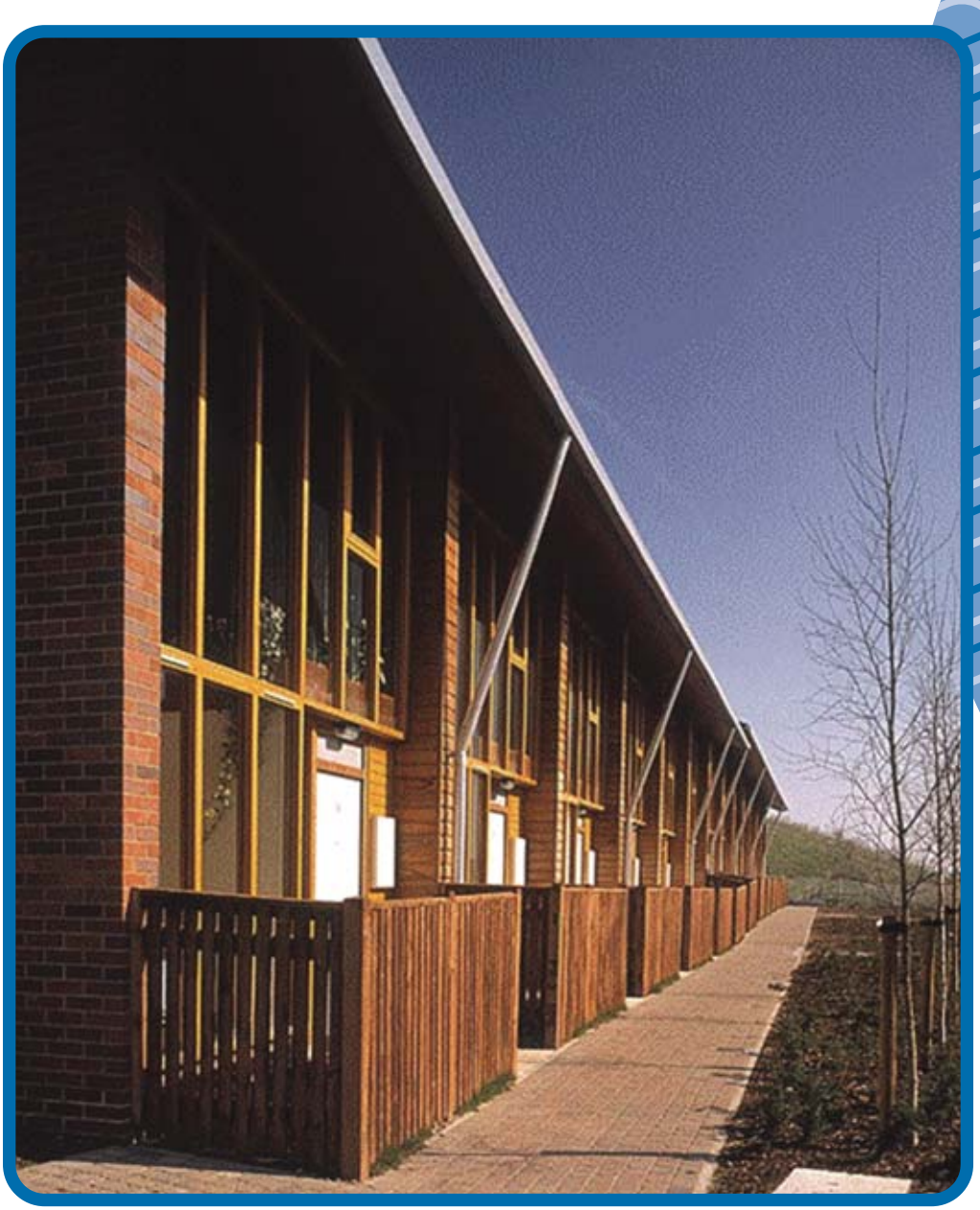
Energy Efficiency Best Practice in Housing

Thamesmead Ecopark – case study Gallions Housing Association



ENERGY EFFICIENCY
SAVE ENERGY MONEY ENVIRONMENT

Energy Saving Trust

Introduction

Home energy use is responsible for 28 per cent of UK carbon emissions which contribute to climate change. By following Best Practice standards, new build and refurbished housing will be more energy efficient and will reduce these emissions, saving energy, money and the environment.

Across the UK, you can now find increasing numbers of innovative sustainable housing schemes.

At Thamesmead Ecopark, Gallions Housing Association has developed an environmentally friendly form of housing construction, suitable for wide scale replication. Having monitored the scheme for a one-year period, Gallions is assessing the different components and technologies used for inclusion in their future development plans.

This case study will provide encouragement to housing associations, local authorities and private developers. It will show that energy efficient housing can be achieved through proven and cost-effective technology. It examines the design, costings and monitoring of the scheme. Most importantly, it shares the lessons learnt.

Background to Gallions Housing Association

Gallions aims to provide affordable quality housing and support services in safe and secure environments. In 2000 Gallions became a registered social housing landlord. It now manages over 6,000 properties in the Thamesmead area.

Background to the scheme

Gallions Reach Urban Village comprises 1,500 new homes, shops and a school. Built on previously contaminated land, the village is arranged around an ecological corridor. Rainwater drains into a network of reed canals, which filter the water and create a rich habitat for wildlife.

Ecopark is part of the Section 106 affordable housing element of the village's third phase. It is a development of 39 two-, three- and four-bedroom houses for rent.

There are four main house types, which are set out in separate blocks as shown in Figure 1. Each type incorporates different combinations of features (detailed in Table 1). This enabled Gallions to use monitoring and tenant satisfaction surveys to make comparisons.

The aim was to show that energy efficient sustainable housing need not be high-tech - and can be built within realistic budgets. The houses achieved an EcoHomes Excellent rating and a SAP (Standard Assessment Procedure) rating of 100 (see back cover of this document for references).

In Holland, the Government provides favourable loan finance when certain sustainable standards are met - called the Dutch Green Financing Model. Gallions commissioned Dutch sustainability consultants and architects to develop the scheme based on this standard. UK architects PRP were appointed to ensure the Dutch design met building regulations, Housing Corporation Scheme Development Standards and all other requirements.

Figure 1: Scheme layout

Table 1: Scheme – key features

All house types	
Timber frame	Chosen as it is a renewable resource unlike brick or concrete.
Insulation	U-values Walls 0.25W/m²K External doors 2.0W/m²K Ground floor 0.30W/m²K Roof 0.18W/m²K
Advanced glazing	Double glazed argon filled windows. U-value of 1.1W/m²K (measured at the centre of the pane).
Condensing boilers	Gas condensing boilers (SEDBUK band A) Class 5 NOx emissions.
Solar water heating	Solar collectors on the roof supplying twin coil hot water cylinder, reducing gas required to heat water.
Water saving features	Smaller sized baths with showers over. Dual low flush toilets (2.5/4 litres). Spray taps to hand basins. Water butt provided to harvest rainwater.
Energy efficient lighting	All habitable rooms have dedicated low energy light fittings.
Internal finishes	Water-based paint.
Sheds	Garden sheds are provided with sufficient space to store a family's bicycles.
Waste management	Internal storage bins for recycling. Can crusher in the kitchen. Central external underground recycling facilities on site for glass, paper, aluminium and plastics. Compost bins provided.
Landscaping	Public landscape designed to maximise the environmental potential of the scheme, incorporating native flora.
Block specific scheme features	
Sun spaces	Houses in blocks A and C feature a two-storey sun space on their south elevation. Provides a bright living space and also preheats air entering the house.
Underfloor heating	Block B has underfloor heating.
Mechanical ventilation heat recovery	Block B has mechanical ventilation heat recovery.

Table 2: Feature combinations by block

Block	Number of beds	Number of units	Floor area m²	Sun room	Rainwater recycling	Underfloor heating	Mechanical ventilation heat recovery
A	2	13	78	X			
B	3	9	91			X	X
C	3	9	95	X			
D	4	8	110		X		

House types layout

Figure 2: Typical floor plans

Procurement

The preferred procurement route for this innovative scheme was through a partnering contract. As the intention was to replicate the scheme, a one-off contract price was not the sole motivation for partner selection. Gallions drew up a 'best value' tendering process, which would enable selection to be based on price, experience and knowledge of sustainable construction.

The PPC 2000 partnering contract had the benefit of enabling contractor input at an early stage. For a one-off project, partnering can add additional costs. However, Gallions will realise the full financial benefits once the scheme is replicated.

Scheme costs

Ecopark was developed for £1,056 per square metre at 2002 prices – achieving cost parity with Gallions' traditional new build schemes. Equivalent costs at the first quarter of 2004 are £1,165 per square metre, with average build costs of £110,580 per house. This is approximately 12 per cent more expensive than architects PRP's average terrace house cost in the south east.

A private developer has estimated costs (at 2002 price levels) for replicating this scheme and these are shown in Table 3. They exclude land, design fees to planning, land remediation and VAT.

Table 3: How much would it cost a private developer to replicate the scheme?

	Deduct	
	£	£
Final contract sum for Gallions		**3,911,186**
Design changes required by Gallions or housing corporation and therefore specific only to social housing.		
Brickwork to underside of timber frame	6,224	
Digital TV installation	16,078	
Boxing to houses	9,749	
Frieze rail to kitchen	683	
Naked House and Visitor Centre	25,600	
Additional external works	30,599	
Security guard	3,602	
Monitoring equipment	26,599	**119,134**
Contractors overhead and profit recovery	397,285	**397,285**
Cost of pre-commencement agreement	40,689	**40,689**
Net build cost		**3,354,078**
Developer's expected margin	20%	**670,816**
Construction costs for a speculative developer		**4,024,894**

Table 4: Cost analysis of special features

Special features	Average cost per house (£)	Normal base specification	Average cost per house (£)	Gallions' reason for including special features
Sun room	7,500	Cost of same floor space in traditional construction	5,900	For passive solar gains
Polyisocyanurate (PIR) wall insulation	2,260	Blown mineral wool	425	Better insulation standards for equivalent thickness
Non-PVC sheet flooring	1,160	PVC	825	Non-use of PVC*
High quality softwood windows with 1.1w/m²k glass	8,200	Basic PVC-U windows with standard double glazing	5,600	Better insulation standards and the non-use of PVC-U*
Solar panels	2,500	N/A		Reduce heating and hot water costs
Water butts	70	N/A		Water use reduction
Low voltage vent fans	800	Standard electric fan	530	Lower running costs
Dedicated low energy light fittings	190	N/A		Lower running costs
Can crushers	30	N/A		Waste recycling encouraged
Recycling bins	564	N/A		Waste recycling encouraged
Gas condensing boiler	980	Standard combi-boiler	610	Lower running costs and reduced carbon emissions
Underfloor heating	1,770	Panel radiators	1,350	Even heat distribution
Timber frame construction	15,870	Traditional brickwork and block work	15,400	Better insulation and faster construction times
Total cost per house	**41,890**		**30,640**	
Extra-over cost	**11,250**			
Extra-over cost per square metre	**117**			

*A Gallions decision to minimise PVC use in the scheme.

Scheme finance

Gallions financed the scheme. No Housing Corporation money was used for the development.

The Housing Corporation awarded an Innovation and Good Practice grant of £45,000 for the monitoring and dissemination of lessons learnt from the development. This included funding for a visitor centre and the Naked House, both open for one year after scheme completion. The Naked House showed exposed elements of the building not normally visible after completion.

Monitoring

The aim of monitoring was to assess which of the components Gallions could include in future development plans.

When low energy houses are designed and constructed, the energy savings can only be assumed. Monitoring is therefore an essential process if actual energy savings are to be identified and quantified.

Monitoring of the Ecopark scheme covered the following aspects:

- airtightness;
- water use;
- energy use – and associated carbon dioxide emissions;
- solar water heating system effectiveness;
- occupants' comfort.

The accuracy of the data depended on knowledge of monitoring equipment accuracy and an adequate sample of dwellings. This compensated for exceptional readings through equipment malfunction, untypical household size or lifestyle choices when analysing the data.

In addition, an externally located weather station was needed to collect information on wind speed and direction, outside air temperature, relative humidity, barometric pressure, solar radiation, UV and rainfall.

Airtightness of buildings

An airtightness survey was conducted on a house in block D. This involved fitting a fan to the frame of the front door and running two tests. In the first test, the fan depressurised the dwelling and in the second, pressurised it.

The maximum air leakage index specified for the house was 10m³/h/m² at a reference pressure of 50Pa. The house outperformed this specification and achieved 7.1m³/h/m².

To meet Energy Efficiency Best Practice in Housing's Best Practice specification, air permeability of less than 3m³/h/m² should be achieved[1].

Water use

Whilst showing variation by house type, the water consumption in all the Ecopark houses is well below the UK average. The totals shown in Table 5 are the average water use per block. The hot water use is the measured use of four particular dwellings.

Table 5: Annual water use per dwelling

(m^3/year)	A	B	C	D	UK average
Total	132	146	142	140	184
Total per person	45	36	35	48	54
Total hot water	48	47	47	53	61

Gas consumption

The annual consumption of gas was recorded for all house types. The consultants based comparisons on a modelled standard Dutch house type, with solar water heating.

The total measured energy use for space heating ranged from 6,260kWh to 9,706kWh per year.

Houses in block B had underfloor heating and mechanical ventilation heat recovery. However, data for only one type B house was available. It showed that house type B had the highest gas consumption, although the lack of monitoring data limits the value of this information.

Houses in block C had the lowest gas consumption, with approximately 32 per cent reduction on use compared to the standard house. This could be related to the south facing sun space. However, block A houses, also with a south facing sun space, had relatively high gas consumption. This could be due to the location of the stairs in the lounge, creating a larger heating zone over two floors.

Houses in block D, without a south facing sunspace, also saw reductions in gas consumption compared to the standard dwelling.

Electricity consumption

Total electricity use for all the house types (apart from block B as no data was available) is shown in Table 6. Electricity used by the extract fans and heat recovery systems is also included.

Table 6: Electricity consumption

kWh/yr Block	Heat recovery	Fans	Total
A	N/A	40	**3,064**
B	669	N/A	**N/A**
C	N/A	194	**3,584**
D	N/A	15	**3,956**
Average UK			**3,400**

The heat recovery system consumes more electricity than the fans. Electricity consumption is also affected by the solar water heating's electrical back-up. This can cause unexpectedly high electrical consumption if used constantly.

Carbon dioxide emissions

The average gas use for the houses is 10,775kWh (38.79GJ). The average electricity use is 3,535kWh. This equates to an annual carbon dioxide emission per dwelling of 3,558kg. This is based on carbon dioxide emission factors for delivered energy as quoted in the Government's standard assessment procedure for energy rating of dwellings, 2001[2].

Solar water heating system effectiveness

Unfortunately the monitoring of the solar hot water systems did not yield any results. Due to an error in the data collection instruments (not the solar hot water system itself) the data showed that there was zero flow between the cold water supply and warm water output from the systems. Therefore no conclusions could be drawn.

Comfort

Summer overheating is an issue when incorporating south facing sun spaces. Block A and C both had south facing two-storey sun spaces.

From the data the sunspaces were approximately 7°C warmer than outdoor temperatures during the winter. During the summer, mean internal room temperatures in block A and C (with sun spaces) were slightly higher than block B, but slightly lower than block D.

Figure 3: South facing sun spaces

Design issues

Design issues to consider for future developments include the following.

- The impact of having an open staircase in the lounge in house type A. This means that the living room heating zone is much bigger, therefore increasing gas consumption.
- The impact of the two-storey south facing sun space. This is a useful area if occupants know how to use it correctly. If internal windows and doors are left open during the day in summer, rooms could overheat.

Tenant satisfaction

In general the tenants are happy with their homes. Most have experienced significant reductions in energy bills compared to their previous properties. All have expressed an improvement in quality of life.

An extensive resident liaison campaign revealed that the main negative issue relating to this scheme was the lack of play areas for children.

Gallions did not supply secondary heating systems. Visits to the property have shown that none of the tenants have since purchased these. However, some households had purchased fans to help with cooling.

Lessons learnt

Gallions have learnt the following lessons.

Monitoring: Whilst advisable to monitor a sample of properties rather than the whole scheme, results can be inaccurate, particularly when calculating averages. The average/mean energy consumption was distorted by two or three high consumption households. The mode/most frequently occurring reading would have been more accurate and more relevant.

Tenant involvement: It would be advisable to identify all tenants prior to the completion of schemes. This would ensure that they could receive training to optimise the benefits of the houses. Where tenant identification is not possible, a 'sweep up' session a couple of months after handover would ensure all tenants have access to the same levels of information.

Technological supply issues: At the time it was very difficult to obtain a number of the incorporated features locally. The timber frame windows, ultra-low flush toilets, underground recycling banks were all supplied by local companies - but sourced in Europe. As these industries expand, it is becoming easier to obtain products in the UK. Gallions' main issue related to certification and accreditation. Whilst products could be sourced in the UK, they didn't have the necessary certification/accreditation to achieve EcoHomes credits.

Communicating technical information: An issue, which emerged during the resident liaison phase of monitoring, was their response to the eco-features in their homes. In most instances the features were passive and required little or no training. However, a significant number of tenants had over-ridden the solar supply to the hot water tank, thereby using electricity to heat the water. This was due to insufficient labelling on the switch. Residents received the properties with the switch turned off (i.e. using the solar supply) and a number of tenants assumed that it should be turned on. This resulted in several electricity bills being higher than expected.

Financial lessons: Through successful partnering (Gallions used PPC2000, which is a partnering contract undertaken during the procurement stage), it is possible to develop an environmentally sustainable housing scheme without grant funding, at a cost comparable with traditional new build. Designing-in sustainable features during the early stages of the scheme, rather than including them later as extras, can result in financial savings.

Scheme replication

Different components were used in different properties on this scheme. Following completion of the detailed monitoring report, Gallions will include the most successful of these components in their future development programme.

CE130

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References

(1) *Energy Efficiency in New Housing – summary of specifications for England, Wales and Scotland* (CE12). Available from Energy Efficiency Best Practice in Housing as below.

(2) The Government's Standard Assessment Procedure for Energy Rating of Dwellings, 2001

Further Reading

Energy Efficiency Best Practice in Housing

These publications can be obtained free of charge by telephoning the helpline on 0845 120 7799 or by visiting the website at www.est.org.uk/bestpractice.

Central Heating System Specifications – CHeSS (GIL59)
Innovative social housing – Alpine Close, Maidenhead, Berkshire (CE37)
Renewable energy sources for homes in urban environments (CE69)
BedZED – Beddington Zero Energy Development, Sutton (GIR89)
Building a sustainable future – homes for an autonomous community (GIR53)
Post-construction testing - a professional's guide to testing housing for energy efficiency (GIR 64)
Passive solar design – the Farrans study (GIL25)
Renewable energy in housing – case studies (CE28)
Solar hot water systems in new housing – a monitoring report (GIR88)
The Hockerton housing project – design lessons for developers and clients (CE15)

Further Information

Grants – prospective grants for renewable energy technologies are now available.

For details on grants for biomass, ground source heat pumps, micro-hydro, solar water heating and wind energy
www.clear-skies.org in England, Wales and Northern Ireland, or
www.est.org.uk/schri in Scotland.

Standard Assessment Procedure (SAP)

The SAP is the Government's recommended system for energy rating of dwellings. For more information visit:
http://projects.bre.co.uk/sap2001/.

EcoHomes

Is an independent, transparent, environmental labelling scheme for housing. It covers houses and apartments, either at the design stage or as part of major refurbishment. For more information visit:
http://products.bre.co.uk/breeam/ecohomes.html.

Useful Organisations

Solar thermal

Solar Trade Association
www.solartradeassociation.org.uk

Acknowledgements

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For further information on the scheme visit the website www.gallionsecopark.co.uk where Energy Consumption and Tenant Feedback Reports are available.

All photos supplied courtesy of Gallions Housing Association

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