THE CODE FOR SUSTAINABLE HOMES

Case studies

Volume 2 March 2010

Communities and Local Government

THE CODE FOR SUSTAINABLE HOMES

BACKGROUND

The Code for Sustainable Homes (the Code) was introduced in England in April 2007 as a voluntary national standard to improve the overall sustainability of new homes by setting a single framework within which the home building industry can design and construct homes to higher environmental standards. Where it is used the Code also gives new homebuyers information about the environmental impact of their new home and its potential running costs.

The Code measures the sustainability of a home against nine design categories, rating the 'whole home' as a complete package. The design categories are:

- Energy and CO_2 emissions
- Water
- Materials
- Surface water run-off
- Waste
- Pollution
- Health and wellbeing
- Management
- Ecology

The Code uses a rating system to communicate the overall sustainability performance of a home. A home can achieve a sustainability rating from one to six stars depending on the extent to which it has achieved Code standards. One star is the entry level – above the level of the Building Regulations; and six stars the highest level – reflecting exemplar development in sustainability terms.

Assessment procedures are based on BRE Global Limited's EcoHomes System which depends on a network of specifically trained and accredited independent assessors. Currently, BRE Global Limited and Stroma Accreditation Limited can offer training and accreditation of Code assessors.

Since May 2008 all new homes will have to have a sustainability certificate in the Home Information Pack. That can be in the form of a Code certificate if the home has been assessed against Code standards or, if it has not been assessed, a 'nil-rated' certificate. A nil-rated certificate can be downloaded from the HIP website:

www.homeinformationpacks.gov.uk

More information about the Code is available on our website: www.communities.gov.uk/thecode

INTRODUCTION

As part of the on-going process of learning from developments being built to the Code standards and to disseminate the information about building sustainable homes, Communities and Local Government has commissioned Jones Lang LaSalle to research and develop a second set of case studies[1] on some of the developments being built to the Code standards.

The case studies cover a range of social and private housing, using a variety of different build systems or materials, and achieving a range of Code standards.

The research has helped further develop and improve the operation of the Code. The case studies also include key learning points that should help those who decide to build to Code standards.

OVERVIEW

DEVELOPMENT TYPES

The projects included in this report are:

- Freshney Green, urban private and social housing to Code Level 3 by Stamford Homes part of Galliford Try and Shoreline Housing Partnership
- Southcroft Park, urban social housing to Code Level 3 by Keepmoat Homes and Isos Housing Group
- Tempo, urban social housing to Code Level 3 by Fairview New Homes and London & Quadrant Housing Association
- Miller Zero, sub-urban housing to Code Level 3 and 6 by Miller Homes
- Upton, semi-rural social housing to Code Level 6 by Metropolitan Housing Partnership

The majority of the projects included within the study were small scale sites or small parts of a larger site, consisting of between 6 and 36 units. However, one of the projects, Freshney Green consisted of 67 homes in the first phase of a development of about 450 homes, all of which will be built to Code standards. The case studies cover a range of building types including:

- Detached and semi-detached homes
- Terraces and flats

The projects also cover a range of tenures and procurement types, including:

- Private housing for sale
- Social housing for rent and sale

[1] The first set of case studies were undertaken by the Good Homes Alliance and were published in March 2009. The Code for Sustainable Homes: Case Studies. This document can be downloaded from the Communities and Local Government website: **www.communities.gov.uk/publications/planningandbuilding/codecasestudies** (ISBN 9781409811954).

CONSTRUCTION AND BUILD SYSTEMS

The sites in this report represent a range of build systems and construction processes that might be adopted by other developers at all scales and sizes:

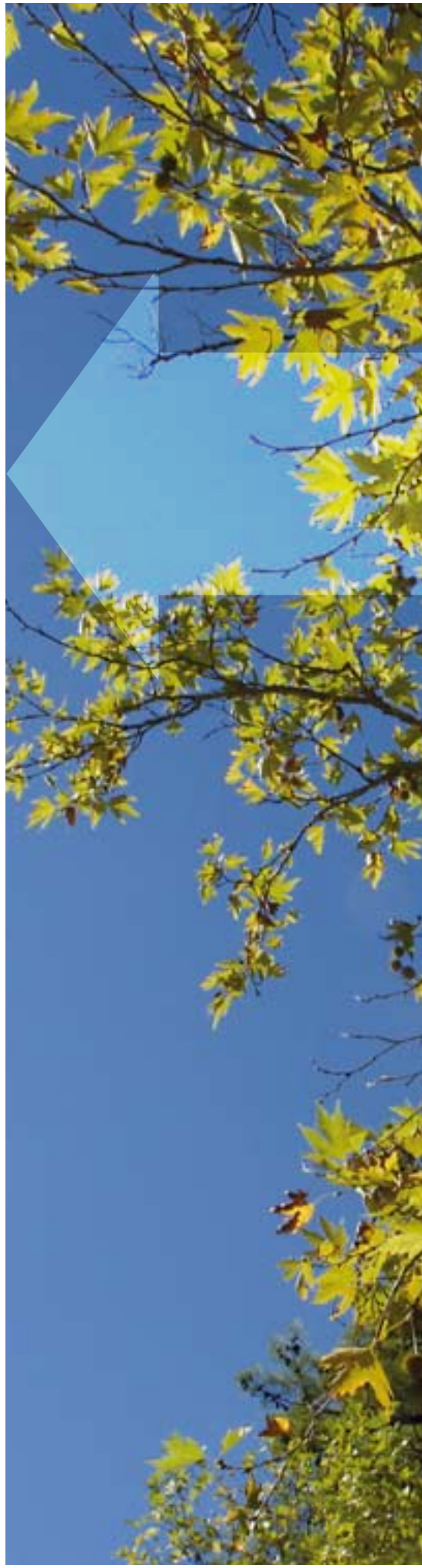
- Brick and block masonry walls with a fully insulated cavity, with or without additional internal insulation
- Off-site manufactured glulam timber frame, in-filled with a secondary timber studwork
- Storey height aircrete panels with external wall insulation

There are a number of other build systems that can be used to construct Code homes that were not examined for this publication, these include:

- Timber frame with orientated strand board cassettes
- Timber frame with a cavity wall of cement particle board outer sheath and brick external cladding
- Timber frame with a cavity wall of concrete external block and insulating internal block
- Timber frame with pre-fabricated solid cross timber laminated panels and external insulation
- Structural Insulated Panel System (SIPS) with additional insulation
- Unfired, insulating clay blocks, with or without external insulation
- Timber frame with pre-cast concrete panels

For information on projects built using a number of these construction methods, please refer to the first case study publication[2].

The projects included within this study represented the first, or one of the first times each developer had adopted the Code for Sustainable Homes. In some cases, the build systems were prototypes and were used as opportunities to learn about new skills and design processes required to work with the Code. In other cases, more standard systems such as brick and block cavity walls were adapted to meet Code requirements. It is interesting to note that there were some difficulties with each approach, which would be expected with the adoption of any new standard. However, the projects show that Code standards can be achieved in a variety of ways.



[2] *The Code for Sustainable Homes: Case Studies.* This document can be downloaded from the Communities and Local Government website: **www.communities.gov.uk/publications/planningandbuilding/codecasestudies** (ISBN 9781409811954).

WORKING WITH THE CODE FOR SUSTAINABLE HOMES

As the developers in this study were using the Code for the first, or one of the first times, they and their advisors had to learn about the assessment and certification processes required to work with the Code.

Some of the developers have specifically chosen to adopt the Code standards because of perceived marketing benefits, or provision of higher quality outcomes to tenants and purchasers, as well as meeting formal funding or planning requirements. Unsurprisingly, those projects that planned to build Code homes from the outset found it easier to meet the requirements rather than adapt homes that had been designed to a different standard, as there are significant differences between the Code and previous standards.

SUSTAINABILITY APPROACHES & TECHNICAL PERFORMANCE

The sustainability approaches adopted on most of the projects were fairly similar, which is to be expected given the formal requirements within the Code for energy-efficient and water-efficient buildings. Most of the projects focused on high quality, highly insulated building shells with low air permeability that took maximum advantage of passive solutions before adding active or renewable features:

- high levels of insulation
- low levels of air permeability
- passive solar design strategies
- low energy lighting
- the use of environmentally benign materials
- low water use sanitary ware
- rainwater harvesting

The schemes that aimed for higher levels of the Code also included renewable energy such as photovoltaic cells, biomass boilers and other features such as green roofs[3].

Many of the projects had incorporated metering equipment and had developed plans for future post-occupancy monitoring, which will help provide feedback on the actual performance of different systems during occupation.

The technical performance of the components of each project varied according to the Code

[3] Green roof is a term used to describe a roof with a vegetated surface. Green roofs can have a number of benefits including: providing wildlife habitats, reducing surface water run-off, enhancing visual amenity, improving the thermal performance of the building and improving local air quality.

Level achieved: low-e double or triple glazing and wall U-values from 0.15W/m^{2}K at Code Level 6 to 0.28W/m^{2}K at Code Level 3. Air permeability test results were also in line with expectations ranging from 2.7m^3/h@50pa at Code Level 6 up to 7m^3/h@50pa for Code Level 3.

All of the projects were able to obtain a standard 10 year building warranty.

SCHEME IMPLEMENTATION

It is worth reiterating that all the developers in this study were using the Code for Sustainable Homes for the first, or one of the first times. These developments were therefore used as opportunities to learn about the new skills and processes required to work with the Code.

Where new systems and materials were used, all of the developers undertook some research into how these would work and visited demonstrations of the products and systems. Despite this, most of the developers still encountered design and/or construction difficulties at some point. Most of the developers reported that in future they would undertake greater research and testing of any new systems or approach. The most common problems for those who used new systems and approaches were:

1. design detailing, especially for integrating Code requirements on air permeability and thermal performance into the architectural design of the scheme
2. quality of the finished construction on site, in terms of understanding both the design details and the importance of achieving the quality specified

The developers who used block cavity wall construction reported fewer difficulties with achieving Code requirements, although all the projects built this way were aiming for Code Level 3 or 4, rather than higher levels. However, even those developers that used more familiar construction methods reported that additional investigation and training was required for new features, such as the solar thermal hot water and the Mechanical Ventilation with Heat Recovery (MVHR).

The projects attracted varied reactions from their local planning authorities. In most cases, the sustainability performance was well received, but different requirements were applied in terms of aesthetic. Some were required to adopt specific design requirements (e.g. traditional vernacular), which sometimes conflicted with the simplest sustainability solutions. In other cases, the sustainability approach persuaded the planning authority to allow a more modern aesthetic.

COSTS, VALUE AND BUYER/ OCCUPANT FEEDBACK

All the case studies indicated that building to the higher environmental standards of the Code for Sustainable Homes was more expensive than building a home to Building Regulations. The estimated increases ranged from around £4000 for a Code Level 3 home to £50,000 for a Code Level 6 home. However, the case studies looked at for this publication suggest that the costs to build to Code Level 3 may have reduced since the first set of case studies were published, with the build costs, excluding land costs and fees, ranging from £900 to £1100 per square meter.

The uplift included both the additional costs for materials, systems and features as well as the training and time costs associated with taking a new approach, although none of these had been recorded nor had these costs been identified separately. Most of the developers using systems or technologies for the first time viewed these projects as prototypes and therefore absorbed most of the additional costs as part of their research and development budget.

The developers reported that they expect to reduce the additional costs on the next and future projects, as the requirement for additional research, training and development systems would be reduced, and the supply chain for products and systems would become better developed and more sophisticated. In addition, they also reported that they should achieve greater build efficiencies through better integration of the sustainability requirements within the design, and through greater focus on buildability of the design details. Build costs could also be reduced if there is a reduction in the cost of sustainable and renewable technologies (such as solar thermal hot water and photovoltaic panels).

Where the properties were for market sale, the sales values of most of the properties compared either evenly or favourably to equivalent sales prices in the area. One of the developers, however, suggested a reduced sales value compared to equivalent local properties. However, this was due to its location in a previously deprived area.

KEY LESSONS

A number of lessons can be drawn from these case studies of Code homes. Firstly, it is clear that Code compliance can be achieved using a wide range of build systems. The Code can also be used on a wide range of building types, from flats through to large detached dwellings. Furthermore, the Code can be a valuable tool for any type of project, whether private or social housing, and covering rental, affordable and private sale properties.

However, it has taken time for those involved to become familiar with the assessment and certification processes, which has led to uncertainty, increased costs and delays in competition of certification.

In more technical terms, there are a number of common lessons about how best to achieve Code compliance:

- A high quality, highly insulted building shell that has low air permeability and makes best use of passive solutions seems to be the most successful and straightforward approach
- Code design criteria should be incorporated from the earliest design phases of a project in order to understand the overall design implications
- A Code assessor should be included in the project plans from the outset
- The build systems and the design approach should be integrated from the earliest design phases
- Renewable energy technologies should be integrated into the overall design concept from the earliest design phases
- When achieving higher levels of the Code (Levels 5 and 6 in particular), success depends on a dedicated and skilled construction team with a strong commitment to sustainability, who bring goodwill and innovation to the use of new systems
- It is important that evidence is gathered for the post-construction certification as early as possible during the construction process

Finally, while there is a cost associated with achieving the Code (of between £3000 per unit at Level 3 to £50,000 per unit at Level 6), customers are becoming more interested in the sustainability performance of Code homes, which may begin to generate a value premium, although this needs further investigation and verification.


SOLD
SOLD

CASE STUDY 5

FRESHNEY GREEN
GRIMSBY, LINCOLNSHIRE

Code Level	Level 3
Development type	67 homes consisting of 52 terrace, semi-detached and detached houses and a block of 15 flats
Construction type	Brick and block masonry walls, 100mm cavity wall insulation, timber frame pitched truss rafter and tile roofs
Key Sustainability Features	Insulation, environmentally benign materials, low energy lighting, low water use, Lifetime Homes, heat recovery exhaust air heating and hot water system, photovoltaic panels (17 units).
Procurement Method	Mixed development (both private and housing association) procured via standard method of procurement

INTRODUCTION

Freshney Green is a large-scale regeneration scheme located in a deprived area of Grimsby. Over the next eight to ten years, Stamford Homes part of Galliford Try, and Shoreline Partnership will transform the previously deprived housing estate into a high quality sustainable urban environment. The final scheme will consist of up to 450 homes, all of which will be built to at least Code Level 3.

The first phase of the regeneration scheme was started in July 2008, and 40 of the 67 homes have now been completed, with a number of these now occupied. All homes have reached Code Level 3 as a minimum, and due to the incorporation of photovoltaic cells on 17 of the rental units following the design stage Code assessment, it is expected that these will reach Code Level 4 on their post-construction certification. The first phase of the scheme also incorporates two bungalows which are being built to Code Level 5.

Once complete, 40 per cent of the new homes will be affordable housing. The scheme will also include new parks, improved infrastructure, community eco-garden, a new pedestrian link to local shops, and the creation of a gateway square to the new medical centre. The vision by both Stamford Homes and Shoreline Housing Partnership is that Freshney Green will completely regenerate the area.

'We are proud to be working with Shoreline Housing Partnership on such an important development which will go a long way in improving the local area. Using our combined vision we are committed to creating modern homes which are both affordable and desirable, completely transforming the current site to build an environmentally friendly hub for the community."

CONSTRUCTION AND BUILD SYSTEM

The new build units (with the exception of the two bungalows) have been constructed on-site using traditional masonry build. The external walls were constructed as a cavity wall with an external brickwork skin, a fully filled cavity containing mineral wool insulation, and an internal skin of ultra lightweight aggregate blocks, finished using standard plasterboard on dabs. In some places external rendering and cedar cladding has been used.

The floors were constructed using concrete slab over a layer of urethane insulation. The roof was constructed using pitched timber truss and concrete interlocking tiles. The mineral wool insulation used in the roof was laid in two layers in order to achieve the required U-value.

SUSTAINABILITY FEATURES

Sustainability approaches and features incorporated into the scheme include high levels of insulation, the use of environmentally benign materials, low energy lighting, the use of water butts to collect rainwater for the garden, low water use sanitary ware and the design of all homes to Lifetime Homes. A heat recovery exhaust air heating and hot water system was also installed. A home user guide is to be provided to residents alongside training on how to operate the heat recovery exhaust air heating and hot water system.

Seventeen of the socially rented homes will also feature photovoltaic panels, which were installed by Shoreline Housing Partnership in order to tackle fuel poverty issues for its tenants.

Photovoltaic panels on one of the socially rented homes

TECHNICAL PERFORMANCE

External Fabric

300mm cavity wall consisting of an external brickwork skin, 100m cavity fully filled with 100mm mineral wool insulation and an internal skin of 100mm ultra lightweight aggregate blocks, finished using standard plasterboard on dabs. U-value of 0.28W/m^2 K

Roof

Pitched timber truss, concrete interlocking tiles, 400mm mineral wool insulation laid in two layers with the first of 200mm laid between ceiling joists with second layer of 200mm laid at 90 degrees to first over ceiling joists. U-value of 0.17W/m^2 K

Floor

100mm concrete slab over a layer of 120mm urethane insulation. U-value of 0.15W/m^2 K

Doors and Windows

Double glazed uPVC windows and doors. U-value of 1.8W/m^2 K

Air-permeability

The target was 7m^3/h@50pa which was achieved by all units during the final air permeability tests, with a small number of units achieving improvements on this.

SCHEME IMPLEMENTATION

The design of the completed units is typical of newer homes in the surrounding area, with only the photovoltaic cells installed on some of the rented units presenting any less-than-usual external features on the development. The low energy merits of the housing were considered a very desirable attribute for this development, and the photovoltaic cells were installed to address fuel poverty issues.

The developer was keen to demonstrate that achieving Code Level 3 did not require significant changes to its standard housing types. Minimal changes to the super structure of the building were required and primarily achieved through higher levels of insulation in the roof and the inclusion of a heat recovery exhaust air heating and hot water system. Training was provided by the supplier of the heat recovery exhaust air heating and hot water system for local plumbers in order to effectively install the system.

The development during construction

The final vision for the site, which was drawn up over two years of extensive consultation, is to regenerate an entire community, part of which includes providing opportunities for local people. Stamford Homes North has sought to utilise local labour during construction, and part of the reason the homes were built using traditional masonry techniques was to utilise local skills without the need for retraining.

While the developer did not experience any issues with achieving Code Level 3, it was felt that in order to meet higher levels of the Code, specifications would have to alter more significantly, for example using renewable energy to achieve Code Level 4.

All build systems have conventional building warranties.

WORKING WITH THE CODE FOR SUSTAINABLE HOMES

This is the first scheme in which either the developer or the housing association had achieved Code Level 3 certification. The developer had worked with the EcoHomes standard prior to this development, and found the transition from EcoHomes to the Code for Sustainable Homes straightforward. The developer worked closely with the housing association to ensure that the specifications it selected to achieve the Code were acceptable (particularly in relation to the heat recovery exhaust air heating and hot water system).

In order to understand and achieve the Code requirements the developer employed an external consultant to assist with the process. The developer felt it was important that both suppliers and site workers understood the Code requirements in order to achieve the design standards during construction. Working to Code Levels 3, 4 and 5 on this project has helped the developer understand how it can most effectively meet Code requirements both in later phases of this development and on other developments.

COST AND VALUE

The build cost excluding land costs and fees was around £900 per square metre.

The developer suggested this represents an additional uplift in costs of £4200–£4300 Code Level 3 unit, and is anticipating an additional uplift in costs of £15,000–£20,000 per unit for the two Code Level 5 bungalows, compared to their standard units built to Building Regulations.

The sales value of the properties that have so far been put on the market range from £124,950 (three-bedroom link property) to £149,950 (three-bedroom semi detached house). These are depressed compared to local sales values due to the development location.

BUYER/OCCUPANT FEEDBACK

Of the 40 units completed on phase 1, 18 have been sold and the first residents moved in recently. Stamford Homes sales manager, Melanie Parker, said

'The interest in Freshney Green is amazing. We have a lot of young people looking to get a foot on the housing ladder and they are attracted by the low cost of the homes and the green measures in place, which will make them very affordable to run. Equally we have interest at the other end of the spectrum from elderly couples who see these homes as long-term investments because as they get older the houses can be adapted to suit them.'

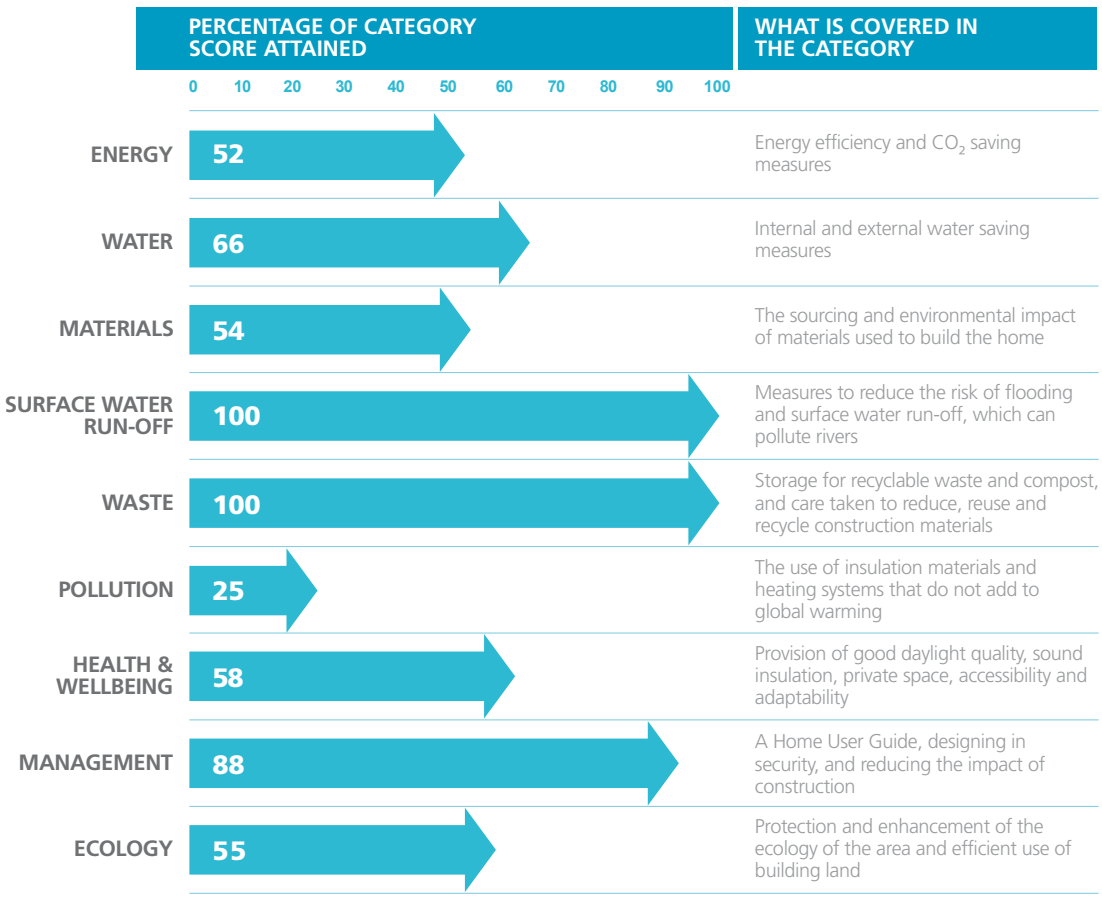
Some early feedback from the residents in the first occupied properties has been received. All have indicated that they are happy with the performance of the new home, with one resident commenting that the house was less draughty than their former home. Another customer said that they were impressed by the 'home for life features'. At the time of visiting the site none of the purchasers is yet to receive bills and therefore was not able to compare this aspect of performance with that of a previous home.

Further monitoring of the performance of the homes is intended to be undertaken in the future.

LESSONS LEARNT

The main lessons learnt from the development have been:

- Code Level 3 is achievable using traditional masonry build with the inclusion of additional insulation and other energy saving technologies
- Achieving Code Level 4 or above requires the inclusion of renewable energy technologies such as photovoltaics
- Occupants must be given detailed information on how to use the home correctly (both at handover and through a Home User Guide) in order to ensure that the home operates to the same level of performance as it was designed
- The inclusion of energy saving technologies not only assists in achieving higher levels of the Code but also helps tackle fuel poverty issues



The figures above are from the design stage assesment and are subject to final approval/certification

DESIGN TEAM

Contractor	**Stamford Homes**
Developer	**Stamford Homes**
Architect	**Stamford Homes**
Design Consultant	**CABE**
Energy Design Consultants	**Focus Consultants UK Ltd**
Structural Engineers	**Atkins**

The figures above are from the design stage assessment and are subject to final approval/certification. A range of points were achieved by different units on the development. The above table provides an example of the performance of one house on the development.

CASE STUDY 6

SOUTHCROFT PARK

STANLEY, COUNTY DURHAM

Code Level	Level 3
Development type	Terrace of 10 three-bedroom homes, all social housing
Construction type	Brick and block masonry walls, 100mm cavity wall insulation, timber frame pitched truss rafter and tile roofs
Key Sustainability Features	Solar thermal panels, low energy lighting, recycling bins, water butts, gas saver heat recovery system
Procurement Method	Housing association development using a standard method of procurement through a developer

INTRODUCTION

Southcroft Park is a development of 10 terraced homes located in Stanley, County Durham. The homes are located on a much larger site in a deprived area of the north-east of England. Funding from the housing association (Isos Housing Group) allowed the completion of the first 10 homes to Code Level 3 on the site.

Keepmoat Homes approached Isos in the autumn of 2008 to discuss the opportunity for an Registered Social Landlord to be involved in the project and to ensure these units were completed. The estimated costs associated with building the 10 units to Code Level 3 were presented to Isos. A bid was submitted to the Homes and Communities Agency (HCA) whom subsequently committed the required funding. The relationship formed between the developer and the housing association has seen the provision of affordable homes on a site that had previously achieved planning without the provision of any affordable housing.

The project was originally designed to meet the criteria for EcoHomes Very Good, although the final target was to achieve Code Level 3. The developer has found the transition from EcoHomes to the Code for Sustainable Homes to be relatively smooth, with few alterations to the standard product.

CONSTRUCTION AND BUILD SYSTEM

The houses have been constructed using traditional masonry build. The external walls are constructed with an external brickwork skin, a fully filled cavity containing mineral wool insulation, and an internal skin of concrete blockwork.

The floors were concrete slab over a layer of urethane insulation. The roof was constructed using pitched timber truss and concrete interlocking tiles. The fibreglass insulation used in the roof was laid in layers in order to prevent cold bridging and to achieve the required U-value.

SUSTAINABILITY FEATURES

Solar thermal water heating on the homes

Sustainability approaches and features incorporated into the Code Level 3 units include solar thermal water heating, low flow rate sanitary ware, the use of water butts to collect rainwater, the design of all homes to Lifetime Homes, the use of more environmentally benign materials, higher levels of insulation, low energy lighting, internal recycling bins.

TECHNICAL PERFORMANCE

External Fabric

300mm cavity wall consisting of an external brickwork skin, 100m cavity fully filled with 100mm mineral wool insulation and an internal skin of 100mm ultra lightweight aggregate blocks, finished using standard plasterboard on dabs. U-value of 0.23W/m^2 K.

Roof

Pitched timber truss, concrete interlocking tiles, 450mm fibreglass insulation laid in layers with the first of 100mm laid between bottom trusses with the remaining 350mm cross layered. U-value of 0.09W/m^{2}K

Floor

100mm concrete slab over a layer of 130mm urethane insulation. U-value of 0.13W/m^2 K.

Doors and Windows

Double glazed, low-e windows were used with an average U-Value of 1.36W/m^{2}K. Doors average U-Value of 1.36W/m^{2}K.

Air-permeability

The target was 6m^3/h@50pa. The Code Level 3 houses achieved this or better through testing.

SCHEME IMPLEMENTATION

To achieve Code Level 3, few alterations needed to be made to the developer's standard house design. The main design changes were the installation of solar thermal panels and an increase in the thickness of the cavity walls to provide the capacity required to install the additional insulation (100mm compared to 75mm in a standard house designed to comply with Part L of the Building Regulations).

The supply of solar panels was placed with the plumbing contractor so that it formed part of the plumbing contract. However, the panels were then installed by the roofer to ensure that the roofing materials could be set out correctly. This change in trades between supply and fitting complicated the installation of the panels and required training from the supplier to the roofers. This cost was covered by the supplier and did not form part of the direct construction costs for the developer, but would be an additional cost on future developments if there was no skilled workforce in the area.

The developer, with the support of their Code assessor, had a positive experience of experimenting with new products to achieve Code requirements. For example, there were products which did not at the time comply with Robust Details[4] requirements but were installed at Southcroft Park and gave excellent sound testing results. Consequently the products used have now achieved Robust Details requirements and will achieve a better than initially expected set of credits in various sections.

[4] Robust Details are construction solutions that can be applied to separating walls and floors to ensure that they are built to comply with Part E of the Building Regulations (England and Wales). They provide an alternative to on-site pre-completion sound testing and are also recognised under the Code for Sustainable Homes.

WORKING WITH THE CODE FOR SUSTAINABLE HOMES

The developer had previously been designing and building to EcoHomes Very Good and found the transition to the Code for Sustainable Homes to be relatively smooth.

An accredited assessor was appointed to carry out a full Code assessment. The developer found that it was important to gather evidence for the post-construction certification as early as possible during the construction process. This includes taking photographs of those areas which will be hidden at the end of the construction process (e.g. insulation) as well as the site management processes (e.g. dust management). The process of evidence collection has been streamlined to meet the Code assessor's needs, which will make evidence collection on future developments, where there is more than one house type, much more succinct.

Overall, it was considered that the process of designing and building to the Code was a positive one as it ensured that there was consistent communication and collaboration between the design, technical, commercial and construction teams. Environmental considerations are now being made by the design team from the start of the projects to ensure the most effective route to meeting the Code requirements is achieved. The developer is now going through a process of obtaining ISO14001, which will help to standardise paperwork and processes across the business. This means that lessons learnt in relation to the Code in one part of the business can be shared through the organisation.

'As Code assessors we work closer with various personnel at developers than we normally would as architectural and engineering consultants. Whilst the Code exercise can be a steep learning curve for some of the points of contact, the process generally helps us work closer and better with the developer.'
Michael Axtell, Architectural Manager /Licensed CSH Assessor, Queensberry Design Ltd.

COSTS AND VALUE

The build cost excluding land costs and fees was around £1100 per square metre.

The homes were built for social housing purposes, and were not intended for sale. It was estimated by the developer that the cost to design and build to Code Level 3, compared to a standard unit to Building Regulations was about £7500 per unit.

Since the completion of this development, further Code Level 3 schemes have been designed and built by the developer. It is considered that the uplift in cost has dropped to between £3500 and £4000 per units. The decrease in cost can primarily be attributed to an increase in the number of suppliers of solar thermal panels which has resulted in a decrease in price.

BUYER/OCCUPANT FEEDBACK

All of the 10 units are occupied by housing association residents. A full handover pack was provided including standard information on how to use the home, and additional information related to the Code Level 3 elements, including the solar panels and heating control system.

The living room of one of the homes

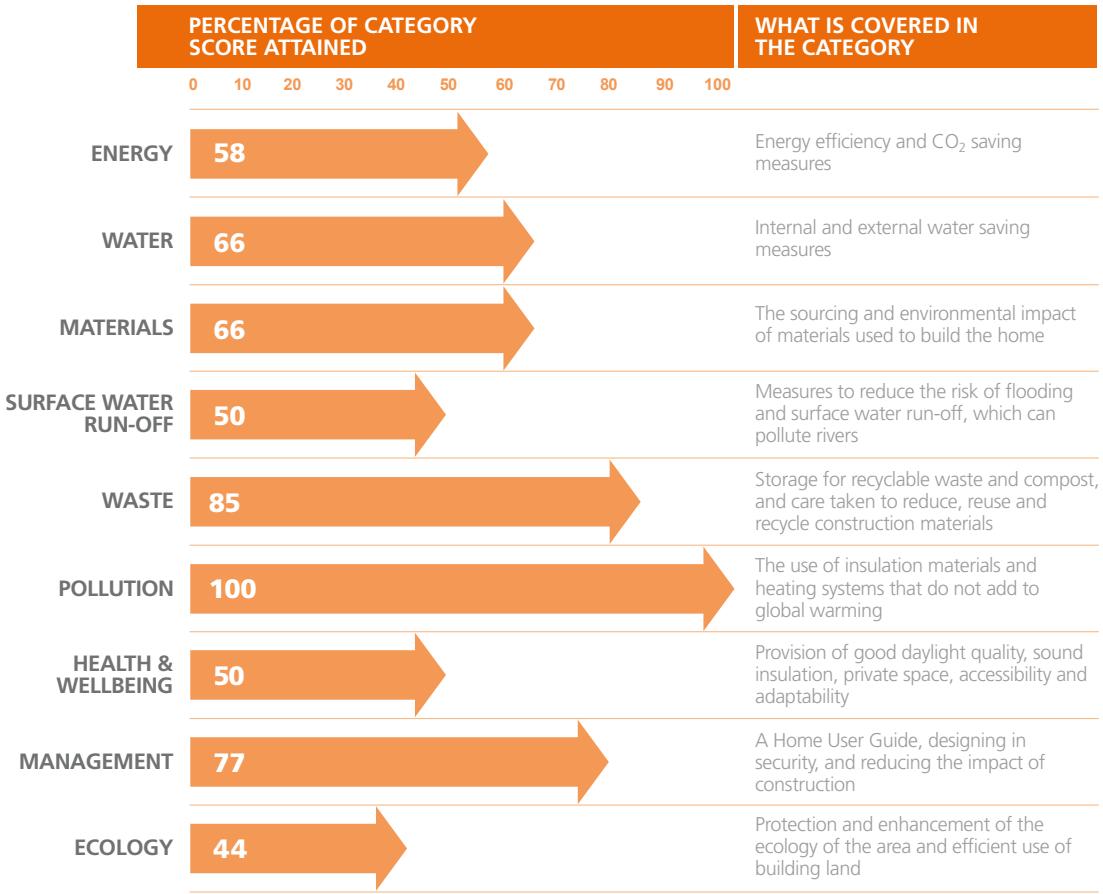
Isos undertakes a new home survey with all residents after six months of occupancy, which is yet to be carried out at the Southcroft Park development. Isos also invite residents to join a panel to discuss issues related to the homes they occupy. This is then fed back into the housing association design brief to assist future developments being built to the levels of the Code.

'Residents of the Southcroft Park homes will see a small saving on their energy bills compared to their previous homes, depending on how the home is used. Isos has been building Code Level 3 units for the past year and we are currently moving to Code Level 4. It is at this level and beyond that we anticipate seeing greater savings for our residents on their energy bills.'
Lea Smith, Development and Regeneration Manager, Isos Housing Group

LESSONS LEARNT

The main lessons learnt from the development have been:

- It is important that evidence is gathered for the post-construction certification as early as possible during the construction process. This includes taking photographs of those areas which will be hidden at the end of the construction process (eg insulation) as well as the site management processes (eg dust management)
- Ensure that the site managers are aware of the Code requirements and the process so they know what activities need to be managed and monitored at a site level (waste, energy, water data collection and collation)
- Achieving the minimum mandatory energy credits for Code Level 3 typically requires the use of renewable energy generating technologies which can incur additional costs both for the products and for training the workforce to know how to install these correctly
- Occupants must be given detailed information on how to use the home correctly. On developments where the heating, hot water and lighting systems are more complicated than new owners may be used to, the handover and home demonstration must be sufficient to explain systems to the resident. When handing over homes to housing a ssociations, the Home Owners Guide is critical to ensure the information is handed onto the resident in the most appropriate manner, as the developer will not necessarily be able to offer a home demonstration



DESIGN TEAM

Contractor	**Keepmoat Homes**
Developer	**Keepmoat Homes**
Architect	**Queensberry Design**
Design Consultant	**Queensberry Design**
Energy Design Consultants	**Queensberry Design**

The figures above are from the post-construction certificates for the units. A range of points were achieved by different units on the development. The above table provides an example of the performance of one house on the development.


Plot 6
SOLD

CASE STUDY 7

TEMPO

PALMERS GREEN, LONDON

Code Level	Level 3
Development type	36 Homes, 4 Houses, 32 Flats; all social housing
Construction type	Brick and block masonry walls, 100mm cavity wall insulation, flat roof with timber trusses, partial external timber cladding
Key Sustainability Features	Solar thermal water heating (houses), photovoltaic cells (flats), water efficiency measures, Lifetime Homes, environmentally benign materials, recycling bins.
Procurement Method	Private housing (with housing association units), standard method of procurement with the developer acting as main contractor

INTRODUCTION

Tempo is a development comprising of 142 units located in Palmers Green in north London being developed by Fairview New Homes. The 36 housing association units on the site, being constructed for London & Quadrant Housing Association, are the only part of the development being constructed to the Code for Sustainable Homes.

The 36 homes are distributed throughout the development, with the four houses being located next to each other in a terrace. The 32 flats are located within three of the blocks of flats which also contain flats for private sale.

The development is on the site of a former recreational ground, and the new development will regenerate what was a run-down site. Alongside the creation of new recreational facilities, the ecology on the site will also be considerably improved.

CONSTRUCTION AND BUILD SYSTEM

The houses and flats on the development have been constructed on-site using traditional masonry build. The external walls are constructed with an external brickwork skin, a fully filled cavity containing mineral wool insulation, and an internal skin of concrete blockwork. The walls to the housing association houses are internally finished using thermal enhancement comprising of thermal laminate plasterboard on continuous ribbons and dabs, whilst the private houses and flats are finished with standard plasterboard.

Ground floors to flats and houses are screed finished on rigid urethane insulation, laid on grouted beam and medium dense block. In order to achieve the energy requirements for Code Level 3 the flats are provided with 50mm insulation and the private houses with 85mm insulation (compared to the private houses built to Part L 2006 Building Regulations this is an increase of 10mm of insulation). Upper floors to houses utilise timber eco-joists, whilst the separating floors between flats are constructed using pre-cast concrete planks, with resilient layer and screed.

The roofs to both flats and houses are flat, constructed using timber joists, insulation, plywood decking and a PVC single ply roof membrane. A flat roof design was selected in order to facilitate the use of solar energy on site, removing constraints on orientation of the houses and flats.

The roofs of the Code Level 3 houses were insulated with 300mm of mineral wool insulation (compared to 250mm used in the private housing). As an enhanced fabric construction did not form part of the strategy for the flats, they were provided with a standard 90mm rigid urethane board laid directly on the roof decking.

SUSTAINABILITY FEATURES

Sustainability approaches and features incorporated into the Code Level 3 units include solar thermal water heating (on the houses), photovoltaic cells (on the flats), low flow rate sanitary ware, the use of water butts to collect rainwater, the design of all homes to Lifetime Homes, the use of more environmentally benign materials, higher levels of insulation, low energy lighting, internal and external recycling bins (including the provision of composting through the local authority collection scheme).

Photovoltaic cells on the roof of the flats

TECHNICAL PERFORMANCE

External Fabric

300mm cavity wall consisting of an external brickwork skin, 100m cavity fully filled with 100mm mineral wool insulation, an internal skin of 100mm lignacite blockwork. The external walls are finished using internal thermal enhancement comprising of thermal laminate plasterboard comprising of 35.5mm extruded polystyrene insulation bonded to 9.5mm wall board. U-value of 0.23W/m^{2}K

Roof

Flat roof constructed using timber joist, plywood decking and a PVC single ply roof membrane. The Code Level 3 houses have 300mm mineral wool insulation laid in two layers with the first of 100mm insulation laid between ceiling ties to trusses with second layer of 200mm insulation laid at 90 degrees. U-value of 0.13W/m^{2}K.
The flats were provided with a standard 90mm rigid urethane board laid directly on the roof decking. U-value of 0.13W/m^{2}K

Floor

Code Level 3 Houses – 65mm screed with 85mm urethane insulation. U-value of 0.15W/m^{2}K.
Flats – 65mm screed with 50mm urethane insulation. U-value of 0.2W/m^{2}K.

Doors and Windows

All doors and windows are double glazed. U-values (wholeframe) of 1.5W/m^{2}K.

Air-permeability

The target was 5m3/h@50pa. The Code Level 3 houses achieved 4.97 through testing, but the flats are yet to be tested.

SCHEME IMPLEMENTATION

The design of the completed units is typical of newer homes in the surrounding area, with only the solar thermal panels on the houses and the photovoltaic cells on the flats presenting any less than usual design features.

The decision to achieve Code Level 3 was driven solely by the housing association funding requirements. In order to achieve Code Level 3 the developer made a number of changes to its standard house types. This included increasing insulation to the housing association houses (there were no changes to the insulation levels for the flats).

The inclusion of renewable energy in both the houses and flats was the other key way in which the developer's standard specification was changed to order to achieve the energy credits. Using solar thermal hot water on the houses and photovoltaics on the flats was a deliberate decision by the developer to ensure the best end use of the energy produced.
In the two blocks of flats owned by the housing association, the energy produced by the photovoltaic panels will be divided between all the units in the block. As the housing association will own the building they will be able to ensure that the communal solar photovoltaic system is optimally maintained.
In the block containing the four Code Level 3 shared ownership dwellings alongside private flats that were not assessed using the Code, the photovoltaic system has been directly connected to the four units in order to ensure the 25 per cent improvement in dwelling emission rates is achieved for only those units. The hot water produced by the solar thermal hot water panels will be used by a single house only. Both solar technologies will contribute to reducing tenants' energy bills as well as their carbon emissions, either directly or indirectly via the housing association.

The boiler in the flats

While the performance of this development will not be monitored, the developer will be able to monitor the performance of future Code developments using Smart meters as part of a company wide agreement with an energy supplier. The developer felt this was essential to understand actual performance versus designed performance, and improve future designs, particularly where other low or zero carbon energy technologies were specified.

The developer felt that while Code Level 3 was achievable through minor changes to the specification on standard houses and flats on this development, it has been more challenging on other sites where there are different site conditions, planning requirements and local authority services. It would be more challenging to cost effectively reach Code Level 4 and above using the design and construction methods used on this site, and would probably entail a completely different approach for the energy credits.

All build systems have conventional building warranties.

WORKING WITH THE CODE FOR SUSTAINABLE HOMES

This is one of the first developments on which either the developer or the housing association has achieved Code certification.

Given that the houses and flats are based on standard houses types, there have been limited challenges to overcome by the developer to achieve Code Level 3. The site allowed the developer to gain good ecology credits due the condition of the site pre-development and planning requirements. A planning requirement for Lifetime Homes meant that all four credits within the Code were awarded, though the developer may have wished to utilise other methods of reaching Code Level 3 in this particular instance. Because the design was adapted from an existing set of plan types, the space impacts for meeting the Lifetime Homes requirements were greater than in schemes developed from scratch and equate to approximately an additional 5–10 per cent of total floor area in each unit.

The developer sought to maximise the use of cost effective design and specification to achieve Code credits, including: low energy lighting, recycling bins in kitchens, provision of drying lines in gardens and/or bathrooms, provision of home office space and the use of water butts in gardens. The credit obtained by registering the site under the Considerate Constructors Scheme (CCS) was also considered to be an easy win. However, as a CCS certificate needs to be provided at the handover of the final Code unit, the construction of the private units will not benefit from the CCS registration.

The developer felt that having an in-house Code assessor has been essential in understanding and achieving the Code status required in the most cost effective way. This has also ensured that the process of achieving design stage certification and obtaining evidence for the post-construction certification has been easier than for other developers who rely on external assessors. It has allowed a greater control over the end product and has meant that certification is not reliant on an additional third party with other commitments. The site is also located very close to head office, which has meant that site visits could be easily made to keep track of progress and any problems that have arisen.

COSTS AND VALUE

The build cost excluding land and fees was around £1050 per square meter. The developer estimated that the marginal additional cost/unit to achieve Code Level 3 was £3000–£3500 compared to a standard unit built to Building Regulations. Additional costs, such as those for training, were not specifically quantified but were absorbed into overall costs.

This project used a common build system, with which the contractor had previous experience. The developer estimated that these costs would not reduce on future developments (where the design solutions being used at Tempo are being replicated) unless the cost of items such as the solar thermal water heating or photovoltaic cells were reduced.

The homes were built for social housing purposes, and were not intended for sale. The private sale value of these properties was estimated at about £200,000 for the flats and £350,000 for the houses, equal to sales values for equivalent properties in the area.

BUYER/OCCUPANT FEEDBACK

At the time of this research, none of the units was occupied, so post-occupancy information was not available. Feedback from the London Quadrant Housing Association has been positive, and they are pleased with the final design of the units and the environmental features integrated into them.

LESSONS LEARNT

The main lessons learnt from the development have been:

- Having an in-house Code assessor is an effective way of ensuring that the Code requirements can be achieved in the most cost effective way as well as ensuring the post-construction evidence requirements can be easily collated and submitted
- Achieving the minimum mandatory energy credits for Code Level 3 typically requires the use of renewable energy generating technologies. Although the achievement of a 25 per cent reduction in dwelling emission rates is possible without using renewable technologies, this is difficult on flats and terraced units as they are already inherently energy efficient
- Solutions to achieve Code Level 3 at one development can be used on other developments. For example, the Home User Guide at Tempo can now be used as a template document on other schemes
- Building homes with lower lebels of air permeability may require additional training for on-site operatives and design teams in order to ensure that construction details are designed and built correctly

PERCENTAGE OF CATEGORY SCORE ATTAINED (0 10 20 30 40 50 60 70 80 90 100)		WHAT IS COVERED IN THE CATEGORY
ENERGY	55	Energy efficiency and CO_2 saving measures
WATER	66	Internal and external water saving measures
MATERIALS	45	The sourcing and environmental impact of materials used to build the home
SURFACE WATER RUN-OFF	100	Measures to reduce the risk of flooding and surface water run-off, which can pollute rivers
WASTE	85	Storage for recyclable waste and compost, and care taken to reduce, reuse and recycle construction materials
POLLUTION	100	The use of insulation materials and heating systems that do not add to global warming
HEALTH & WELLBEING	75	Provision of good daylight quality, sound insulation, private space, accessibility and adaptability
MANAGEMENT	55	A Home User Guide, designing in security, and reducing the impact of construction
ECOLOGY	55	Protection and enhancement of the ecology of the area and efficient use of building land

The figures above are from the post-construction certificates for the units. A range of points were achieved by different units on the development. The above table provides an example of the performance of one house on the development.

DESIGN TEAM

Contractor	**Fairview New Homes**
Developer	**Fairview New Homes**
Architect	**Fairview New Homes**
Design Consultant	**Fairview New Homes**
Energy Design Consultants	**Fairview New Homes**
Structural Engineers	**Fairview New Homes**

'This is a good example of a solution for meeting level 3 of the Code for Sustainable Homes that is relevant to mass market new housing. It utilises standard designs with modest enhancements to the performance of the thermal envelope combined with proven reliable and low maintenance solar energy technologies to achieve the minimum energy efficiency and carbon abatement requirements. There are many aspects of this scheme that can be replicated around the country where Code 3 is a planning requirement.
– Fairview Homes

CASE STUDY 8

MILLER ZERO, MERTON RISE
BASINGSTOKE, HAMPSHIRE

Code Level	Levels 1, 3, 4, 5 and 6 on site. This case study will focus on the Code Level 3 and Code Level 6 units
Development type	Five two-storey detached four-bedroom houses, private sale
Construction type	Code Level 3: Thin joint masonry walls, 90mm cavity wall insulation, timber frame mono-pitched roofs. Level 6: Storey height aircrete panels, 200mm external wall insulation and so on...
Key Sustainability Features	Code Level 3: High levels of insulation, passive solar design strategies, low water use sanitary ware, the use of environmentally benign materials, low energy lighting, cycle storage etc.
Procurement Method	Private housing, site acquired through a design competition with Hampshire County Council

INTRODUCTION

Miller Zero comprises of five houses built to five different levels of the Code for Sustainable Homes – Code Levels 1, 3, 4, 5 and 6. All homes are available for private sale and are indistinguishable in design from the other 74 homes located on the development. The site was acquired by the developer, Miller Homes, through a design competition by Hampshire County Council.

The five Miller Zero homes were built primarily as a research and development project for the developer to understand the requirements relating to the higher levels of the Code for Sustainable Homes. The site was selected as it represented a typical UK housing development. Tim Hough, chief executive of Miller Homes, commented:

'Rather than just waiting until we had to implement the Code, we decided to get a head start on understanding the cost implications alongside learning how to possibly build the homes of the future with Miller Zero. Meeting the requirements of the Code, particularly Levels 5 and 6 is a huge challenge, financially and technically. It has given us an excellent understanding of the design implications, additional costs, demands and issues that housebuilders, suppliers and contractors will face.

Miller Zero has shown that zero carbon is achievable within an active site. The next challenge is to incorporate these learnings feasibly into the every day construction of homes on a large scale.'

For simplicity, this case study focuses on the construction and technical specifications (including sustainability features) for the Code Level 3 and 6 units. However, the sections on scheme implementation and lessons learnt include information on all five units. The technical specifications for all the units are available on the Miller Homes website: **www.millerhomes.co.uk/millerzero/**

CONSTRUCTION AND BUILD SYSTEM

Despite the near identical appearance of the units, different construction and build systems were used on all the units. This included thin joint masonry for the Code Level 3 and 4 homes, structural insulted panels (SIPs) on the Code Level 5 home and storey height aircrete panels for the Code Level 6 home. The specific construction and build systems for the Code Level 3 and Code Level 6 homes are described in more detail below:

Code Level 3: The new build unit has been constructed using thin joint masonry walls containing a 90mm cavity which has been injected with glass mineral wool insulation, with the internal walls finished using standard plasterboard on dabs. The whole unit has been externally rendered and in some places cedar cladding has been used.

The floors were constructed using beam and block pre-cast floor system, covered by a 100mm thick polystyrene insulating board with a screed finish. The mono-pitched roof was constructed using timber joists, with 160mm rigid urethane insulation with low emissivity foil laid in two layers in order to achieve the required U-value.

Code Level 6: The new build unit has been constructed using storey height aircrete panels and 200mm of external wall insulation. The internal walls have been finished using wet plaster to improve airtightness. The whole unit has been externally rendered and in some places cedar cladding has been used.

The floors were constructed 300mm thick aircrete pre-cast flooring system with 110mm thick urethane insulation and a screed finish. The unit has underfloor heating with the pipework laid in the screed finish. The first floor also has under floor heating within joist void. The mono- pitched roof was constructed using timber joists, with 280mm rigid urethane insulation with low emissivity foil insulation laid in three layers, as well an insulating plasterboard layer to the internal side of the roof construction.

Biomass boiler supplying the Code Level 5 and 6 homes

SUSTAINABILITY FEATURES

Code Level 3: High levels of insulation, passive solar design strategies, low water use sanitary ware, the use of environmentally benign materials, low energy lighting, cycle storage, recycling and composting systems, the use of water butts to collect rainwater for the garden. Mechanical vent heat recovery system and an air source heat pump have also been installed.

Additional features in the Code Level 6 unit: Low air permeability, thermal mass construction, underfloor heating via biomass boiler, photovoltaic panels, rainwater harvesting system. (The air source heat pump used in the Code Level 3 unit was not included in the Code Level 6 unit.)

Sensors have been installed into the five Miller Zero carbon homes to enable the homes to be monitored for a period of 12 months after completion. The sensor will monitor energy consumption and generation as well as the humidity of the properties. In addition to this, occupiers will also be asked to complete a log and answer questions about the properties on a continuous basis throughout the year. This monitoring will enable Miller Homes, and the wider industry, understand how the homes are being used, and what homeowners' attitudes are to sustainability features.

Smart meter for electricity and gas use

TECHNICAL PERFORMANCE

External Fabric

Code Level 3: 300mm cavity wall consisting of a thin joint external brickwork skin, 90mm cavity fully filled with 90mm mineral wool insulation and an internal skin of 100mm aircrete panels. U-value of 0.29W/m^{2}K.
Code Level 6: 200mm storey height aircrete panels and 200mm of external wall insulation. U-value of 0.09W/m^2 K

Roof

Code Level 3: Timber joists, 160mm rigid urethane insulation with low emissivity foil laid in two layers. U-value of 0.18W/m^2 K.
Code Level 6: Timber joists, 280mm rigid urethane insulation with low emissivity foil laid in three layers, 52.5mm insulating plasterboard layer. U-value of 0.12W/m^2 K.

Floor

Code Level 3: Beam and block pre-cast floor system, 100mm thick polystyrene insulating board. U-value of 0.22W/m^2 K.
Code Level 6: 300mm thick aircrete pre-cast flooring system with 110mm thick urethane insulation. U-value of 0.11W/m^2 K.

Doors and Windows

Code Level 3: Double glazed low-e doors and windows. Windows – U-value of 1.7W/m2 K; Doors – U-value of 1.06W/m^2 K.
Code Level 6: Triple glazed low-e doors and windows. Windows – U-value of 0.68W/m^2 K; Doors – U-value of 0.68W/m^2 K.

Air-permeability

Code Level 3: Target was 8m³/h@50pa; achieved 5.41m³/h@50pa in testing.
Code Level 6: Target was 1.5m³/h@50pa; achieved 1.48m³/h@50pa in testing.

SCHEME IMPLEMENTATION

The five Code homes are indistinguishable in design from the other new homes on the development, but are contemporary in style compared to other homes in the area. The internal specifications of the homes are very similar, and much of the technology installed will not be visible to the occupier. As the site had been acquired through a design competition, the overall design of the site and homes was supported by the local authority.

The design of the homes and their position on the site had already been established before it was decided to build to the Code. This was a deliberate decision by the developer who felt that retaining the existing design of house types on the site would provide a better learning experience from the research and development project, on the basis that it would be harder to comply with Code requirements with 'non code designed' house types. Given that the developer was building five different units using different construction and build systems and differing sustainability specifications, a number of issues were encountered during the design and construction process. There were some issues associated with fitting certain build systems to the pre-defined design (notably the SIPS panelling system on the Code Level 5 units). The developer felt that while this was an issue on this site due to working with a predefined design for the dwelling, it could easily be overcome if the units had been designed to work with the SIPS panel system and complied with the Code from the outset.

The developer also encountered some issues with the mono-pitched roof, both in terms of the internal design (which meant there is a noticeable step between the external walls and the roof in two of the bedrooms) and in terms of airtightness performance. The issues of airtightness were overcome by wet plastering and using a membrane in the Code Level 5 house to cover the steel work used to support the SIPS panelling system.

A variety of renewable energy systems have been installed in the five units including: photovoltaic panels and biomass boiler (in the Code Level 5 and Code Level 6 units); ground source heat pump (Code Level 4); air source heat pump (Code Level 3). This was a conscious decision by the developer in order to understand how to install the technologies and how these work in practice. However, the developer did question whether some of the technologies that need to be installed to achieve Code Levels 5 and 6 are practicable on a small scale, and whether encouragement of more site or community based systems would be a more effective way of delivering energy. While the decision to build the units to the Code was supported by the local planning authority, an initial application to install a communal small scale vertical axis wind turbine was refused.

The developer also encountered some issues with sourcing the products required to meet the higher levels of the Code such as highly thermally efficient windows. They highlighted that the supply chain will need to be much further developed and aware of the required standards if the industry is to deliver higher levels of the Code at mass scale. Close collaboration will be essential.

WORKING WITH THE CODE FOR SUSTAINABLE HOMES

This is the first scheme in which the developer has achieved Code certification above Code Level 3. The developer felt that in terms of changes in design, the biggest challenge come when moving from Code Level 4 to Code Levels 5 and 6, due to a number of factors including the inclusion of a greater amount of renewable energy, more water efficient technologies and greater airtightness.

The developer also felt that the inherent features of the site play a key role in the achievability and cost of achieving higher levels of the Code (most notably Code Levels 5 and 6). For example, if a developer is easily able to achieve the ecology credits or the flood risk or surface water run-off credits, then this will allow more scope to decide how the other credits are achieved by the house design. As the layout and design of the units had already been determined, certain features were installed primarily to achieve Code points. The developer felt that this box ticking approach was not beneficial and that ideally features should be designed in from the outset in order to deliver real benefits on the site. There can also be issues associated with site wide credits if the homes being assessed against the Code are only one phase of a much larger development, particularly in associating achievements made across the whole development with only one part of the site. Through this project the developer has gained a better understanding of the design implications associated with high level Code compliance and has also found that this is not always straight forward. It became apparent that compliance with one area of the Code could often present conflicts of difficulties in complying with another part of the requirements, and very often a compromise had to be reached.

COSTS AND VALUE

The build cost excluding land and fees was around £985/m² for the Code Level 3 unit and £1423/m² for the Code Level 6 development. The costs on this site were higher than on a more 'traditional' site due to the bespoke design and specification for the development. The Code Level 3 unit cost around £4500 more to build than a standard unit on the site built to Building Regulations, while the Code Level 6 unit cost around £50,000 more to build than a standard unit.

The units are currently on sale ranging from £305,950 for the Code Level 1 unit to £339,950 for the Code Level 6 unit. While the developer is selling the units at a premium, which increases in relation to the level achieved, this premium is still less than the cost required to achieve the specification, particularly at higher code levels.

BUYER/OCCUPANT FEEDBACK

The units have reached practical completion. All units were launched on the market in September, and are awaiting sale. So far, there has been a lot of interest in the units from potential customers, with very positive feedback on their environmental attributes.

Living room

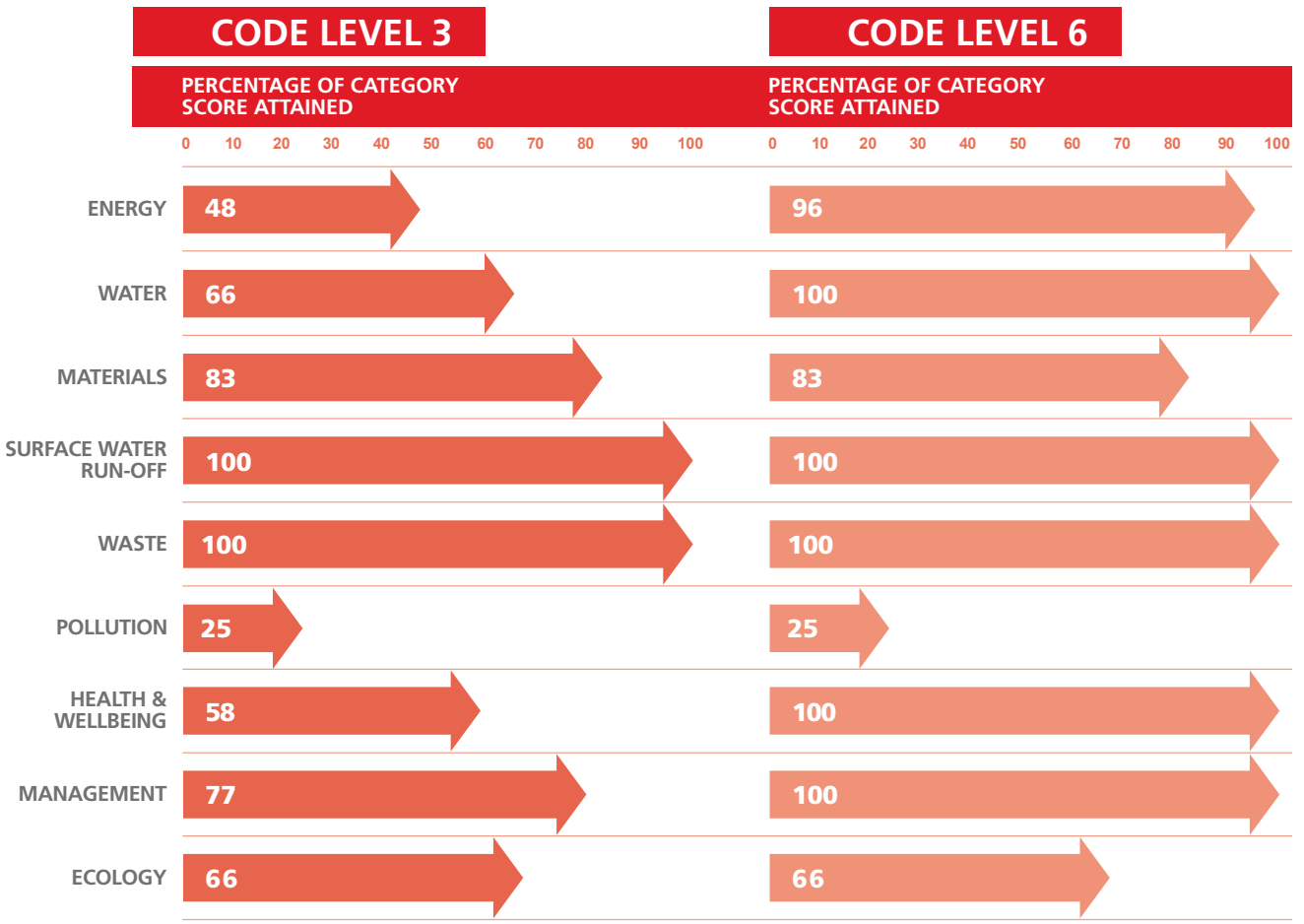
To ensure the correct use of all the sustainability features in the units, a detailed Home User Guide has been developed for the future residents. Pre and post-occupancy monitoring will be undertaken (see sustainability features). Residents are also being supplied with Smart meters so that they are able to monitor energy usage within their own home and understand how much energy the units are generating (where renewable energy technologies have been installed). Feedback will also be sought from residents on their views of the homes and the features installed.

The developer highlighted that one of the marketing challenges faced on the development is that the Code Level 1 unit has a higher SAP rating than the Code Level 3 or 4 units. This is primarily due to the provision of gas heating in the Code Level 1 home and electric heating in the Code Level 3 and 4 units. While the carbon emissions associated with the Code Level 3 and 4 units will be lower than the Code Level 1, the expected costs are higher due to the fuel factors used in the SAP calculations. The developer feels that this means they will have to provide a technical explanation to customers for the reason behind this, which is not a simple message to sell.

LESSONS LEARNT

The main lessons learnt from the development have been:

- Delivery of Code Level 5 and 6 developments required high levels of commitment and a good working relationship between all partners, including the supply chain
- The research and development used at one project can be used to ensure the deliverability and cost effectiveness of future schemes
- Monitoring the actual performance of homes against design specification is crucial in understanding the success of exemplar schemes in achieving their aspirations. Such research will also enable the construction industry to understand how to develop all levels of Code homes at a mass market scale.
- Occupants must be given detailed information on how to use the home correctly (both at handover and through a Home User Guide) in order to ensure that the home operates to the same level of performance as it was designed
- Retrofitting the Code to developments that have already been planned can make it more challenging to deliver solutions both technically and cost effectively
- It is possible to design homes which meet different levels of the Code that to the customer would be practically indistinguishable in design



WHAT IS COVERED IN THE CATEGORY

Energy efficiency and CO_2 saving measures

Internal and external water saving measures

The sourcing and environmental impact of materials used to build the home

Measures to reduce the risk of flooding and surface water run-off, which can pollute rivers

Storage for recyclable waste and compost, and care taken to reduce, reuse and recycle construction materials

The use of insulation materials and heating systems that do not add to global warming

Provision of good daylight quality, sound insulation, private space, accessibility and adaptability

A Home User Guide, designing in security, and reducing the impact of construction

Protection and enhancement of the ecology of the area and efficient use of building land

DESIGN TEAM

Contractor	**Miller Homes**
Developer	**Miller Homes**
Architect	**Fraser Brown MacKenna Architects/Miller Homes**
Energy Design Consultants	**BRE**

The figures above are from the design stage assessment and are subject to final approval/certification.

CASE STUDY 9

ONE EARTH HOMES, UPTON
NORTHAMPTON, NORTHAMPTONSHIRE

Code Level	Level 6
Development type	Six terrace units, two-storey three-bedroom houses, two rental, four shared ownership
Construction type	Off-site manufactured glulam timber frame, in-filled with a secondary timber studwork
Key Sustainability Features	High levels of insulation, low air permeability, passive solar design, thermal mass construction, district heating via a wood pellet boiler, photo-voltaic panels, solar thermal hot water
Procurement Method	Housing association development procured by standard procurement method

INTRODUCTION

The One Earth Homes are six houses located on the Upton development (large scale, multi-developer site), three miles outside of Northampton town centre. These houses are the UK's first certified, open-market, Code Level 6 homes.

The One Earth Homes form part of the first phase of the Metropolitan Housing Partnership's activities on the Upton development, during which 345 homes will be built. Plans for the whole development include around1380 units, a primary school, a local centre with retail; offices; a public house; café and restaurant, a medical centre and a nursery.

The proposals for Upton began in 2001, when a consortium of stakeholders including English Partnerships (the landowner), NBC and the Princes Foundation drew up a strategy for Upton to demonstrate and promote sustainable urban growth. The strategic plan for the whole development was drawn up through extensive consultation with stakeholders, with sustainability forming a key part of the design code for the development. The masterplan for the site included requirements for all units to be built to EcoHomes Excellent. The development of the Code Level 6 homes was made possible through the partnership between the Metropolitan Housing Partnership and Homes and Communities Agency (formerly English Partnerships and the Housing Corporation) to grant fund the affordable homes and contribute to the build costs.

HCA Chairman, Robert Napier, said:
'The Code Level 6 status at Upton is testament to HCA's work in supporting developers to incorporate sustainability throughout the entire building process from drawing board to final development. This includes design, materials used, construction methods adopted and other environmental components such as water usage and waste generation.'

CONSTRUCTION AND BUILD SYSTEM

The new build units have been constructed from off-site manufactured glulam timber frame, in-filled with a secondary timber studwork creating a 300mm insulated cavity for super mineral wool insulation. This provides a layer of insulation which is three times the thickness found in a standard house. The whole building is wrapped in a breather membrane that keeps the building airtight but allows any moisture out. The membrane is covered and protected by a lightweight rain screen. The box roof was constructed in a similar way to the walls with a glulam timber frame in-filled with mineral wool insulation. This was covered with a breather membrane and a further layer of mineral wool insulation.

Pre-cast eco-concrete panels were used for the walls and ceilings, and waxed slabs laid on the floors to create the high thermal mass. The floor was constructed using glulam joists in-filled with mineral wool insulation. This was covered with waxed slabs laid on an acoustic mat and plywood.

Site during construction

SUSTAINABILITY FEATURES

As well as highly insulated walls, roof and floor and low air permeability, sustainability approaches and features incorporated into the scheme include passive solar design strategies including a sunspace, awning for shading and passive heat recovery ventilation, thermal mass construction, district heating system via a wood pellet boiler, an array of photovoltaic panels, solar thermal panels, the use of low energy white goods (in some units), low water use sanitary ware, the use of environmentally benign materials, low energy lighting, rainwater recycling, green sedum roof, recycling and composting system.

A sunspace used to enhance passive solar gain

Sensors have been installed into three of the six One Earth Homes to enable the energy consumption and generation to be measured. Metropolitan Housing Partnership is currently working with the University of Northampton looking to monitor a range of factors in the One Earth Homes including:

- Electricity consumption of different electrical circuits in order to identify if there is excessive use, monitored using sub-metering
- Roof level irradiance as well as wind speed and direction to validate renewable technology performance, monitored using a weather station
- Energy generated from the solar thermal array and consumption from the district heating wood pellet circuit, monitored using heat meters
- Back-up immersion heater use by occupant, monitored using amp meters
- Space temperatures within living room, single bedroom and at high and low level within the sunspace

The properties which are being monitored will be supplied with Smart Meters, which have a visual display so that occupants can monitor their own energy consumption. These meters are for occupants use only and do not form part of the external monitoring.

Bill Payne, Chief Executive of Metropolitan Housing Partnership says:
'This is a wonderful achievement; however, all these efforts will be of limited value if we do not learn from these innovative homes. We are committed to working with the residents to discover what works best for them and the environment by close monitoring in the short, medium and long term.'

TECHNICAL PERFORMANCE

External Fabric

The development was constructed using a glulam timber frame shell with 300mm of mineral wool insulation, eco-concrete panels and a breather membrane. U-value of 0.15W/m^2 K.

Roof

Glulam timber frame in-filled with 250mm mineral wool insulation. This was covered with a breather membrane and a further layer of 50mm mineral wool insulation. U-value of 0.10W/m^2 K.

Floor

Glulam timber joists in-filled with 300mm mineral wool insulation. This was covered with waxed slabs laid on an acoustic mat and plywood. U-value of 0.12W/m^2 K.

Doors and Windows

Double glazed, low-e windows and doors. U-value of 0.66W/m^2 K.

Air-permeability

The test results were 2.7m^3/h@50pa.

SCHEME IMPLEMENTATION

The One Earth Homes were built using the RuralZED housing system and incorporates similar elements of design that can be seen at other ZEDFactory developments (eg BedZED, BowZED). The vision for the site was to demonstrate that it is possible to combine sustainable technology with good design. The scheme required high levels of commitment and a good working relationship between all partners.

The houses were designed to be extremely energy efficient, having been designed to take advantage of solar gain and thermal mass. Renewable technologies also formed a key part of the strategy of the site in order to reach the Code Level 6 energy requirements and were designed to include solar panels and photovoltaic panels.

Specialist contractors were used to install the passive ventilation system and photovoltaic and solar thermal panels. Although this meant that the installation of these features was smooth, there are questions about whether there may be maintenance and repair problems in the future for their standard maintenance contractor.

The original energy strategy included the provision of wind turbines on four of the units. However, issues around performance have resulted in the turbines being removed and replaced with additional photovoltaic panels to ensure the energy needs could be met.

The One Earth Homes with the planned wind turbines before their removal

A wood pellet boiler provides heat to a number of homes on the development, as well as the six Code Level 6 homes. An additional sensor has been fitted to the hopper to recognise when wood pellets are running low to eliminate the risk of running out.

Overall, the project helped highlight the advantages of environmental technology for occupiers, such as low fuel bills, and is a key part of the housing association's wider commitment to tackle fuel poverty. The lessons learned from the development of the One Earth Homes will help future plans to build even better zerow carbon homes.

WORKING WITH THE CODE FOR SUSTAINABLE HOMES

The whole Upton scheme has been designed to high levels of energy efficiency and was committed to EcoHomes Excellent across the whole site prior to the planning and development of the six One Earth Homes.

An accredited assessor was appointed to carry out a full Code assessment. Upgrading the homes from EcoHomes Excellent to Code Level 6 required:

- additional photovoltaic and solar panels to provide renewable energy
- rainwater harvesting system for the recovery of non-potable water
- additional clothes drying facilities
- a composting system
- changing of the lights in the kitchen to LEDs

Of the Code requirements, achieving the energy requirements provided the most challenges, particularly in relation to the installation of renewables (see previous section on Scheme Implementation).

COSTS AND VALUE

The extra over costs to uplift the homes from EcoHomes Excellent to Code Level 6 was £159,000, which equates, approximately, to £26,500 per unit. Funding for the affordable housing of £140,000 was received for the affordable housing (three units) from the Homes and Communities Agency. A further £22,500 was provided from English Partnerships towards achieving the Code for Sustainable Homes Level 6.

The private units have not yet been marketed and the sales price is yet to be determined. However, it is not expect there will be a substantial premium for the Code Level 6 homes over and above an equivalent home.

BUYER/OCCUPANT FEEDBACK

The units have reached practical completion and are awaiting occupancy by tenants. The three private units are to be launched to market in the near future.

Pre and post-occupancy monitoring will be undertaken (see sustainability features). Residents living in monitored units are also being supplied with Smart meters so that they are able to monitor energy usage within their own home.

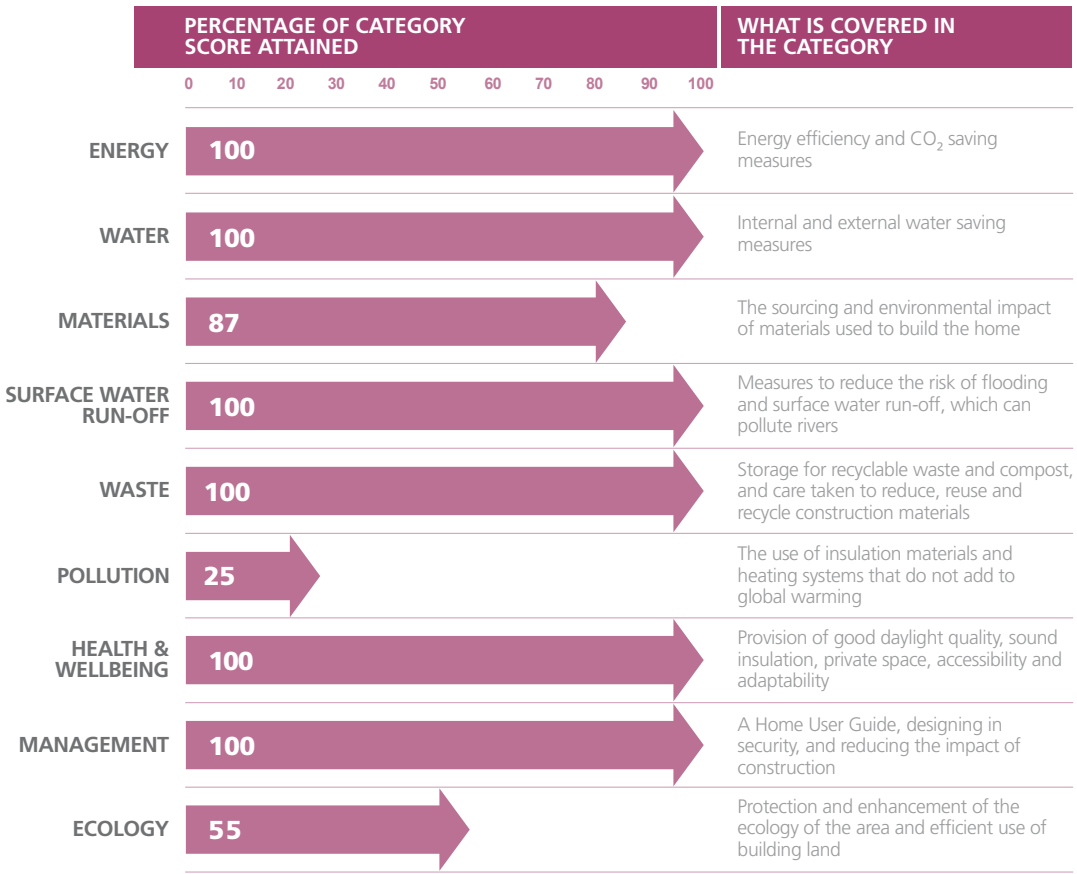
To ensure the correct use of all the sustainability features in the units, a detailed Home User Guide has been developed for the future residents.

LESSONS LEARNT

The main lessons learnt from the development have been:

- Passive technologies (such as increased insulation, passive ventilation and solar gain) should be considered before mechanical technologies. These established technologies do not require specialised regular maintenance, have no high tech control panel and more than often are unnoticed by the resident
- Delivery of Code Level 6 developments required high levels of commitment and a good working relationship between all partners
- It is important that evidence is gathered for the post-construction certification as early aspossible during the construction process
- The use of specialist contractors for design and installation of sustainable technologies (particularly renewables) can be beneficial to ensure successful delivery, but future maintenance and repair must be considered

- Shared heating systems can be a practical and cost effective solution
- Monitoring the actual performance of homes against design specification is crucial in understanding the success of exemplar schemes in achieving their aspirations. Such research will also enable the construction industry to understand how to develop Code Level 6 homes at a mass market scale.
- Occupants must be given detailed information on how to use the home correctly (both at handover and through a Home User Guide) in order to ensure that the home operates to the same level of performance as it was designed



DESIGN TEAM

Contractor	**Mansell Construction Services Limited**
Developer	**Metropolitan Housing Partnership**
Architect	**Bill Dunster Architects ZEDFactory Ltd**
Energy Design Consultants	**Arup**

The figures above are from the post-construction certificates for the units. A range of points were achieved by different units on the development. The above table provides an example of the performance of one house on the development.

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