighting gains	-56	(53a)
Additional gains (Table 5a)	10	(53b)
Water heating	169	(54)
Total internal gains	**717**	(55)

6. Solar gains							
Orientation	Area	Flux	g	FF	Shading	Gains (W)	SAP line nos
East (1)	0.9 × 12.70	48	0.64	0.70	0.77	189	(58)
East (2)	0.9 × 4.20	48	0.57	0.70	0.77	56	(58)
Total						**245**	(65)
Total gains						962	(66)
Gain/loss ratio						7.87	(67)
Utilisation factor						0.898	(68)
Useful gains						865	(69)

7. Mean internal temperature	°C	SAP line nos
Mean temperature of the living area	18.88	(70)
Temperature adjustment from Table 4e	0.00	(71)
Adjustment for gains	0.61	(72)
Adjusted living area temperature	19.49	(73)
Temperature difference between zones	1.44	(74)
Living area fraction	0.250	(75)
Rest-of-house area fraction	0.750	(76)
Mean internal temperature	18.42	(77)

8. Degree-days	°C	SAP line nos
Temperature rise from gains	7.07	(78)
Base temperature	11.35	(79)
Degree-days	1209.1	(80)

9a. Energy requirements			kWh/year	SAP line nos
Space heating requirement (useful)			3549	(81)
Fraction of heat from secondary system		0.00		(82)
Efficiency of main heating system		92.0		(83)
Efficiency of secondary heating system		0		(84)
Space heating fuel (main)			3857	(85)
Space heating fuel (secondary)			0	(85a)
Water heating requirement	3326			
Efficiency of water heater		92.0		(86)
Water heating fuel			3616	(86a)
Electricity for pumps and fans (heating pump 130, flue fan 45, mech vent fans 1182)			1357	(87)
Electricity for lighting (75% fixed LEL)			620	(87g)
Energy saving/generation technologies				
Appendix Q Energy saved (mains gas): Energy used (unspecified):			 0 0	 (87k) (87L)

10a. Fuel costs	kWh/year	p/k Wh	£/year	SAP line nos
Space heating – main system	3857	1.63	62.87	(88)
Space heating – secondary system	0	0.00	0.00	(89)
Water heating	3616	1.63	58.94	(91b)
Pump/fan energy cost	1357	7.12	96.56	(92)
Electricity for lighting	620	7.12	44.18	(93)
Additional standing charges			34.00	(94)
Appendix Q Energy saved (mains gas): Energy used (unspecified):	 0 0	 0 0	 0 0	 (95a) (96a)
Total energy cost			**296.58**	(97)

11a. SAP rating		SAP line nos
Energy cost deflator	0.91	(98)
Energy cost factor (ECF)	1.61	(99)
SAP value	77.52	(99a)
SAP rating	**78**	(100)
SAP band	C	

12a. Carbon dioxide emissions	Energy kWh/year	Emissions factor	Emissions kg/year	SAP line nos
Space heating, main – box (85)	3857	0.194	748	(101)
Space heating, secondary – box (85a)	0	0.422	0	(102)
Water heating – box (86a)	3616	0.194	701	(103)
Space and water heating			1450	(107)
Pumps and fans – box (87)	1357	0.422	572	(108)
Electricity for lighting	620	0.422	262	(109)
Appendix Q Energy saved: Energy used:	 0 0	 0.194 0.422	 0 0	 (110) (111)
Total kg/year			**2284**	(112)
			kg/m^2/year	
CO_2 emissions per m^2			**21.96**	(113)
EI value			79.46	(113a)
EI rating			**79**	(114)
EI band			C	

13a. Primary energy	Energy kWh/year	Primary factor	P.Energy kWh/year	SAP line nos
Space heating, main – box (85)	3857	1.15	4436	(101)
Space heating, secondary – box (85a)	0	2.80	0	(102)
Water heating – box (86a)	3616	1.15	4158	(103)
Space and water heating			**8594**	(107)
Pumps and fans – box (87)	1357	2.80	3798	(108)
Electricity for lighting	620	2.80	1737	(109)
Appendix Q Energy saved: Energy used:	 0 0	 1.15 2.80	 0 0	 (110) (111)
Primary energy kWh/year			**14130**	(112)
Primary energy kWh/m^2/year			**136**	(113)

Worksheet calculated by:			
Summary (SAP 2005 v 9.81):	SAP Rating:	C 78	
	Emissions:	C 79	2.3 tonnes/year
	Primary energy:		136 kWh/m^2/year
Fuel use:			
Mains gas	7473 kWh		
Standard tariff	1977 kWh		
Emissions:			
Space heating:	1321 kg (including pumps and fans)		
Water heating:	701 kg		
Lighting:	262 kg		

APPENDIX 2

Case studies: example credit scores when designing new dwellings to achieve compliance with the Code

The case studies illustrated in Tables 32 to 34 show detached, semi-detached/mid-terrace houses and flats on brownfield and greenfield sites. In the case of houses, greenfield sites are split between 'large' and 'small'.

TABLE 32

Detached houses

Credit type	Credit	Brief description	Code Level 3						Code Level 4					
			Credits			Points scored (57 required)			Credits			Points scored (68 required)		
			Greenfield		Brownfield	Greenfield		Brownfield	Greenfield		Brownfield	Greenfield		Brownfield
			Small sites	Large sites	Large sites	Small sites	Large sites	Large sites	Small sites	Large sites	Large sites	Small sites	Large sites	Large sites
Easy-win, stand-alone	Ene 4	Drying space	1	1	1	1.25	1.25	1.25	1	1	1	1.25	1.25	1.25
	Ene 5	White goods	2	2	2	2.51	2.51	2.51	2	2	2	2.51	2.51	2.51
	Was 3	Composting	1	1	1	0.91	0.91	0.91	1	1	1	0.91	0.91	0.91
	Man 1	User guide	3	3	3	3.33	3.33	3.33	3	3	3	3.33	3.33	3.33
Site-specific	Sur 2	Flood risk	2	2	2	1.10	1.10	1.10	2	2	2	1.10	1.10	1.10
	Eco 1	Ecological value	0	0	1	0.00	0.00	1.33	0	0	1	0.00	0.00	1.33
	Eco 2	Eco enhancement	1	1	1	1.33	1.33	1.33	1	1	1	1.33	1.33	1.33
	Eco 3	Protection of features	0	0	1	0.00	0.00	1.33	0	0	1	0.00	0.00	1.33
	Eco 4	Change in eco value	0	0	2	0.00	0.00	2.66	0	0	2	0.00	0.00	2.66
Construction and supply chain	Was 2	Construction waste	0	2	2	0.00	1.82	1.82	0	2	2	0.00	1.82	1.82
	Man 2	Considerate constructor	0	2	2	0.00	2.22	2.22	0	2	2	0.00	2.22	2.22
	Man 3	Construction impacts	1	2	2	1.11	2.22	2.22	1	2	2	1.11	2.22	2.22
	Mat 2	Sourcing – basic	0	4	4	0.00	1.20	1.20	0	4	4	0.00	1.20	1.20
	Mat 3	Sourcing – finishing	0	2	2	0.00	0.60	0.60	0	2	2	0.00	0.60	0.60
Water and SUDS	Wat 1	Internal potable	3	3	3	4.50	4.50	4.50	3	3	3	4.50	4.50	4.50
	Wat 2	External	1	1	0	1.50	1.50	0.00	1	1	1	1.50	1.50	1.50
	Sur 1	Reduction in run-off	0	0	0	0.00	0.00	0.00	2	0	0	1.10	0.00	0.00
Space and design	Hea 4	Lifetime Homes	4	0	0	4.66	0.00	0.00	4	0	0	4.66	0.00	0.00
	Ene 8	Cycle storage	2	2	0	2.51	2.51	0.00	2	2	2	2.51	2.51	2.51
	Was 1	Household waste store	4	4	4	3.65	3.65	3.65	4	4	4	3.65	3.65	3.65
	Eco 5	Building footprint	0	0	0	0.00	0.00	0.00	0	0	0	0.00	0.00	0.00
	Hea 1	Daylight	3	1	0	3.50	1.16	0.00	3	3	0	3.50	3.50	0.00
	Ene 9	Home office	0	0	0	0.00	0.00	0.00	1	0	0	1.25	0.00	0.00
Specifying materials	Mat 1	Impact of materials	10	10	10	3.00	3.00	3.00	10	10	10	3.00	3.00	3.00
	Pol 1	GWP of insulants	1	1	1	0.70	0.70	0.70	1	1	1	0.70	0.70	0.70
Security and external lights	Man 4	Security	2	2	2	2.22	2.22	2.22	2	2	2	2.22	2.22	2.22
	Ene 6	External lights	2	2	2	2.51	2.51	2.51	2	2	2	2.51	2.51	2.51
Fabric and balconies	Hea 2	Sound insulation	4	4	4	4.66	4.66	4.66	4	4	4	4.66	4.66	4.66
	Ene 2	Building fabric (HLP)	2	2	2	2.51	2.51	2.51	2	2	2	2.51	2.51	2.51
	Hea 3	Private space	1	1	1	1.16	1.16	1.16	1	1	1	1.16	1.16	1.16
Energy and DER	Pol 2	NO_x emissions	3	3	3	2.10	2.10	2.10	3	3	3	2.10	2.10	2.10
	Ene 7	LZC technologies	0	0	0	0.00	0.00	0.00	2	2	2	2.51	2.51	2.51
	Ene 3	Internal lighting	2	2	2	2.51	2.51	2.51	2	2	2	2.51	2.51	2.51
	Ene 1	DER	5	5	5	6.27	6.27	6.27	10	10	8	12.55	12.55	10.04
Total						59.50	59.45	59.60				70.64	70.58	69.89

Explanation and assumptions:

Easy-win, stand-alone: These credits are achieved in all cases.

Site-specific: It is assumed that there is no flood risk on any sites (Sur 2 achieves 2 credits). Greenfield sites achieve no other site-specific credits except for ecological enhancement (Eco 2). For the brownfield sites it is assumed that the site has low ecological value (Eco 1) with no ecological features to protect (Eco 3) and that the ecological value of the site will be enhanced by the development. The ecologist's recommendations (all the key ones + 30% of the additional ones) have been adopted in all cases (Eco 2).

Construction and supply chain: These credits are difficult to manage on small sites where all that can be achieved is that two actions have been taken to minimise construction impacts (Man 3, eg best practices for air and water pollution). For large sites it is assumed that, in addition, the following have been adopted: best-practice SWMP (Was 2), Considerate Constructors – beyond best practice (Man 2) and an additional two actions to minimise construction impacts (Man 3, eg monitoring site water consumption and CO_2 from transport). All timber is sourced from tier 1 and masonry products from tier 2 (Mat 2 and 3).

Water and SUDS: In all cases the houses use less than 105 litres/person/day and so achieve the mandatory requirements for Code Levels 3 and 4 without the need for greywater or rainwater recycling (Wat 1). All of them (with the exception of the of the Code 3 brownfield house where the points from the credit are not needed) have a water butt for external water (Wat 2). Reduction in surface run-off credits are only assumed for the small greenfield Level 4 site (Sur 1).

Space and design: In all cases there is provision for segregated waste storage (Was 1). None of the cases has an efficient build footprint (Eco 5). All the houses have cycle storage (with the exception of the Code 3 brownfield house where the points from the credit are not needed – Ene 8). Lifetime Homes (Hea 4) is complied with on the small sites only. The requirement for good daylighting for the home office (Ene 9) means that this credit is only sought for small greenfield sites at Level 4. For daylighting (Hea 1) the full 3 credits are needed on small sites and large greenfield sites at Level 4. Large greenfield sites at Level 3 only need to achieve 1 credit. No daylighting credits are required on brownfield sites.

Specifying materials: In all cases it has been assumed that the following applies for the materials elements (Mat 1): roof A, external walls A, non-load-bearing partition walls A, load-bearing partitions B, ground floor A, upper floor A+, windows A. Insulation is assumed to comply with the requirements of Pol 1.

Security and external lights: Secured by Design section 2 is achieved (Man 4). Energy-efficient fittings with suitable controls specified to internal, communal and external areas (Ene 6).

Fabric and balconies: Sound insulation is not an issue as the houses are detached (Hea 2). The houses have been designed to give an HLP ≤1.10 (Ene 2) and all have private gardens (Hea 3).

Energy and DER: Low NO_x boilers are specified – emissions <40 mg/kWh (Pol 2). Solar thermal panels of 4 m^2 are used on Code 4 houses and on greenfield sites this is supplemented with 1 kWp of PV (Ene 7). Minimum 75% of light fittings are dedicated low energy (Ene 3). The DER (Ene 1) for Code Level 3 houses assumes the following: for U-values, roof – 0.13, walls – 0.2, ground floor – 0.2, windows – 1.2, doors – 1; for y-value, 0.04; airtightness 3; MVHR 85% 1 W/(l/s) fan power; 90% efficient condensing boiler; programmer; room thermostat and thermostatic radiator valves. Code Level 4 houses are the same, but with added LZC technology.

TABLE 33

Semi-detached or mid-terrace houses

Credit type	Credit	Brief description	Code Level 3: Credits, Greenfield, Small sites	Code Level 3: Credits, Greenfield, Large sites	Code Level 3: Credits, Brownfield, Large sites	Code Level 3: Points scored (57 required), Greenfield, Small sites	Code Level 3: Points scored (57 required), Greenfield, Large sites	Code Level 3: Points scored (57 required), Brownfield, Large sites	Code Level 4: Credits, Greenfield, Small sites	Code Level 4: Credits, Greenfield, Large sites	Code Level 4: Credits, Brownfield, Large sites	Code Level 4: Points scored (68 required), Greenfield, Small sites	Code Level 4: Points scored (68 required), Greenfield, Large sites	Code Level 4: Points scored (68 required), Brownfield, Large sites
Easy-win, stand-alone	Ene 4	Drying space	1	1	1	1.25	1.25	1.25	1	1	1	1.25	1.25	1.25
	Ene 5	White goods	2	2	2	2.51	2.51	2.51	2	2	2	2.51	2.51	2.51
	Was 3	Composting	1	1	1	0.91	0.91	0.91	1	1	1	0.91	0.91	0.91
	Man 1	User guide	3	3	3	3.33	3.33	3.33	3	3	3	3.33	3.33	3.33
Site-specific	Sur 2	Flood risk	2	2	2	1.10	1.10	1.10	2	2	2	1.10	1.10	1.10
	Eco 1	Ecological value	0	0	1	0.00	0.00	1.33	0	0	1	0.00	0.00	1.33
	Eco 2	Eco enhancement	1	1	1	1.33	1.33	1.33	1	1	1	1.33	1.33	1.33
	Eco 3	Protection of features	0	0	1	0.00	0.00	1.33	0	0	1	0.00	0.00	1.33
	Eco 4	Change in eco value	0	0	2	0.00	0.00	2.66	0	0	2	0.00	0.00	2.66
Construction and supply chain	Was 2	Construction waste	0	2	2	0.00	1.82	1.82	0	2	2	0.00	1.82	1.82
	Man 2	Considerate constructor	0	2	2	0.00	2.22	2.22	0	2	2	0.00	2.22	2.22
	Man 3	Construction impacts	1	2	2	1.11	2.22	2.22	1	2	2	1.11	2.22	2.22
	Mat 2	Sourcing – basic	0	4	4	0.00	1.20	1.20	0	4	4	0.00	1.20	1.20
	Mat 3	Sourcing – finishing	0	2	2	0.00	0.60	0.60	0	2	2	0.00	0.60	0.60
Water and SUDS	Wat 1	Internal potable	3	3	3	4.50	4.50	4.50	3	3	3	4.50	4.50	4.50
	Wat 2	External	1	1	1	1.50	1.50	1.50	1	1	1	1.50	1.50	1.50
	Sur 1	Reduction in run-off	2	2	2	1.10	1.10	1.10	2	2	2	1.10	1.10	1.10
Space and design	Hea 4	Lifetime Homes	4	0	0	4.66	0.00	0.00	4	0	0	4.66	0.00	0.00
	Ene 8	Cycle storage	2	2	0	2.51	2.51	2.51	2	2	2	2.51	2.51	2.51
	Was 1	Household waste store	4	4	4	3.65	3.65	3.65	4	4	4	3.65	3.65	3.65
	Eco 5	Building footprint	0	0	0	0.00	0.00	0.00	1	0	0	1.33	0.00	0.00
	Hea 1	Daylight	3	3	0	3.50	3.50	0.00	3	3	3	3.50	3.50	3.50
	Ene 9	Home office	0	0	0	0.00	0.00	0.00	1	0	0	1.25	0.00	0.00
Specifying materials	Mat 1	Impact of materials	9	9	9	2.70	2.70	2.70	9	9	9	2.70	2.70	2.70
	Pol 1	GWP of insulants	1	1	1	0.70	0.70	0.70	1	1	1	0.70	0.70	0.70
Security and external lights	Man 4	Security	2	2	2	2.22	2.22	2.22	2	2	2	2.22	2.22	2.22
	Ene 6	External lights	2	2	2	2.51	2.51	2.51	2	2	2	2.51	2.51	2.51
Fabric and balconies	Hea 2	Sound insulation	3	1	0	3.50	1.16	0.00	3	3	1	3.50	3.50	1.16
	Ene 2	Building fabric (HLP)	2	2	2	2.51	2.51	2.51	2	2	2	2.51	2.51	2.51
	Hea 3	Private space	1	1	1	1.16	1.16	1.16	1	1	1	1.16	1.16	1.16
Energy and DER	Pol 2	NO_x emissions	3	3	3	2.10	2.10	2.10	3	3	3	2.10	2.10	2.10
	Ene 7	LZC technologies	0	0	0	0.00	0.00	0.00	2	2	2	2.51	2.51	2.51
	Ene 3	Internal lighting	2	2	2	2.51	2.51	2.51	2	2	2	2.51	2.51	2.51
	Ene 1	DER	5	5	5	6.27	6.27	6.27	10	10	8	12.55	12.55	10.04
Total						59.14	59.09	59.75				70.51	70.22	70.69

Explanation and assumptions

Easy win, stand-alone: These credits are achieved in all cases.

Site-specific: It is assumed that there is no flood risk on any sites (Sur 2 achieves 2 credits). Greenfield sites achieve no other site-specific credits except for ecological enhancement (Eco 2). For the brownfield sites it is assumed that the site has low ecological value (Eco 1) with no ecological features to protect (Eco 3) and that the ecological value of the site will be enhanced by the development. The ecologist's recommendations (all the key ones + 30% of the additional ones) have been adopted in all cases (Eco 2).

Construction and supply chain: These credits are difficult to manage on small sites where all that can be achieved is that two actions have been taken to minimise construction impacts (Man 3, eg best practices for air and water pollution). For large sites, it is assumed that, in addition, the following have been adopted: best-practice SWMP (Was 2), Considerate Constructors – beyond best practice (Man 2) and an additional two actions to minimise construction impacts (Man 3, eg monitoring site water consumption and CO_2 from transport). All timber is sourced from tier 1 and masonry products from tier 2 (Mat 2 and 3).

Water and SUDS: In all cases the houses use less than 105 litres/person/day and so achieve the mandatory requirements for Code Levels 3 and 4 without the need for greywater or rainwater recycling (Wat 1). All of them have a water butt for external water (Wat 2). Reduction in surface run-off is assumed for all sites (Sur 1).

Space and design: In all cases there is provision for segregated waste storage (Was 1). Only the Code 4 small greenfield site requires the houses to have an efficient build footprint (Eco 5). All the houses have cycle storage with the exception of the Code 3 brownfield house where the points from the credit are not needed (Ene 8). Lifetime Homes (Hea 4) is complied with on the small sites only. The requirement for good daylighting for the home office (Ene 9) means that this credit is only sought for small greenfield sites. The full 3 daylighting (Hea 1) credits are sought on all sites (except the Level 3 brownfield site where the points are not needed).

Specifying materials: In all cases it has been assumed that the following applies for the materials elements (Mat 1): roof A, external walls A, non-load-bearing partition walls A, load-bearing partitions B, separating walls B, separating floors B, ground floor A, upper floor A, windows A. NB: Semi-detached houses would achieve 10 credits. Insulation is assumed to comply with the requirements of Pol 1.

Security and external lights: Secured by Design section 2 is achieved (Man 4). Energy-efficient fittings with suitable controls specified to internal, communal and external areas (Ene 6).

Fabric and balconies: A 5 dB improvement is assumed for small sites and large greenfield Level 4 sites. Level 4 brownfield and large Level 3 greenfield sites will only need to obtain a 3 dB improvement (Hea 2). The houses have been designed to achieve an HLP ≤1.10 (Ene 2). All houses have private gardens (Hea 3).

Energy and DER: Low NO_x boilers are specified – emissions <40 mg/kWh (Pol 2). Solar thermal panels of 4 m^2 are used on Code 4 houses and on greenfield sites this is supplemented with 1 kWp of PV (Ene 7). Minimum 75% of light fittings are dedicated low energy (Ene 3). The DER (Ene 1) for Code Level 3 houses assumes the following: for U-values, roof – 0.13, walls – 0.2, ground floor – 0.2, windows – 1.2, doors – 1: for y-value 0.04; airtightness 3; MVHR 85% 1 W/(l/s) fan power; 90% efficient condensing boiler; programmer; room thermostat and thermostatic radiator valves. Code Level 4 houses are the same, but with added LZC technology.

TABLE 34

Mid-storey flat in five-storey block

Credit type	Credit	Brief description	Code Level 3 Credits Greenfield	Code Level 3 Credits Brownfield	Code Level 3 Points scored (57 required) Greenfield	Code Level 3 Points scored (57 required) Brownfield	Code Level 4 Credits Greenfield	Code Level 4 Credits Brownfield	Code Level 4 Points scored (68 required) Greenfield	Code Level 4 Points scored (68 required) Brownfield
Easy-win, stand-alone	Ene 4	Drying space	1	1	1.25	1.25	1	1	1.25	1.25
	Ene 5	White goods	2	1	2.51	1.25	2	1	2.51	0.00
	Was 3	Composting	0	0	0.00	0.00	0	0	0.00	0.00
	Man 1	User guide	3	3	3.33	3.33	3	3	3.33	3.33
Site-specific	Sur 2	Flood risk	2	2	1.10	1.10	2	2	1.10	1.10
	Eco 1	Ecological value	0	1	0.00	1.33	0	1	0.00	1.33
	Eco 2	Eco enhancement	1	1	1.33	1.33	1	1	1.33	1.33
	Eco 3	Protection of features	0	1	0.00	1.33	0	1	0.00	1.33
	Eco 4	Change in eco value	0	2	0.00	2.66	0	2	0.00	2.66
Construction and supply chain	Was 2	Construction waste	2	2	1.82	1.82	2	2	1.82	1.82
	Man 2	Considerate constructor	2	2	2.22	2.22	2	2	2.22	2.22
	Man 3	Construction impacts	2	2	2.22	2.22	2	2	2.22	2.22
	Mat 2	Sourcing – basic	3	3	0.90	0.90	3	3	0.90	0.90
	Mat 3	Sourcing – finishing	2	2	0.60	0.60	2	2	0.60	0.60
Water and SUDS	Wat 1	Internal potable	3	3	4.50	4.50	5	3	7.50	4.50
	Wat 2	External	0	0	0.00	0.00	0	0	0.00	0.00
	Sur 1	Reduction in run-off	0	0	0.00	0.00	0	0	0.00	0.00
Space and design	Hea 4	Lifetime Homes	0	0	0.00	0.00	4	4	4.66	4.66
	Ene 8	Cycle storage	0	0	0.00	0.00	2	0	2.51	0.00
	Was 1	Household waste store	4	0	3.65	0.00	4	4	3.65	3.65
	Eco 5	Building footprint	2	2	2.67	2.67	2	2	2.67	2.67
	Hea 1	Daylight	0	0	0.00	0.00	0	0	0.00	0.00
	Ene 9	Home office	0	0	0.00	0.00	0	0	0.00	0.00
Specifying materials	Mat 1	Impact of materials	9	9	2.70	2.70	9	9	2.70	2.70
	Pol 1	GWP of insulants	1	1	0.70	0.70	1	1	0.70	0.70
Security and external lights	Man 4	Security	2	2	2.22	2.22	2	2	2.22	2.22
	Ene 6	External lights	2	2	2.51	2.51	2	2	2.51	2.51
Fabric and balconies	Hea 2	Sound insulation	3	3	3.50	3.50	3	3	3.50	3.50
	Ene 2	Building fabric (HLP)	2	2	2.51	2.51	2	2	2.51	2.51
	Hea 3	Private space	0	0	0.00	0.00	1	1	1.16	1.16
Energy and DER	Pol 2	NO_x emissions	3	3	2.10	2.10	3	3	2.10	2.10
	Ene 7	LZC technologies	2	2	2.51	2.51	2	2	2.51	2.51
	Ene 3	Internal lighting	2	2	2.51	2.51	2	2	2.51	2.51
	Ene 1	DER	8	8	10.04	10.04	8	8	10.04	10.04
Total					59.40	59.81			70.73	70.54

Explanation and assumptions

Easy win, stand-alone: These credits are achieved in all cases except composting (Was 3). Only 1 credit is required for the white goods in the Level 3 brownfield site (an energy efficiency leaflet is supplied).

Site-specific: It is assumed that there is no flood risk on any sites (Sur 2 achieves 2 credits). Greenfield sites achieve no other site-specific credits except for ecological enhancement (Eco 2). For the brownfield sites it is assumed that the site has low ecological value (Eco 1) with no ecological features to protect (Eco 3) and that the ecological value of the site will be enhanced by the development. The ecologist's recommendations (all the key ones + 30% of the additional ones) have been adopted in all cases (Eco 2).

Construction and supply chain: In all cases the following have been adopted: four actions to minimise construction impacts (Man 3), best-practice SWMP (Was 2) and Considerate

Constructors – beyond best practice (Man 2). All timber is sourced from tier 1 and masonry products from tier 2 (Mat 2 and 3).

Water and SUDS: In order to obtain enough points it is necessary to adopt recycling of greywater to achieve a water use less than 80 litres/person/day for the greenfield Level 4 site. The other sites achieve the mandatory requirements for Code Levels 3 and 4 (105 litres/person/day) without the need for greywater or rainwater recycling (Wat 1). No score is assumed for external water (Wat 2) or reduction in surface run-off (Sur 1).

Space and design: In all cases (excepted the Code Level 3 greenfield site) there is provision for segregated waste storage (Was 1). All the flats have an efficient build footprint (Eco 5). The greenfield Level 4 flats require cycle storage (Ene 8). Lifetime Homes (Hea 4) is complied with on Code Level 4 sites. The requirement for good daylighting for the Home Office (Ene 9) means that this credit is not sought. The daylighting (Hea 1) credits are not sought.

Specifying materials: In all cases it has been assumed that the following applies for the materials elements (Mat 1): roof A, external walls A, non-load-bearing partition walls A, load-bearing partitions B, party walls B, party floors B, ground floor A, upper floor A, windows A. Insulation is assumed to comply with the requirements of Pol 1.

Security and external lights: Secured by Design section 2 is achieved (Man 4). Energy-efficient fittings with suitable controls specified to internal, communal and external areas (Ene 6).

Fabric and balconies: A sound testing or Robust Details for a 5 dB improvement is assumed for all sites (Hea 2). The flats have been designed to give an HLP ≤1.10 (Ene 2). The Level 4 flats have balconies (Hea 3).

Energy and DER: 200–300 kWe CHP to supply 300–600 dwellings. CHP specified to produce low NO_x emissions. System provides 60% of the space heating and hot water, with the rest being provided by communal gas boilers of 90% efficiency. Minimum 75% of light fittings are dedicated low energy (Ene 3). The DER (Ene 1) assumes: for U values, roof – 0.13, walls – 0.2, ground floor – 0.2, windows – 1.2, doors – 1; for y-value, 0.04; airtightness 3; MVHR 85% 1 W/(l/s) fan power; programmer; room thermostat and thermostatic radiator valves.

APPENDIX 3

Case studies: example credit scores when upgrading existing Part L designs to achieve Code Level 3

Note that the score required to attain Level 3 is difficult to achieve on greenfield sites (Table 35).

TABLE 35

Credit score when upgrading existing Part L designs to achieve Code Level 3

Credit type	Credit	Brief description	Detached				Mid-terrace			
			Credits		Points scored (57 required)		Credits		Points scored (57 required)	
			Greenfield	Brownfield	Greenfield	Brownfield	Greenfield	Brownfield	Greenfield	Brownfield
Easy-win, stand-alone	Ene 4	Drying space	1	1	1.25	1.25	1	1	1.25	1.25
	Ene 5	White goods	2	2	2.51	2.51	2	2	2.51	2.5
	Was 3	Composting	1	1	0.91	0.91	1	1	0.91	0.91
	Man 1	User guide	3	3	3.33	3.33	3	3	3.33	3.33
Site-specific	Sur 2	Flood risk	2	2	1.10	1.10	2	2	1.10	1.10
	Eco 1	Ecological value	0	1	0.00	1.33	0	1	0.00	1.33
	Eco 2	Eco enhancement	1	1	1.33	1.33	1	1	1.33	1.33
	Eco 3	Protection of features	0	1	0.00	1.33	0	1	0.00	1.33
	Eco 4	Change in eco value	0	2	0.00	2.66	0	2	0.00	2.66
Construction and supply chain	Was 2	Construction waste	2	2	1.82	1.82	2	2	1.82	1.82
	Man 2	Considerate constructor	2	2	2.22	2.22	2	2	2.22	2.22
	Man 3	Construction impacts	2	2	2.22	2.22	2	2	2.22	2.22
	Mat 2	Sourcing – basic	4	4	1.20	1.20	4	4	1.20	1.20
	Mat 3	Sourcing – finishing	2	2	0.60	0.60	2	2	0.60	0.60
Water and SUDS	Wat 1	Internal potable	5	3	7.50	4.50	5	3	7.50	4.50
	Wat 2	External	1	1	1.50	1.50	1	1	1.50	1.50
	Sur 1	Reduction in run-off	2	2	1.10	1.10	2	2	2.10	2.10
Space and design	Hea 4	Lifetime Homes	0	0	0.00	0.00	0	0	0.00	0.00
	Ene 8	Cycle storage	2	2	2.51	2.51	2	2	2.51	2.51
	Was 1	Household waste store	4	4	3.66	3.66	4	4	3.66	3.66
	Eco 5	Building footprint	0	0	0.00	0.00	0	0	0.00	0.00
	Hea 1	Daylight	0	0	0.00	0.00	0	0	0.00	0.00
	Ene 9	Home office	0	0	0.00	0.00	0	0	0.00	0.00
Specifying materials	Mat 1	Impact of materials	10	10	3.00	3.00	9	9	2.70	2.70
	Pol 1	GWP of insulants	1	1	0.70	0.70	1	1	0.70	0.70
Security and external lights	Man 4	Security	2	2	2.22	2.22	2	2	2.22	2.22
	Ene 6	External lights	2	2	2.51	2.51	2	2	2.51	2.51
Fabric and balconies	Hea 2	Sound insulation	4	4	4.66	4.66	1	1	1.16	1.16
	Ene 2	Building fabric (HLP)	0	0	0.00	0.00	0	0	0.00	0.00
	Hea 3	Private space	1	1	1.16	1.16	1	1	1.16	1.16
Energy and DER	Pol 2	NO_x emissions	0	0	0.00	0.00	0	0	0.00	0.00
	Ene 7	LZC technologies	0	0	0.00	0.00	0	0	0.00	0.00
	Ene 3	Internal lighting	2	2	2.51	2.51	2	2	2.51	2.51
	Ene 1	DER	5	5	6.27	6.27	8	8	10.04	10.04
Total					57.79	60.11			57.76	60.08

Explanation and assumptions

Easy win, stand-alone: These credits are achieved in all cases.

Site-specific: It is assumed that there is no flood risk on any sites (Sur 2 achieves 2 credits). Greenfield sites achieve no other site-specific credits except for ecological enhancement (Eco 2). For the brownfield sites it is assumed that the site has low ecological value (Eco 1) with no ecological features to protect (Eco 3) and that the ecological value of the site will be enhanced by the development. The ecologist's recommendations (all the key ones + 30% of the additional ones) have been adopted in all cases (Eco 2).

Construction and supply chain: In all cases the following have been adopted: four actions to minimise construction impacts (Man 3); best-practice SWMP (Was 2) and Considerate Constructors – beyond best practice (Man 2). All timber is sourced from tier 1 and masonry products from tier 2 (Mat 2 and 3).

Water and SUDS: In order to obtain enough points it is necessary to adopt rainwater recycling to achieve a water use less than 80 litres/person/day for the greenfield houses and the mid-terrace brownfield sites. The brownfield detached houses can achieve the mandatory requirements for Code Levels 3 and 4 (105 litres/person/day) without the need for greywater or rainwater recycling (Wat 1). All of them have a water butt for external water (Wat 2). Reduction in surface run-off is assumed for all sites (Sur 1).

Space and design: In all cases there is provision for segregated waste storage (Was 1) and cycle storage (Ene 8). No other credits are assumed.

Specifying materials: In all cases it has been assumed that the following applies for the materials elements (Mat 1): roof A, external walls A, non-load-bearing partition walls A, load-bearing partitions B, separating walls B, separating floors B, ground floor A, upper floor A, windows A. Insulation is assumed to comply with the requirements of Pol 1.

Security and external lights: Secured by Design section 2 is achieved (Man 4). Energy-efficient fittings with suitable controls specified to internal, communal and external areas (Ene 6).

Fabric and balconies: Detached houses receive all the sound insulation credits. Attached houses have a 3 dB improvement (Hea 2). No credits are assumed for the HLP (Ene 2). All houses have private gardens (Hea 3).

Energy and DER: GSHP is specified – hence no credits for NO_x emissions. Minimum 75% of light fittings are dedicated low energy (Ene 3). The fabric remains unchanged from a Part L standard.

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A guide to modern methods of construction — **NF1**, December 2006

Conserving energy and water, and minimising waste
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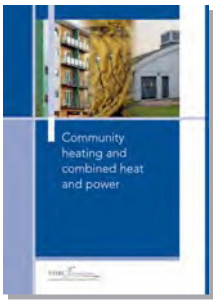
The use of lime-based mortars in new build — **NF12**, December 2008



Community heating and combined heat and power

The advent of the Code for Sustainable Homes means that low carbon solutions, such as community heating, are a key consideration for new developments. There are powerful environmental drivers for this approach principally because it enables the integration of combined heat and power and renewables.

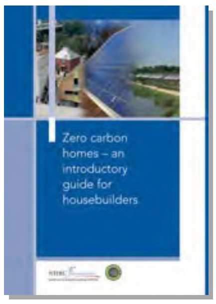
This guide aims to introduce the reader to the concept of community heating and combined heat and power and how they can be applied. The focus is principally on new housing developments, but the possibilities for serving a mixture of both new and existing buildings, as well as mixed use developments, is also described.

NF13, February 2009

Zero carbon homes – an introductory guide for housebuilders

This guide is designed to help builders understand the issues associated with the definition of zero carbon and help them engage in the consultation process. It provides an overview of CO_2 emissions from homes, how these can be reduced and how zero carbon standards can be set through the Building Regulations, the Code for Sustainable Homes and stamp duty tax relief.

NF14, February 2009



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- Assessing life safety of open plan flat layouts
- Water efficiency guidelines
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The Code for Sustainable Homes simply explained

The Code for Sustainable Homes calls for a step change in the way new homes are designed and constructed. In May 2008 it became a mandatory requirement for all new-build homes in England.

Many housing developers are quickly developing their expertise. Others have not yet built homes to comply with the Code and for them the prospect of getting to grips with the Code Technical Guide may be somewhat daunting.

This guide will help developers get to grips with the Code by distilling the experience gained from a large number of Code assessments and advises designers and builders on a strategic way through. It highlights the interaction between the various issues and suggests how they can be addressed in the most practical way and most cost-effectively. Throughout, it includes a variety of useful tips and further information.

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Housing research & development in partnership with BRE Trust

The NHBC Foundation has been established by NHBC in partnership with the BRE Trust. It facilitates research and development, technology and knowledge sharing, and the capture of industry best practice. The NHBC Foundation promotes best practice to help builders, developers and the industry as it responds to the country's wider housing needs. The NHBC Foundation carries out practical, high quality research where it is needed most, particularly in areas such as building standards and processes. It also supports house builders in developing strong relationships with their customers.

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