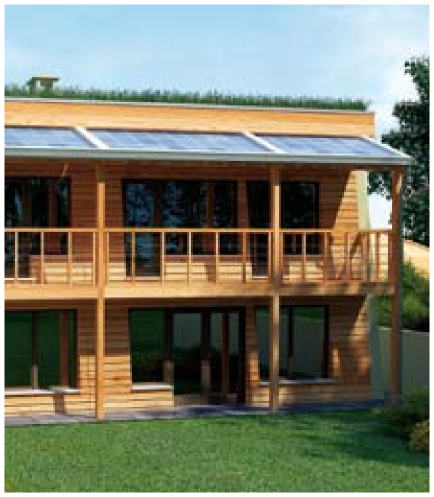
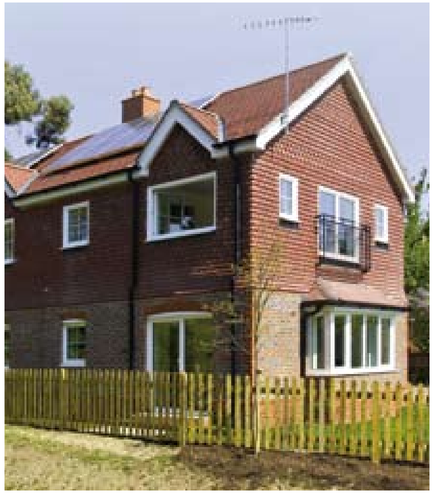
THE CODE FOR SUSTAINABLE HOMES

Case studies

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
- Heath 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.

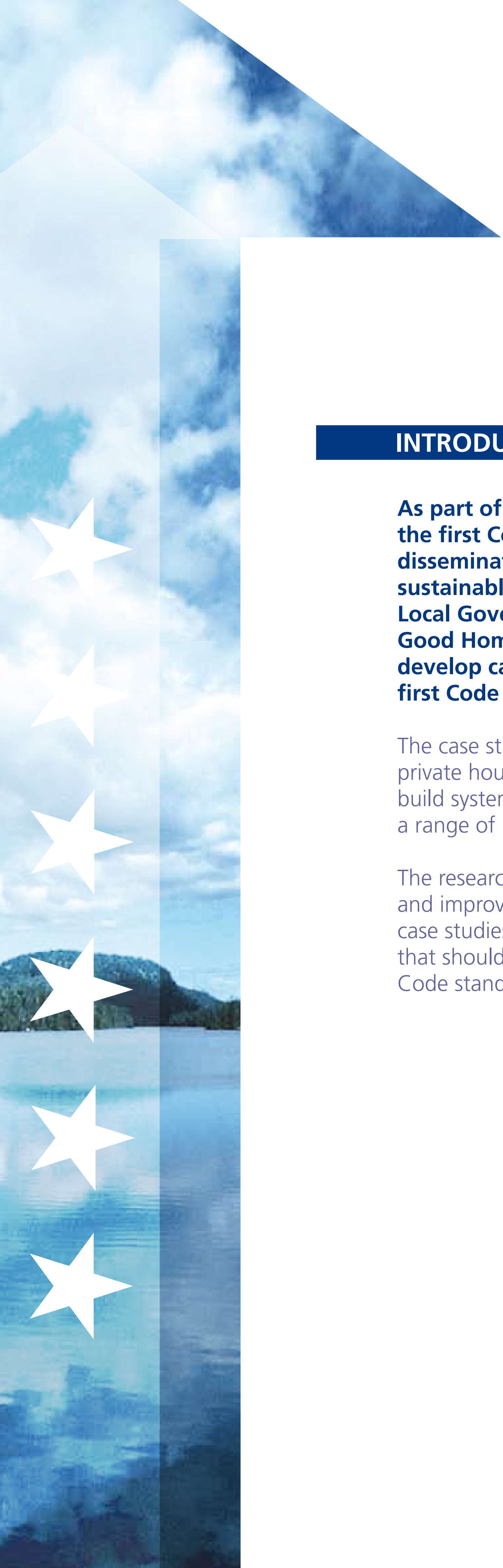
One star is the entry level – above the level of the Building Regulations; and six stars is the highest level – reflecting exemplar development in sustainability terms.

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 process of learning from the first Code developments and to disseminate information about building sustainable homes, Communities and Local Government commissioned the Good Homes Alliance to research and develop case studies on some of the first Code homes built.

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

The research has helped to 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:

- Stawell, rural private housing to Code level 5 by ECOS Homes
- CO2 Zero, urban private live-work units to Code level 5 by Logic CDS Ltd
- Mid Street, semi-rural social housing to Code level 5 by Raven Housing Trust
- Norbury Court, urban social housing to Code level 3 by Staffordshire Housing Association

All the projects included within this study were small scale sites, consisting of between 2 and 22 properties, but they covered a range of building types, including:

- Detached and terraced homes
- Flats and apartments
- Live-work units

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

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

CONSTRUCTION AND BUILD SYSTEMS

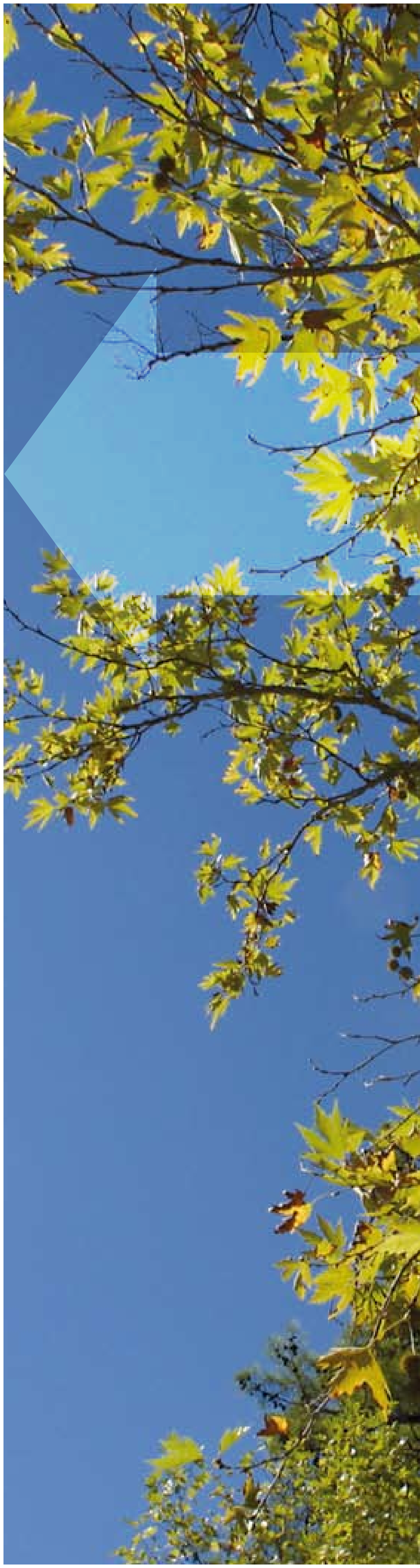
The sites in this report represent a range of build systems and construction processes that might be adopted by other developers at all scales and sizes:

- 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

A number of other projects that had used the Code as part of their development process were also examined. Although these were not yet formally certified as Code homes, they showed that Code standards could also be achieved using other build systems, such as:

- Unfired, insulating clay blocks, with or without external insulation
- Timber frame with pre-cast concrete panels

The projects included within this study represented the first time each developer had adopted the Code for Sustainable Homes. In most cases, the build systems were prototypes and were used as opportunities to learn about the new skills and design processes required to work with the Code. In other cases, more standard build systems such as 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.



WORKING WITH THE CODE FOR SUSTAINABLE HOMES

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

Some of the developers had 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 to meet formal funding or planning requirements. Others were built by eco-developers who had initially designed the sites to meet the EcoHomes standard, and then subsequently adapted them to meet the Code requirements. Unsurprisingly, those projects that planned to build Code homes from the outset found it easier to meet the Code requirements in reality, as there are significant differences between the Code and previous standards.

Other projects that had used the Code as a design or planning tool or had undertaken a full or partial assessment were also considered as potential case studies, but as they have not been formally certified, could not be included as Code-compliant homes.

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- and water-efficient buildings. Most of the projects focused on a high-quality, highly insulated building shell 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.

Many of the projects had incorporated metering equipment and had developed plans for future post occupancy monitoring, which will help to 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 level achieved: low-e double or triple glazing, and wall U-values ranging from 0.10 W/m^2 K at Code Level 5 to 0.29 W/m^2 K at Code Level 3. Air-permeability test results were also in line with expectations, ranging from 1.7 m^3/h@50pa at Code level 5 up to 5.63 m^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 time. 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, all 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 the Code requirements, although all the projects built this way were aiming for Code Level 3, 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 water heating 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 the design aesthetic. Some were required to adopt a 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

The build costs, excluding land costs and fees, ranged from £950 to £1,850 per square metre. It is very difficult to find a benchmark figure against which these can be compared, as the costs vary so much by building type, the standard of finish, the target market etc. However, the developers who had similar schemes with which to compare estimated that this equated to an uplift of about 15% over standard build costs.

This 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 the developers had recorded or identified these costs separately. Most of the developers 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 be able to reduce the additional costs on their next and future projects, as the requirement for additional research, training and development would be reduced, and the supply chains for the products and systems would become better developed and more sophisticated. In addition, they also reported that they should be able to achieve greater build efficiencies through better integration of the sustainability requirements within the design, and through greater focus on buildability of the design details.

The sales values of most of the properties compared favourably to equivalent sales prices in the local area, with increased values of approximately 10% being suggested, although it was difficult to obtain exact comparisons against equivalent new build properties, and the figures were further distorted by recent difficult market conditions. One of the developers, however, suggested a reduced sales value compared to equivalent local properties, but it was not clear whether this was due to the sustainability credentials or buyer preferences for a local vernacular in that particular location.

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/apartments 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.

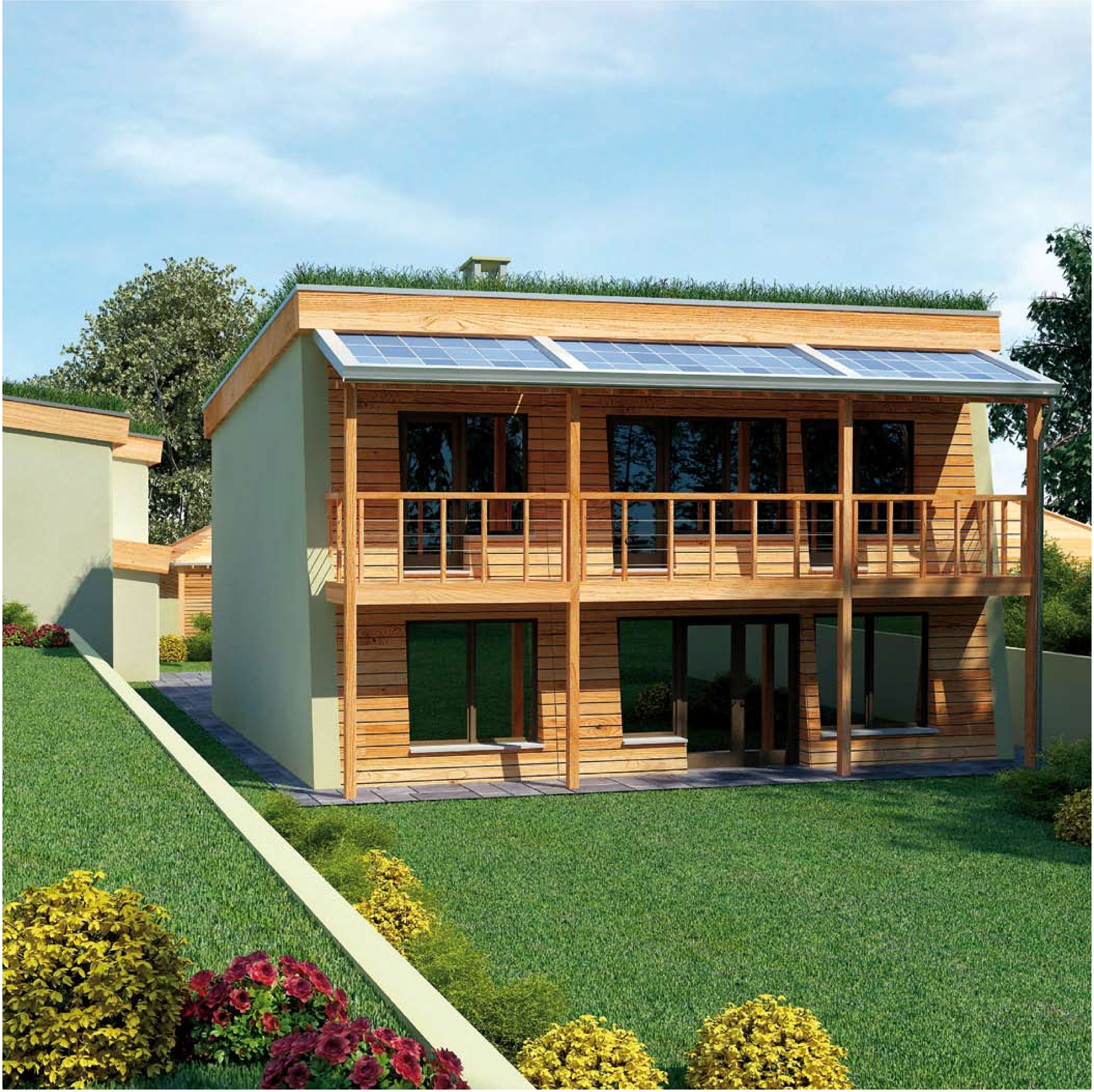
However, it has taken time for those involved to become familiar with the assessment and certification process, which has led to uncertainty, increased costs, and delays in completion of certification.

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

- A high-quality, highly insulated 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
- 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.

And, finally, it seems that there is a cost premium associated with achieving Code requirements, currently estimated at about 15% including training costs which should reduce on future projects. Equally, the sustainability performance of Code homes may generate a value premium, possibly about 10%, although this needs further investigation and verification.

Digital Image by Blue Edge



CASE STUDY 1

THE OLD APPLE STORE

STAWELL, SOMERSET

CSH Level	Level 5
Development type	Private housing, 5 units, detached & terraced residencies
Construction type	Glulam Frame with Orientated Strand Board (OSB)
Key Sustainability Features	Photovoltaic cells, solar thermal water heating, passive solar design, wood pellet boilers, rainwater harvesting
Procurement Method	Private housing procured via standard method of procurement

INTRODUCTION

The Old Apple Store site is a project being built by Pippin Properties Ltd, a joint venture between the landowners and award winning developers Ecos Homes Ltd with Ecos managing the build.

The project was originally designed to meet the criteria for Ecohomes Excellent, although the final target was to achieve Code Level 5. The overall vision was to produce an added value sustainable development constructed from low impact materials and components.

This development is for five new family homes and sits within the grounds of the Old Apple Store in Stawell, Somerset. An additional existing unit on the site is being retained and completely refurbished.

Of the five units, two are four bedroom houses with the other three making up a terrace of three bedroom units. The project was due for completion in early 2009.

CONSTRUCTION AND BUILD SYSTEM

The new build units are being constructed from off-site manufactured timber and Orientated Strand Board (OSB) cassettes with glulam beams used where possible in place of steel.

The insulation between the timber studs was recycled newspaper and the external insulation was woodfibre boards, which wrapped the complete building envelope. This was then rendered with mineral render and clad in baked soft wood. Sheep's wool insulation was used for inter-floor insulation.

Installation of the cladding

SUSTAINABILITY FEATURES

Sustainability approaches and features incorporated into the scheme include photovoltaic cells, solar thermal water heating, passive solar design strategies, rainwater harvesting, the use of more environmentally benign materials, high levels of insulation and low air-permeability, low energy lighting and wood pellet boilers, together with the incorporation of metering and plans for future post occupancy monitoring.

Installation of rainwater harvesting system

TECHNICAL PERFORMANCE

External Fabric

The development was constructed with a thermally efficient timber cassette shell that was considered replicable for future projects. U-value of 0.14W/m^2 K

Roof

Engineered 'I' beams were used, filled with recycled newspaper insulation with 100mm woodfibre with OSB top and bottom and an internal vapour control layer to the underside of the OSB. U-value of 0.12W/m^2 K

Floor

The ground floor was constructed from concrete planks with 150mm foam insulation under a 50mm screed with 50mm edge upstands. U-value of 0.15W/m^2 K

Doors and Windows

Windows were triple-glazed FSC certified with U-values of 1.2W/m^2 K. External doors U-value of 1.1 W/m^2 K

Air-permeability

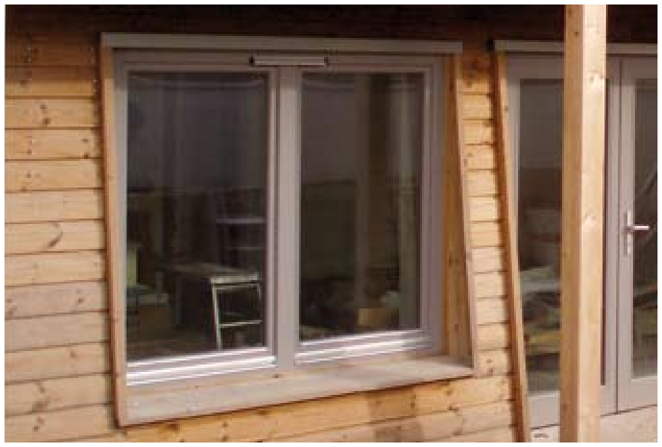
The target was 3m^3/h@50pa but tests have shown improvements upon this with two of the houses achieving 2.57 and 2.17m^3/h@50pa respectively.

SCHEME IMPLEMENTATION

The project was carried out using standard procurement methods, although the developer also took the role of main contractor for the first time on this project.

The complex design of the architecture did not aid the build process and made it more difficult to achieve low air-permeability. In addition, many of the build systems and technologies were being trialled on this project for the first time. It was considered that in the future the use of specific build systems should be integrated with the architecture from the earliest design phases so that site construction complications could be avoided. The developer also stated that in order to achieve the same quality more economically, future designs would need to be more build friendly and a greater emphasis would also be required to resolve design details from the start of a design.

Rear façade showing complex geometry



The use of this specific build system was something new for the developers and was chosen primarily in relation to U-values, energy performance and environmental impact of materials. Demonstrations of the system were viewed in operation and manufacturer's representatives visited and were in close contact with the design team. However, given the complexity of meeting level 5 of the Code, the developer considered that in future it would be appropriate to invest significantly more time scrutinising the implications of any new systems being used for construction prior to the start of a project.

In the case of the photovoltaic cells (PVs), the roofs of the houses were not originally designed with the optimum orientation to accommodate them. The PVs were therefore installed on the car port, which created ownership and deed issues.

COST AND VALUE

The build cost, excluding land costs and fees, was £1,375 per square metre, which the developer estimated was higher than standard expectations. Ecos is a 'young' developer so there was no precedent which could be used to directly compare costs for this type of development.

The developer attributed the perceived increase in build costs per square metre to:

1. the prototype nature of the development, which was used to learn about the adoption of new systems and approaches.
2. taking a new role as main contractor for the first time on this project.
3. additional costs for renewable energy and low carbon heating systems required to meet Code Level 5.

In terms of prototype costs, the construction and installation techniques required for many of the build systems, design details and sustainability features presented significant learning curves. In future the developer anticipated that per square metre build costs would be reduced if the same build systems and technologies were used.

Specific additional costs, such as for training, were not quantified but were absorbed into overall costs. Since the construction involved the transition of the developer to main contractor during the build process this meant that records of such costs were also complex to obtain. However, the developer estimated approximate additional costs of £170 per square metre for the water management and renewable energy systems required to meet Code Level 5.

The sales values of the properties were between £275,000 and £399,000, or £2,238 – £2,615 per square metre, which compares to sales prices in the local area for existing stock of about £2,045 per square metre.

BUYER/OCCUPANT FEEDBACK

At the time of this research, three of the properties had been sold off plan and none were occupied, so in depth post occupancy information was not yet available.

The properties were marketed specifically to those interested in sustainable/environmental design criteria and this was a key consideration for those who have bought the properties so far. The aim to achieve the target of Code Level 5 was used as a specific marketing feature, as were all the sustainable features, all of which attracted considerable interest.

Those who bought the properties reported that they were interested in their environmental credentials and the potential reduced energy and water use costs. They were also interested in buying 'homes' which they could inhabit for a long period of time.

LESSONS LEARNT

The main lessons learnt from the development have been:

- Designing for compliance with Code Level 5 or 6 requires a holistic approach to design and a very detailed knowledge and careful consideration of CSH criteria at the earliest design stage
- Design detailing for the Code can be time consuming and labour intensive if the overall design concept is complex
- The administration of the Code process should be considered from the outset of a project and suitable systems implemented with contractual obligations for suppliers/contractors to provide information relevant to the agreed design and construction programmes
- Assembling and educating a dedicated construction team is essential to meeting the challenges of higher level Code developments, particularly when new materials and construction methods are being used

	PERCENTAGE OF CATEGORY SCORE ATTAINED	WHAT IS COVERED IN THE CATAGORY
ENERGY	97	Energy efficiency and CO_2 saving measures
WATER	100	Internal and external water saving measures
MATERIALS	100	The sourcing and environmental impact of materials used to build the home
SURFACE WATER RUN-OFF	50	Measures to reduce the risk of flooding and surface water run-off, which can pollute rivers
WASTE	100	Storage for recyclable waste and compost, and care taken to reduce, reuse and recycle construction materials
POLLUTION	25	The use of insulation materials and heating systems that do not add to global warming
HEALTH & WELLBEING	58	Provision of good daylight quality, sound insulation, private space, accessibility and adaptability
MANAGEMENT	100	A Home User Guide, designing in security, and reducing the impact of construction
ECOLOGY	67	Protection and enhancement of the ecology of the area and efficient use of building land

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

DESIGN TEAM

Contractor	**Ecos Homes**
Developer	**Pippin Properties**
Environmental Design Consultants	**Brookes Devlin**
Architect	**Malcolm McAll**
Design Consultant	**O2i Design**
Engineers	**John Beverage /Ellis & Moore**

'We are obviously setting our stall out at code 5 which I think had a tangible effect on drawing the buyers. Even if they initially didn't understand the rating, this benchmark set the development at a measurably high standard' – Ecos Homes

'We were interested in the low energy bills and buying a "home" in which we could live for a long time' – Buyer who bought one of the properties off plan

All photographs for the Old Apple Store case study, with the exception of the digital image, supplied by Ecos

CASE STUDY 2

CO2 ZERO

BRISTOL

CSH Level	Level 5
Development type	9 two- bedroom, three storey live-work units
Construction type	Solid cross laminated timber panels with external insulation and render. Aluminium sheet roof with upstand seam and curved profile
Key Sustainability Features	Passive solar design, low flow rate sanitary ware, rainwater recycling, low energy LED lighting, PV array, biomass pellet boiler, low energy rated white goods, FSC timber, green roof and MVHR
Procurement Method	Private housing, standard method of procurement with the developer acting as contractor

INTRODUCTION

CO2 Zero is a development of nine, three storey live-work units located in Wilder Street in the heart of Bristol. The development has been constructed on a brownfield site on the location of an old car park in a built-up area of the city by developer/contractor Logic CDS Ltd.

This Code Level 5 development is made up of individual units each containing a two-bedroom duplex flat over a ground floor office/work space. The developer sought to achieve high environmental standards and to generate the maximum amount of renewable energy from within the site boundaries as practicable, creating an as near zero-carbon development as possible for heating, lighting and ventilation. It is the first private residential development in the UK and the first live-work development to reach Code Level 5.

Achievement of a high Code level meant that the developer had to carefully consider all aspects of the Code from the start of the project.

'Powering down "does not mean deprivation, or a return to the hardships of the past. It does however entail a thorough overhaul of attitudes towards energy consumption"'. Paul Warren-Cox (Developer)

CONSTRUCTION AND BUILD SYSTEM

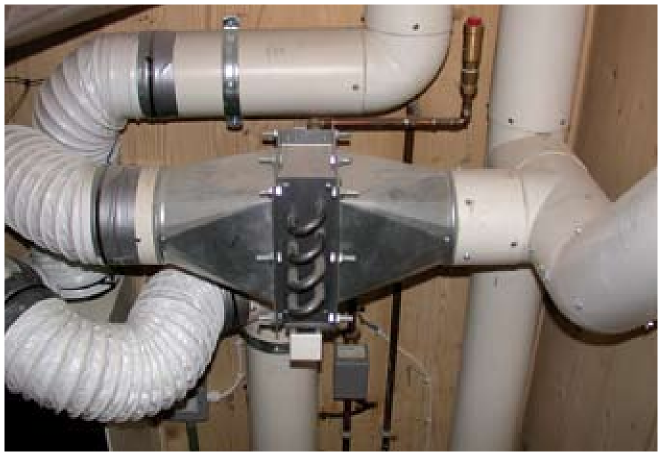
The new build units have been constructed using pre-fabricated solid cross timber laminated panels with external insulation and render. The walls are rendered with modified polymer long life render finishes. The workspace 'shopfront' uses galvanised sheet facings and sign/shutterbox fascias.

The roof is aluminium sheet, upstand seam, curved profile with aluminium powder coated gutters and flashings. Rooflights are triple glazed highly insulated units complete with weather and draught seals. Windows are timber, thermally broken frames with triple glazed units using insulated perimeter seals, with the exception of large shop-front windows on the ground floor, which are double-glazed with thermally broken frames. External doors are fully insulated and weather stripped. All timber is FSC certified from responsible and sustainable sources.

The development in construction

SUSTAINABILITY FEATURES

MVHR heater coil



As well as highly insulated walls and roof, high performance windows and low air-permeability, the sustainability approaches and features incorporated into the scheme include passive solar design strategies, rainwater harvesting, a green roof on the plantroom, the use of environmentally benign materials, high levels of insulation and low air-permeability, low energy LED lighting, an array of PV panels, the use of low energy rated white goods, triple-glazed windows, a biomass pellet boiler and MVHR (Mechanical Ventilation with Heat Recovery) incorporating a heater coil for space heating. This system includes for weather compensated control.

TECHNICAL PERFORMANCE

External Fabric

Solid cross laminated timber panels with 290mm mineral fibre bat external insulation. U-value of 0.10W/m^2 K

Roof

Aluminium sheet, upstand seam, curved profile with 200mm mineral wool plus 100mm foam sheet insulation.
U-value of 0.10 W/m^2 K

Floor

50% 99BS concrete slab with 165mm foamed sheet insulation and FSC raised timber floor. U-value 0.10 w/m^2 k

Doors and Windows

Roof-lights (U-value 1.1W/m^2 K) and duplex windows (U- value 0.70W/m^2 K) are triple-glazed, low–e windows with thermally broken frames. Shop front windows are double-glazed with thermally broken frames (U-value of 1.2W/m^2 K). Doors are fully insulated, in thermally broken timber frames with U-value of 1.0W/m^2 K when unglazed and 1.4W/m^2 K with vision panels.

Air-permeability

Test results were 1.2m^3/h@50pa for the first complete dwelling.

SCHEME IMPLEMENTATION

The units were constructed from a build system that is seldom used in the UK. As the developer/contractor had not previously used this system, they undertook considerable research into the potential for its application, including a visit to a recently completed UK building. No specific further training was undertaken by the main contractor before its installation.

The tight dimensions and limitations of the site presented particular difficulties and constraints, especially in relation to provision of amenity space, installation of renewable energy technologies and the daylighting requirements.

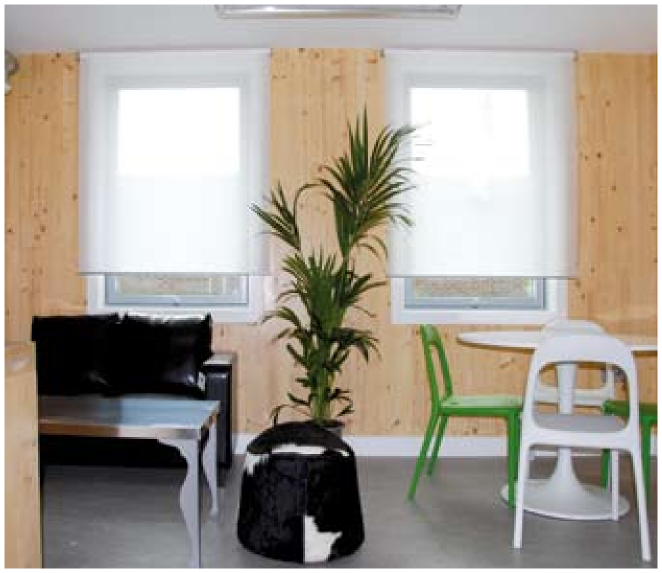
The development met with some initial problems in the planning phases because of the potentially conflicting requirements of the credits chosen, such as spatial requirements for lifetime homes and wheelchair access on a constrained site. These problems were resolved as the project progressed. Both Planning and Building Control Officers were very supportive and enthusiastic about the project.

The use of a new build system did cause some problems, particularly in relation to insulation detailing, since the implications of the thickness of external insulation were not fully appreciated by the subcontract teams.

Specialist sub-contractors were employed to design renewable energy technologies and for installation of MVHR equipment, rather than attempting to do specialist work with in-house teams. This specialist input was co-ordinated early with the work of the main design team. The developer felt that this approach of using specialists was ultimately a success.

In addition, well co-ordinated construction programmes and delivery management systems were developed before the construction commenced, and were then adhered to during construction. This was important in ensuring successful delivery and integration of the sustainability features on this project.

First floor living area



COSTS AND VALUE

The build cost excluding land costs and fees was £1,428 per square metre.

The developer estimated that this equated to an uplift of about 15% over standard build costs. Additional costs such as for training, research and development were not specifically quantified but were absorbed into overall build costs.

The use of a new build system meant that these residencies are prototypes for the developer, particularly in relation to the use of the renewable energy technologies. As such there were some learning curves and increased costs, however the developer anticipated that future costs would be reduced if the same build system and technologies were used.

The estimated sales value of these properties was about £250,000 or c.£2,974 per square metre (net internal). Sales prices for similar properties in the area were not available at the time of writing this report.

BUYER/OCCUPANT FEEDBACK

There has been considerable interest from potential purchasers and those interested in renting units, but at the time of writing this report none of the units had been sold or rented out. The client was however proposing to occupy one of the units and use the ground floor office/work space as a gallery as he could see the benefit of lower energy and utility bills, and it would be a good advertisement for future purchasers.

LESSONS LEARNT

The main lessons learnt from the development have been:

- There needs to be a greater understanding of the implications of detailing to achieve low U-values and low levels of air-permeability
- The use of specialist sub-contractors for design and installation can be beneficial in terms of ensuring successful delivery

- Preparing well co-ordinated construction and delivery management programmes at an early stage is essential to understand and avoid likely difficulties
- Some specialist MVHR suppliers in the UK do not yet seem to appreciate the considerable potential that their systems have for use in smaller scale, highly insulated developments
- There needs to be a greater awareness of zero carbon and the implications of building to high levels of the CSH throughout the construction industry

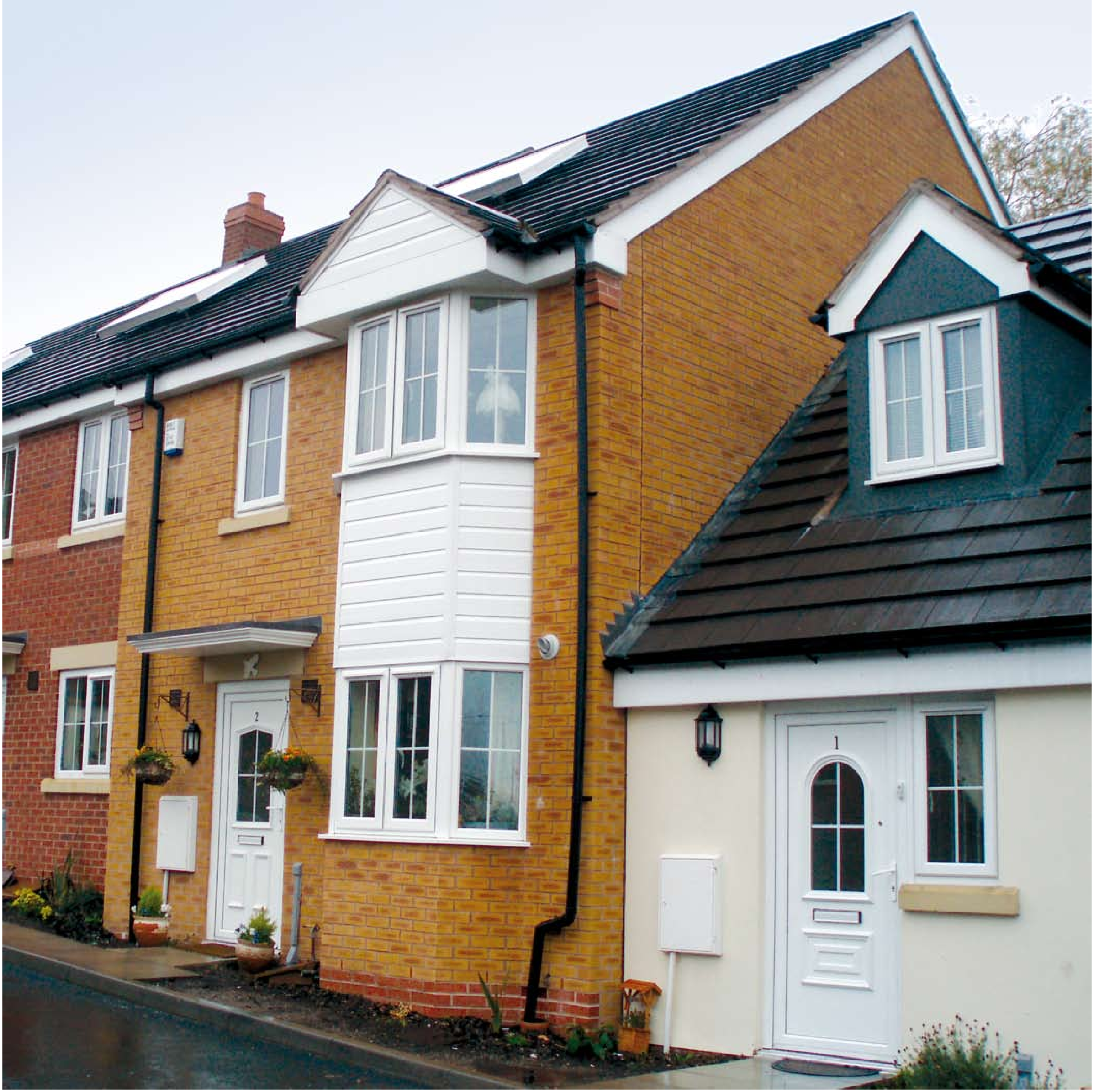
	PERCENTAGE OF CATEGORY SCORE ATTAINED	WHAT IS COVERED IN THE CATAGORY
ENERGY	93	Energy efficiency and CO_2 saving measures
WATER	100	Internal and external water saving measures
MATERIALS	87	The sourcing and environmental impact of materials used to build the home
SURFACE WATER RUN-OFF	100	Measures to reduce the risk of flooding and surface water run-off, which can pollute rivers
WASTE	100	Storage for recyclable waste and compost, and care taken to reduce, reuse and recycle construction materials
POLLUTION	25	The use of insulation materials and heating systems that do not add to global warming
HEALTH & WELLBEING	91	Provision of good daylight quality, sound insulation, private space, accessibility and adaptability
MANAGEMENT	100	A Home User Guide, designing in security, and reducing the impact of construction
ECOLOGY	77	Protection and enhancement of the ecology of the area and efficient use of building land

DESIGN TEAM

Contractor	**Logic CDS Ltd**
Developer	**Logic CDS Ltd**
Architect	**Brandon Lloyd RIBA**
Design Consultant	**Logic CPS Ltd**
Energy Design Consultants	**Sustain Ltd**
Structural Engineers	**SEDC Ltd**
Super Structure Engineer	**Eurban Ltd**

Paul Warren-Cox – Client/future occupant – 'I am happy to occupy one of the units since I think this will be a good advertisement for future buyers and tenants'

All photographs for the CO2 Zero case study supplied by Brandon Lloyd RIBA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CASE STUDY 3

NORBURY COURT

STAFFORDSHIRE

CSH Level	Level 3
Development type	Nine terraced units – seven three bedroom houses, One two-bedroom house and one three bedroom dormer bungalow
Build System	Factory fabricated timber frame construction with particle board sheathing and brick cladding
Key Sustainability Features	Solar thermal water heating, passive solar design, low flow rate sanitary ware, rainwater recycling for garden, low energy lighting
Procurement Method	Housing Association development procured via standard method of procurement

INTRODUCTION

Norbury Court is a development comprising seven three-bedroom houses, one two-bedroom house and one three-bedroom dormer bungalow constructed in 2007.

It was developed by Staffordshire Housing Association in partnership with Staffordshire Moorlands District Council and LHL Developments to meet the area's need for more family accommodation for rent. This was the first social housing in the Staffordshire area to be awarded Code for Sustainable Homes Level 3.

The development is on the site of an old redundant garage. The homes were built with the intention of being affordable and sustainable with the hope that they would make a real difference to people's lives and the local community.

Councillor Andrew Hart, Staffordshire Moorlands District Council cabinet member for regeneration and housing, said:

> *'As a council, we have nomination rights for such social housing, and the waiting list is unfortunately a long one. These houses will provide high quality accommodation for nine families.*
>
> *There is a clear need for affordable social housing in the district and we'd like to see other developers follow the very high standards set at Norbury Court.'*

CONSTRUCTION AND BUILD SYSTEM

The new build units have been constructed using factory fabricated timber frame construction, with cement particle board external sheathing and brick outer cladding. Phenolic foam insulation was injected into the external wall panel void and this was supplemented with cut block foam insulation in remaining voids that could not be filled in this manner. The floors were constructed from a concrete beam system using polystyrene infill with concrete screed.

Pre-fabricated timber frame

SUSTAINABILITY FEATURES

Sustainability approaches and features incorporated into the scheme include solar thermal water heating, passive solar design strategies, the use of water butts to collect rainwater for the garden, the use of more environmentally benign materials, high levels of insulation, low energy lighting, internal recycling bins and low water use sanitary ware.

Solar thermal panels on front roof

TECHNICAL PERFORMANCE

External Fabric

Timber frame with cement particle board sheathing and phenolic foam insulation – U-value of 0.29W/m^2 K

Roof

Timber frame with timber strand board and cut block foam insulation with a U-value of 0.20W/m^2 K

Floor

Proprietary concrete beam construction with polystyrene infill and concrete screed. The U-value for the floor is 0.21W/m^2 K

Doors and Windows

Double glazed, low - e windows were used with a U-value of 1.20W/m^2 K – Doors average U-value of 2.0W/m^2 K

Air-permeability

The final air-permeability tested was 5.63m^3/@50pa for the first complete dwelling

SCHEME IMPLEMENTATION

The design of the housing is fairly typical for the area and caused no problems during the planning phase of the development. The low energy merits of the housing were considered a very desirable attribute for this social housing development.

There were some site construction complications associated with the installation of the renewable energy systems and energy reduction measures. It was considered that in future these should be integrated with the architecture from the earliest design phases so that site construction complications could be avoided.

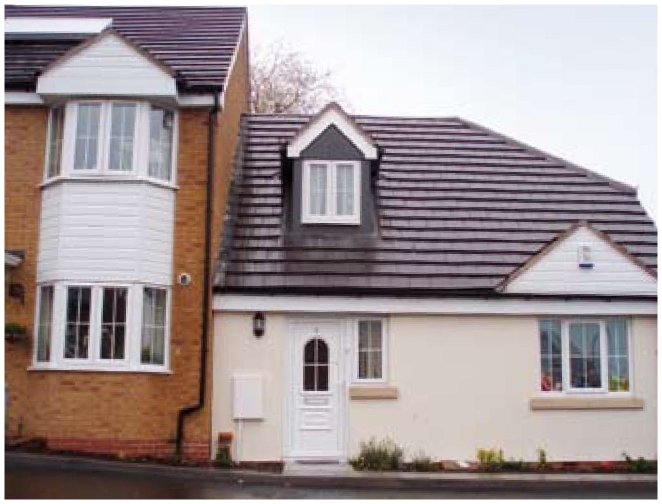
The developer/contractor was already familiar with the build system, which met client aspirations in terms of affordability whilst still offering an opportunity to take a proactive environmental stance by using an FSC timber frame.

Because the project was low budget, it was not possible to spend much time on research and development. However additional training was necessary for the installation of the solar thermal water heating.

The target of a Level 3 Code rating was a requirement of the developers. It was not considered necessary or desirable that this development should achieve a higher Code rating, mainly due to anticipated extra costs for higher Code levels. Teething problems were experienced with the installation of the low-flush/low flow-rate water systems and extra time (approximately one month) and money had to be spent on land remediation for the brownfield site. Otherwise the construction of the development was relatively trouble free.

All build systems have a 10 year conventional building warranty.

The dormer bungalow



WORKING WITH THE CODE FOR SUSTAINABLE HOMES

A consultant was employed to help achieve the Code. This was considered absolutely essential to understanding and achieving the Code status required.

It was found to be slightly difficult to meet the criteria for the low water use sanitary ware because the supply chains for equipment supply were not adequately established at the time of construction of this development.

COSTS AND VALUE

The build cost excluding land costs and fees was £950 per square metre.

The developer estimated that the development cost about £7,500 per unit extra in terms of build costs to meet the requirements of Code Level 3. Additional costs such as for training were not specifically quantified but were absorbed into overall costs.

Even though this project used a common build system, with which the contractor had previous experience, there were still a few prototypes on the homes, particularly the renewable energy technologies, which presented some learning curves and increased costs for the contractor/developer. In future the developer anticipated that the per square metre build costs would be reduced if the same build systems and technologies are used due to the lessons learnt through this initial development processes.

The estimated private sale value of these properties was estimated at about £135,000 or c.£1,688 per square metre; this compares to sales prices in the local area for existing stock of about £125,000 or £1,563 per square metre.

BUYER/OCCUPANT FEEDBACK

The dwellings are now 100 per cent occupied. Prospective residents expressed reactions of delight when viewing the homes prior to moving in. An occupant said:

> *'These homes are fantastic, especially with all the green features that have been built in. I can't wait to move the family in and make the place our own.'*

Another occupant of one of the three-bedroom houses was interviewed and expressed considerable satisfaction with the property, particularly due to the fact that their new home meant that they had lower energy and water bills. The occupant was also extremely happy that the house was draught free in comparison with previous accommodation and allowed for fresh air from opening windows and had good acoustic properties.

DEVELOPMENT SPECIFIC LESSONS LEARNT

The main lessons learnt from the development have been:

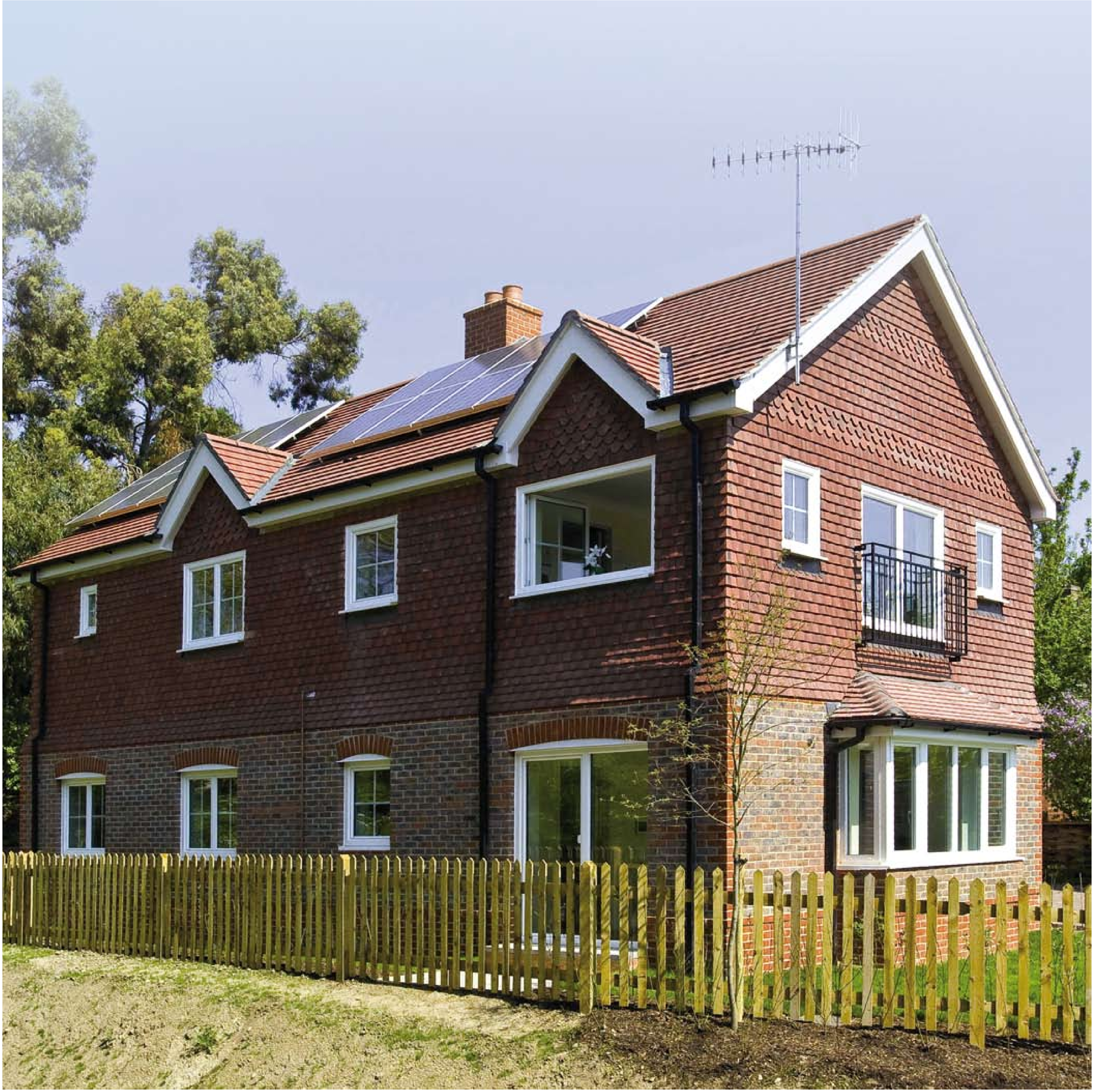
- Use a good Code for Sustainable Homes assessor and work with them from the start of the project
- Achieving Code Level 3 or above means extra costs for renewable energy technologies such as solar thermal water heating
- Not all renewable energy technologies will be appropriate for all sites
- Supply chains for some items required to achieve Code Level 3 and above are somwtimes still in development.

	PERCENTAGE OF CATEGORY SCORE ATTAINED (0–100)	WHAT IS COVERED IN THE CATAGORY
ENERGY	62	Energy efficiency and CO_2 saving measures
WATER	66	Internal and external water saving measures
MATERIALS	75	The sourcing and environmental impact of materials used to build the home
SURFACE WATER RUN-OFF	50	Measures to reduce the risk of flooding and surface water run-off, which can pollute rivers
WASTE	100	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	41	Provision of good daylight quality, sound insulation, private space, accessibility and adaptability
MANAGEMENT	66	A Home User Guide, designing in security, and reducing the impact of construction
ECOLOGY	44	Protection and enhancement of the ecology of the area and efficient use of building land

DESIGN TEAM

Contractor	**LHL Development Ltd**
Developer	**LHL Development Ltd**
Architect	**Sammonds Architectural**
Environmental Design Consultants	**Hydrock Consultants**
Engineers	**Sammonds Architectural**

All photographs for the Norbury Court case study supplied by the Good Homes Alliance and LHL Development Ltd



CASE STUDY 4

MID-STREET

SOUTH NUTFIELD, SURREY

CSH Level	Level 5
Development type	2 x two-bedroom flats
Build System	Structural Insulated Panel System (SIPS) and beam-and-block flooring with mineral wool and expanded polystyrene insulation
Key Sustainability Features	Passive solar design, low flow rate sanitary ware, rainwater recycling, low energy lighting, PV array, biomass pellet boiler, low energy rated white goods, FSC timber, and MVHR
Procurement Method	Housing association development Standard method of procurement. Design and build contract.

INTRODUCTION

Mid-Street is a development of two, two-bedroom flats located in the village of South Nutfield in Surrey. The development was constructed in a rural area by building contractors Osborne on behalf of Raven Housing Trust.

The development was initially planned to meet the requirements of the Code Level 3 and planning consent was gained on this basis. However, because Osborne had previous experience in building high level sustainable housing, Raven Housing Trust saw this as a great opportunity to learn about building low energy housing and the development was redesigned to meet as high a Code Level as possible. Eventually, the scheme became the first publicly funded social housing development in the UK to achieve Code Level 5.

Raven Housing Trust saw the development as –

> *'an opportunity to explore the cost and practicalities of new technologies particularly in relation to small, rural sites'*

and a –

> *'way of finding out the implications of building to Code Level 5, what the additional costs would be and to enable us to test a range of new technologies and determine what their future and cyclical maintenance implications are.'*

The development is in a rural area so the final design had to reflect the planning requirements for it to aesthetically blend with its surroundings. Further planning consent was also required to construct an external boiler house and pellet store for the biomass boiler, which had not been included in the original consent.

CONSTRUCTION AND BUILD SYSTEM

The new build units were constructed using a pre-fabricated Structural Insulated Panel System (SIPS) and beam and block flooring, with high levels of insulation. The SIPS system has a sandwich of mineral wool and expanded polystyrene insulation.

The SIPS system was chosen because the contractor had previously worked with it and it was considered compatible with the design and cost constraints applicable to the site. The windows were low - e triple glazed and the roof construction was timber truss with concrete interlocking tiles. All the systems and components were chosen because they were seen as integral parts of the means to achieve a high Code level.

Photovoltaic panels

SUSTAINABILITY FEATURES

Sustainability approaches and features incorporated into the scheme include passive solar design strategies, rainwater harvesting, the use of environmentally benign materials, high levels of insulation, low levels of air-permeability, low energy lighting, an array of Photovoltaic panels (PVs), the use of low energy rated white goods, triple-glazed windows, a biomass pellet boiler and MVHR (Mechanical Ventilation with Heat Recovery).

A 'Home User' guide was also provided with information about how to operate the renewable energy and ventilation systems, and one-to-one training was provided for the occupants. The Energy Saving Trust (EST) has also been involved in monitoring the project, and is due to provide additional training for residents following a period of monitoring of the systems and their usage. This should enable tenants to optimise their use of the systems and gain maximum benefit from the sustainability approach.

The biomass boiler and store

TECHNICAL PERFORMANCE

External Fabric

Structural Insulated Panel System (SIPS) with 50mm of external insulation – U-value of $0.14W/m^2 K$

Roof

Timber frame with concrete tiles and 400mm mineral wool insulation – U-value of $0.13W/m^2 K$

Floor

Beam-and-block with an additional 75mm insulation – U-value $0.14W/m^2 K$

Doors and Windows

Windows were triple-glazed, low–e windows uPVC – U-value of $0.80W/m^2 K$. Doors were fully insulated, U-value of $1.2W/m^2 K$

Air-permeability

Design air-permeability test targets were $3m^3/h$@50pa. Final tests provided results of $4.9m^3/h$@50pa

SCHEME IMPLEMENTATION

To achieve Code Level 5, a base model specification, similar to that of the Passivhaus standard was adopted and a range of renewable energy technologies that would be appropriate for the site were fully researched before the final renewable energy solutions were chosen.

One of the initial aims of this project was to adopt construction detailing that would achieve low levels of air-permeability with the aim of meeting the Passivhaus standard of $1m^3/h$@50pa. However, this target was relaxed for the final specification to $3m^3/h$@50pa because the project could meet the requirements of Code Level 5 by incorporating the wood pellet boiler and central heating system at the design stage.

As the project progressed, the team recognised the need to focus on the principles of trying to reduce thermal bridging and delivering low air-permeability (supported by a ventilation strategy utilising Mechanical Ventilation with Heat Recovery), in order to achieve points for the 'Heat Loss Parameter' section of the energy credits part of the Code. For example, initial 1:20 construction details were produced at the design stage to demonstrate the removal of non-repeating thermal bridging from the building fabric.

During the course of construction several site visits and tests showed that there were air leakages which would cause problems in terms of finally meeting level Code Level 5. The ground floor flat in particular was shown to have air leakage problems. Some of the air leakage pathways were remedied as part of the ongoing building work, whilst some needed immediate attention e.g. the wall-to-floor perimeter and service entries needed sealing and the window taping and air-permeability joints needed to be improved.

All build systems have conventional building warranties.

Living room in the first floor maisonette

WORKING WITH THE CODE FOR SUSTAINABLE HOMES

This development was the first time that Raven Housing Trust had used the Code for Sustainable Homes although all their housing from January 2009 will be constructed to Code Level 3 or 4.

The Mid-Street development already had planning consent and was due to be constructed to Level 3 before the decision was made to try to achieve a higher Code level; much of the design of the flats had therefore already been fixed. Raven Housing Trust worked closely with Osborne and the Energy Saving Trust to look at how the development could be built to Code Level 5.

Of the Code requirements, achieving the heating, hot water and water consumption requirements were found to be most difficult for this development. In addition, because the project had initially been designed to meet the requirements of Code Level 3, the roof areas were insufficient to accommodate both photovoltaic (PV) and solar thermal renewable energy technologies with the result that only the PV panels were finally installed.

An accredited assessor was appointed to carry out a full Code assessment. Major changes required to bring the development from Code Level 3 to 5 were in the areas of:

- The use of a biomass boiler to replace mains gas for heating and hot water
- PVs were added to provide renewable energy
- Whole house MVHR was utilised
- Higher thermal efficiency of floors, walls, windows and roofs were required
- A reduction in thermal-bridging was required
- Lower air-permeability was required
- Rainwater harvesting and water saving appliances were introduced
- Very low energy appliances were required

COSTS AND VALUE

The build cost excluding land costs and fees was c. £1,850 per square metre. The developer estimated that this equated to an uplift of about 20% over standard build costs. Additional costs such as training, research and development were not specifically quantified but were absorbed into overall build costs. This project used a build system that is currently unusual for the UK. However the contractor had some prior knowledge of its use since they had previously used this system for their Ecohomes demonstration project at the BRE (Building Research Establishment) and the supply chain and main build specification details were already defined.

Despite this, these flats were still prototypes, particularly in relation to the use of the renewable energy technologies, which presented some learning curves and increased costs for the developer and contractor.

The biomass boiler presented the biggest source of problems, with a requirement for maintenance attention at roughly 1-2 weekly intervals. In conjunction with this, the boiler receives servicing at six monthly intervals. So far during the life of the project there has been a series of additional 'call outs' to service the biomass boiler. According to the Raven Housing Trust, this has resulted in significantly greater cyclical maintenance costs than would have been the case with a gas boiler.

The development was built for social housing purposes, and was not intended for sale. Nevertheless the flats have been built in keeping with the setting and housing of the village of South Nutfield and it is estimated by the developer that the sales value of the homes would be in the region of £175,000 to £200,000 or c. £2,857 per square metre, roughly equal to or above sale values for equivalent properties in the local area.

BUYER/OCCUPANT FEEDBACK

Generally the occupants have been satisfied with the development, but they have experienced some irritation with the erratic working of the biomass boiler system.

A tenant, who has lived in Raven's Mid-Street Code 5 flats for over six months, said:

> *'I like the area and it suits me. My flat is really spacious, airy and light during the day – I've got five windows in my living room!'*

she also said:

> *'There has been a problem with the heating system [the biomass boiler] – when the heating works, it works well, the flat warms up quite quickly. But there have been times when the flat has been quite cold when the boiler has stopped working. Raven is trying to sort this out at the moment.'*

DEVELOPMENT SPECIFIC LESSONS LEARNT

- It is important to involve a code assessor with experience in energy efficiency before drafting initial designs
- Construction details need to be produced early in the design process – remedial work is not as effective as achieving low levels of air permeability on the first attempt
- MVHR (Mechanical Ventilation with Heat Recovery) can offer significant advantages in reducing energy requirements if correctly specified and installed
- Local planning constraints may limit the available design options
- For small dwellings in rural locations wood pellet boilers can be an attractive option
- Shared heating systems can be a practical and cost effective solution
- A good relationship and understanding with the site manager is necessary for a design to be realised
- Heating, ventilation and renewable energy systems specified in a project need to be demonstrated to the occupants. Clear written guidance on their use also needs to be provided

DESIGN TEAM

Contractor	**Osborne**
Developer	**Raven Housing Trust**
Architect	**Harrington Design**
Engineers	**BEP Consulting Engineers Ltd**

Peter Trowbridge, Raven's development manager – 'We saw a Code Level 6 house at BRE and talked about it – we wanted to try the new technology. Most code schemes are large schemes, but this shows you can do an ordinary looking small house.'

	PERCENTAGE OF CATEGORY SCORE ATTAINED	WHAT IS COVERED IN THE CATAGORY
ENERGY	96	Energy efficiency and CO_2 saving measures
WATER	100	Internal and external water saving measures
MATERIALS	50	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	71	Storage for recyclable waste and compost, and care taken to reduce, reuse and recycle construction materials
POLLUTION	50	The use of insulation materials and heating systems that do not add to global warming
HEALTH & WELLBEING	91	Provision of good daylight quality, sound insulation, private space, accessibility and adaptability
MANAGEMENT	88	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

All photographs for the Mid-Street case study supplied by Raven Housing Trust

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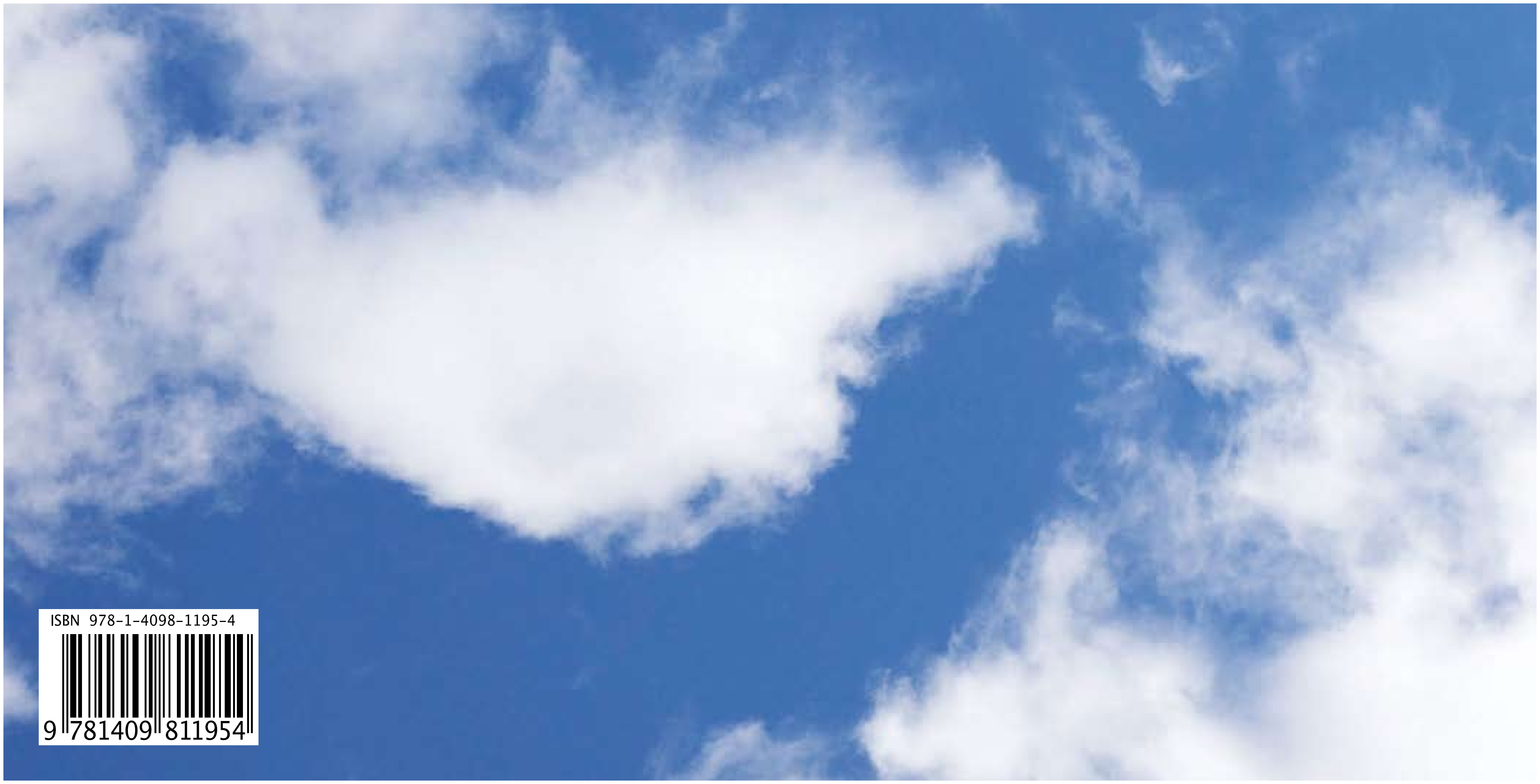

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