Technology Strategy Board
Driving Innovation

Retrofit for the Future

Project final report

Cover note

This report was prepared by the collaborative project team for this Retrofit for the Future project, to provide fuller context on their experiences and the particulars of their retrofit's specification, construction and occupation.

The authors were encouraged to include honest, transparent and constructive comment, garnered from multiple perspectives across their team. All views are taken to be an accurate account from the time.

There may have been further modifications to the property after this report was produced. It is therefore possible that a small minority of statements will no longer be valid.

Although minor modifications have been made to this report by the Technology Strategy Board, these were only to ensure the privacy of individuals, including the residents, and compliance with the Data Protection Act.

This report may contain links to other websites, such as for project partners or the retrofit project. The Technology Strategy Board is not responsible for the content of those websites.

This report has already proven to be a valuable source of information for the technical and cost analysis reports published by the Technology Strategy Board which are available at: www.retrofitanalysis.org

Retrofit for the Future Project Final Report

Project number: ZA107M
Property number: TSB034

The Hyde Group

The work reported here has been funded by the Technology Strategy Board under the Small Business Research Initiative (SBRI) under the Retrofit for the Future programme. This project is one of nearly 90 projects funded under the programme. Further information on the programme can be found at: www.innovateuk.org/retrofit

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SBRI Government challenges. Ideas from business. Innovative solutions.

Final Report

Project information

- **ZA reference number:** ZA107M
- **Location of property:** London, SE9
- **Lead participant details:** The Hyde Group, 30 Park Street, London, SE1 9EQ
- **Date report issued:** December 2011

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1. Project details and directory

Role	Organisation	Contact Details
Property Owner		
Housing Association	The Hyde Group	**Address:** 30 Park Street, SE1 9EQ **Tel:** 020 3207 2600 **Email:** communications@hyde-housing.co.uk **Website:** www.hyde-housing.co.uk
Design Team		
Architect	ECD Architects	**Address:** Studio 3, Blue Lion Place, 237 Long Lane, SE1 4PU **Tel:** 020 7939 7509 **Website:** www.ecda.co.uk
QS	Keegans	**Address:** Studio 2, Blue Lion Place, 237 Long Lane, SE1 4PU **Tel:** 020 7199 0900 **Website:** www.kgans.co.uk
Project Management	Keegans	**Address:** Studio 2, Blue Lion Place, 237 Long Lane, SE1 4PU **Tel:** 0207 199 0912 **Website:** www.kgans.co.uk
CDM	Keegans	**Address:** Studio 2, Blue Lion Place, 237 Long Lane, SE1 4PU **Tel:** 020 7199 0900 **Website:** www.kgans.co.uk
Contractor		
Main contractor	Mears	**Address:** 7 Twisleton Court, Dartford, DA1 2EN **Tel:** 01322 319 100 **Website:** www.mearsgroup.co.uk
Suppliers		
Pavadentro	NBT	**Address:** The Hanger, Worminghall Road, Oakley, H18 9UL **Tel:** 01844 338 338 **Website:** www.nbtconsult.co.uk/about_nbt_consult.html
Windows	Jeld-Wen UK	**Address:** Retford Road, Sheffield, S13 9WH **Tel:** 0114 542 000 **Website:** www.jeld-wen.co.uk/
PV installer	Solar Technologies	**Address:** Unit 51 Romsey Industrial Estate, Romsey, SO51 0HR **Tel:** 01794 830 154 **Website:** www.solartechnologies.co.uk
Heat Recovery Ventilation	EnviroVent Ltd	**Address:** Envirovent House, Hornbeam Business Park, Harrogate, HG2 8PA **Tel:** 01423 810 810 **Website:** www.envirovent.com
Micro CHP	Baxi	**Address:** Brooks House, Coventry Road, Warwick, CV34 4LL **Tel:** 0844 871 1525 **Website:** www.baxi.co.uk
LED Lighting	GreenLED Lighting Ltd	**Address:** Avening Building, Priory Park Industrial Estate, GL8 8HZ

		Website: www.greenled.co.uk
Intelligent Heating Controls	Wattbox Ltd	**Address:** The Technocentre Coventry, CV1 2TT **Tel:** 02476 236 708 **Website:** www.wattbox.com

2. Introduction

The Hyde Group was awarded funding by the Technology Strategy Board's 'Retrofit for the Future' competition to retrofit a property in Eltham, South London. 'Retrofit for the Future' seeks to kick start the revolution needed in our social housing stock, and indeed the rest of the housing stock in Britain, to achieve the government's target laid out in the Climate Change Act 2008 - an 80% reduction in CO_2 by 2050.

This project is the second 'Retrofit and Replicate' venture for Hyde and it follows the success of its first award-winning Retrofit and Replicate project in Mottingham, South London. Hyde were keen to distinguish Retrofit & Replicate 2 from its predecessor and opted to retrofit a house in a conservation area which would hopefully bring to light the different challenges of reducing carbon emissions in our heritage properties. The project draws on the expertise of ECD Architecture, Mears and Keegans to deliver an outcome which can be followed by local authorities, social housing bodies and private owners.

3. Occupants

The property was void when selected for the retrofit; this allowed the lettings team at Hyde time to find a suitable resident for the property. It was identified from the beginning of the project that the retrofitted home needed residents who would cooperate with the two year monitoring period. Despite this, Hyde felt that it was inappropriate to choose the resident for the property. There was no 'selection' or 'interview' process for the tenancy. Instead, when a shortlist was established in line with policy, an information sheet was given to all the potential residents. This informed the families about the 'Retrofit for the Future' programme and an explanation of what technologies were retrofitted in the home. It also outlined the responsibility of taking on this particular home with the monitoring required. It was hoped that this process would result in a resident responsibly choosing whether it was the right home for them.

The new resident was asked to sign a monitoring agreement. This outlined eight responsibilities of living in the property (for example cooperating with the Energy Saving Trust when they would like to conduct their semi-structured interviews.) In doing so, both Hyde and the resident have a clear understanding of what is required of the two year monitoring period.

4. Dates

Event	Date
Project start date (when was the first proposal discussed or agreed)	October 2009
Planning application submitted (if appropriate)	02/08/10 PV & Windows. 03/05/11 PV second application 14/09/11 Letter of Permitted Development application.
Planning permission granted (if appropriate)	Windows approved 13/09/10 PV refused 01/02/11 PV refused 16/06/11 PV refused 14/11/11
Building Regulations application submitted (if appropriate)	Building Notice – by Contractor 25/01/11; 10/02/11
Building Regulations approval granted (if appropriate)	12/01/11
Contract for work let / signed	Letter of intent issued 20/08/10;
Occupants moved out (state if they remained or property was empty)	Void Property
Start on site	Enabling works 22/02/10 Retrofit works 06/12/10
Completion of retrofit	Enabling Works 23/07/10 Retrofit works 29/03/11
Occupants moved in	04/04/11
Monitoring system commissioned and operating properly	30/03/11
Building defects corrected	Making Good Defects date 29th March 2012
Building services and controls operating correctly	30/03/11

5. Pre-retrofit property

The property is part of the Progress Estate within the London Borough of Greenwich. It is an historic development, listed within a Conservation Area, commanding stricter planning controls. The homes were built in 1915 and have historic significance to our social evolution. The estate was developed due to the demand imposed by The Royal Arsenal Co-operative Society to build sufficient decent housing for their workers on the periphery of Woolwich and is a fine example of the early 20th century Garden City Movement. The homes benefit from decent sized gardens and there are two large green open spaces on the estate, intended to enhance the lives of the people living there and provide them with healthier living, echoing the philanthropy of the time.

The planning controls on the Progress Estate are listed within the Article 4 Direction. Article 4 brings alterations to properties under planning restrictions which ordinarily would not apply. These restrictions tested the retrofit team to use innovative and sympathetic designs, ensuring the retrofit was in keeping with the conservation area.

The property is a 2 bedroom, three person home, with a bathroom, a lounge/dining room and kitchen. The garden is south-east facing, appropriate for the installation of photovoltaic panels on the rear roof. The property has solid-walls and forms one end of a four-house terrace. It is rendered and has a pitched roof with a front-rear gable. Originally the windows would have been in timber six-light casements, but at some point these had been replaced with unsympathetic uPVC double-glazing. The door was the timber original with high level, six-light glazing.

Collectively, the fabric of the building produced a relatively high primary energy demand and carbon count before the retrofit. Consequently the opportunity to improve the home's performance seemed relatively easy. Taking this into account, the team then looked to achieve an 87% carbon reduction in the proposals (Table 1). The baseline figures were provided by the TSB for a property of this type.

Table 1: Baseline and Proposed energy figures

(SAP Calculations)	Primary Energy (kWh/m^2/yr)	**Co^2 Emissions (kg/m^2/yr)**	Heating Demand (kWh/m^2/yr)	Annual Running Cost £
Base case	620.00	**104.00**	329.00	638
Proposed	100.00	**14.00**	70.22	225
	CO^2 saving of	**90.00 (87%)**		

6. Design

The retrofit design encompassed three main components each of which was supported by a number of measures to contribute to the homes high carbon reduction target.

- To minimise the air leakage and heat loss;
- To improve the efficiency of the space and water heating;
- To reduce the overall energy demand of the property.

ECD Architects already had the design of the retrofit drawn up at Phase 1 of the project. The only aspect of the strategy which changed from the initial stage was the removal of the Magnoboard (ceiling board) as this product had been discontinued.

Table 2: Measures Applied at TSB034

Strategy	Measure	Description	Performance (U-value, etc)	CO_2 Reduction
To minimise air leakage and heat loss of the property.	Thermal Insulation	Internal wall insulation - 100mm wood fibre plus lime plaster finish	0.33 W/m^{2}K	3.047 tonnes/yr
		Floor insulation - Wood fibre between and over joists	0.20 W/m^{2}K	
		Roof insulation - 400mm blown cellulose insulation	0.10 W/m^{2}K	
	Air leakage reduction	Wet lime plaster, floor panels, OSB ceiling, proprietary tapes and loft hatch.	Min 3.0 q50, down from 9.4 q50	0.746 tonnes/yr
	Heat recovery ventilation	Envirovent Energivent Q modular system plus ducting	86% efficient heat recovery, sfp = 0.74W/l/s	
	New windows and doors	Legacy vacuum-glazed, timber casements from Jeld-Wen	Uw, 1.55 W/m^{2}K	0.488 tonnes/yr
To improve the efficiency of the space and water heating	Efficient Heating system	Baxi Ecogen micro-CHP boiler plus rads plus Wattbox controller	85% combined efficiency,	1.249 tonnes/yr
	Wattbox	Home heating controller	Maximises the performance of space and water heating	N/A
To reduce the overall energy demand of the home	Photovoltaics	0.85kWp polycrystalline array at 40° pitch	1146 kWh per annum predicted	0.484 tonnes/yr
	Lighting	Antares LED	3.7W per lamp	0.125 tonnes/yr
	Appliances	A++ rated	-	0.134 tonnes/yr

	Resident Engagement	Engage with the resident to enable a full understanding of how to home works and how best to make the most of the energy reduction	-	Unquantifiable benefits
Other Sustainable Refurbishments	Two flush toilet system, eco taps and shower head	To help with water conservation in the property	-	
	Recycling facilities	To encourage the resident to recycle and live in a sustainable manner	-	
	Dulux Ecosure Light & Space paints.	To maximise the natural light within the home, reducing the need to switch the lights on.	-	
Total carbon dioxide reduction				6.273 tonnes/yr
Anticipated carbon dioxide saving (floor area of 62.58 m^2)				*100.23 $kg/m^2/yr$* *(better than target)*

Key choices of materials

Internal Insulation – Pavadentro, a wood fibre insulation lining board was the insulation of choice to use on this project. Internal insulation was the only option within the conservation area. This product was chosen due to its unique properties that are ideally suited to the protection of historic fabric and the creation of healthy, comfortable living environments, specifically designed to make the building fabric 'breathe'. Pavadentro slows water vapour diffusion and relies on its hygroscopic and capillary characteristics to return moisture back to the room as conditions permit.

Windows & Doors - Vacuum glazed windows fitted in heritage frames, from Pilkington energiKare in collaboration with Jeld-Wen UK, were chosen as the most favourable windows in replacement for the uPVC double glazing. The double glazing is unnoticeable, with a 20mm grid of micro-spacers within the unit which keep the glass surfaces 0.2mm apart, giving the effect of single glazing with the properties of double glazing with a U-value of 1.4W/m2K for a glass thickness of only 6.5mm.The front and rear door have also been retrofitted with insulated, air tight replacements, preventing heat from escaping in the usual manner. A letter box is absent from the front door, and fitted by the side of the door on the external wall, to ensure maximum air tightness.

7. Construction

Procurement
Mears negotiated with Hyde on the overall contract.

Contract type & structure
Contract type – JCT Intermediate Building Contract Revision 2 2009 Edition.

Mears Projects are specialists in subcontract management. Through our highly efficient subcontract teams, who have worked and delivered constantly on key drivers such as time, quality and value for money, we were able to manage the cost of delivery and risk. With this joint commitment to the risk element, we achieved an equal understanding as to the importance of this project. Once the buy-in was achieved, all parties involved were committed to delivery which in turn provided flexibility, for example, when long working days were required to complete various elements of the works.

Sub-contractors – how many and which trades?
Mears employed one main subcontractor, managed by our directly employed site manager, who was on site all the time.

Specialist installers
PV element subcontracted out to our Partner British Gas, who also installed the Baxi CHP unit.

Specialist equipment suppliers
PV, MCHP boiler procured though our procurement department at Projects Head Office where all procurement took place with the exception of the Wattbox.

Site supervision
A directly employed Site Manager permanently supervised the site. Regular meetings were held on site with Project QS and Architect.

Role of architect/design team
The combined role of the QS and Architect oversaw the design.

Repeating the success and avoiding problems
After completing a number of sustainable "exemplar" projects, both as part of the TSB initiative and also via directly financed projects with a number of clients, Mears were able to have significant input into the pre-planning and selection process of the various materials and solutions. With the overall specification agreed before hand in the prequalification stage, for the main funding element, and being involved in those early discussions, Mears had a full understanding of the concepts, and the issues which may be involved in the delivery of the same.

Once funding had been secured for delivery of the main project, meetings were held on site to agree how the various areas of expertise and selection of materials were going to be delivered. Mears highlighted the items of concern such as the windows, and the new trial products (to Mears).

The windows proved most challenging due to the delay in delivery from Japan. The team had to work around the window installation, yet still managed to deliver the project on time.

From a contracting position, quantifying (areas) all elements of the works provides clarity in pricing and delivery to budget. Shared risk between the client and the main contractor encouraged responsible pricing on the installation of materials which have not been used before.

Key to the success of this project were the exhaustive pre-planning, understanding of the products and how they integrate with each other, as well as appreciating the needs of the end user.

8. Commissioning & Occupancy

Commissioning

Maintenance was considered early on in the process and, with this, the servicing of the technologies in the property. The equipment which required commissioning / balancing was:

- The Baxi Micro CHP boiler (Landlords Gas certificate issued)
- The Photovoltaic System (electrically tested for compliance)
- The whole house ventilation system (Balanced)

Hand-over process

ECD were tasked with providing a Traffic Light Coded Home User Guide for the resident. This booklet lists tips underneath the titles ‘how to keep your house warm’ and ‘how to keep your house fresh’ as well as providing the resident with an understanding of why they are living in a retrofit house and the importance of the monitoring.

Occupancy & Resident Engagement

As the residents moved into the property, they were given an in-depth, easy to follow tutorial on getting the most out of their new home. They were shown how each piece of equipment worked and how the home would make savings on their utility bills. Education and understanding must always form part of the delivery model.

9. Costs

Item Stage>	Design stage Materials	Design stage Labour	Construction Stage Labour	Comments
Management and administration		Incl.	12,400	PM, QS & CDMC
Design - Architecture		Incl.	12,000	Architect, Structures & M & E
Design – Structural			1,300	Chimney inspection & repairs
Construction Costs				
Prelims			22,040	
2C Roof			2,157	Eaves/soffit vents & Warmcell blown Insulation
2E External Walls			12,206	Pavadentro Insulated dry lining system, external redecoration
2F Windows & External Doors			17,647	External doors and windows – Pilkington EnergiKare Legacy 6.5mm vacuum glazing
2G Internal Walls & Partitions			2,243	Remove and replace internal partitions
2H Internal Doors			636	Undercut door for MVHR
3A Wall Finishes			1,475	Decorations and joinery
3B Floor Finishes			6,572	Warmcell & Pavaboard Insulation, breather membrane, remove & relay boards, ply & hardboard & skirting's
3C Ceiling Finishes			3,140	Remove lath, S & F OSB board & Siga airtight tape & Wellhofer hatch
4A Fittings & Furnishings			1,970	Washing machine, Fridge Freezer, Oven & Extract (recirc)
5A Bathroom			2,100	Bathroom fittings and finishing's.
5A Kitchen			3,675	Kitchen fittings and finishing's.

5C-G Mechanical			212	
MVHR			7,126	Mechanical ventilation, heat recovery system
Boiler/Miro CHP			8,554	Boiler/CHP & insulated pipework etc.
PV & Structural support due to PV			6,534	Photovoltaic panels on roof
5H-L Electrical			5,528	Complete rewire, new LED lighting & connections to PV installation. Supply and fix ariel.
5N BWIC			5,842	Air tightness
External Works			1,021	Paving's & fence repairs
Meters & O & M Manuals			1,221	Electric & gas meters
Monitoring equipment			8,089	Watt Box
Total Final Account			**120,284**	
R & D costs			2,000	National Physics Testing of Thermal Blinds. Not carried out - subject to budget if PV not carried out.
Total			**150,484**	Total Excl. VAT

Note: The above figures reflect the total anticipated final account including PV installation (subject to alteration as a result of planning requirements).

Note: The above figures exclude VAT (Rates vary).

10. Wash–up meeting

No wash up meeting took place for this project.

The main point of discussion from this project arises from the planning refusal for the PV. Despite positive early talks with the council, there are still no panels on the roof at the property and without these; the home will probably not reach the 80% reduction target set by the TSB. This element of the project is frustrating and puts the delivery delay of the windows in the shade. Questions must start to be raised surrounding the different governmental organisations and the commitment to reach the central government's target by 2050.

11. Doing it again

Please see table below which takes a detailed look at the lessons learnt and recommendations which came out of the project.

Recommendation	Response	Reason
Definitely do again	The majority of measures retrofitted in the property	When retrofitting in a Conservation Area again, Hyde would use the majority of the measures implemented (pending monitoring results). To give a few examples – 1. The Pavadentro was challenging to install and could not have been done if the house was occupied, but the finish of the product is pleasing and ticks all the boxes for conservation areas. 2. The Wattbox is easy to use and has learnt the living pattern of the residents. 3. The resident engagement is something that Hyde will be rolling out over the next five years as it is pivotal to the performance of retrofits. 4. The use of experienced and committed contractors. The attention to detail and commitment by Mears Projects was invaluable to the success of the project.
Definitely not do again	Source vacuum glazing from Japan	• Sourcing from Japan was not in keeping with the ethics of the retrofit; however the appearance and performance of the glass was an overriding consideration. • The distance the glass needed to travel caused a substantial delay in delivery and held up the project. • The delay in delivery brings into question how the glass would be replaced efficiently if a pane was to get broken in occupation. • We have been informed that the technology will be moving closer to the UK once demand increases. This will be beneficial for the homes which are currently fitted with the glass and for retrofitting in future conservation projects.

	Lime Plaster	• Mears found the lime plaster extremely difficult to use. • An even finish was very hard to achieve.
Improvement of the design process	Have a contingency for PV	• If the PV panels are not installed, the team have no contingency plan and the home will not reach the 80% reduction target. • In future, it would be sensible to factor in renewable energy contingency plan.
Improvement of the construction process	-	• The construction process reflected the lessons learnt from the first retrofit completed by Hyde, Mears and ECD. The team ensured a comprehensive air tightness strategy was in place before entering the property and this enabled the property to reach a better than anticipated final air tightness. No improvement could be made. The contractor's commitment to the project was invaluable.
Improvement of the commissioning and occupancy process	-	• The approach to the residents and commissioning could not be improved.
A large scale retrofit using the same strategy and technologies would be achievable. However, the monitoring results will be crucial in order to assess the true value of the retrofitted technologies.		

12. Business benefits

Hyde has recently launched our five year Environmental Strategy, proving that we are not just about one off exemplar projects. Within the strategy, we aim to use our experience and findings from the Retrofit & Replicate projects to ensure that Hyde is moving forward and progressing with retrofitting in the best possible way.

Hyde believes resident engagement is just as important as retrofitting technologies in order to reach our 80% reduction target by 2050. Without engaging residents and providing a greater understanding of the importance of living in a sustainable manner, retrofitting is almost insignificant. Hyde recognises the importance of educating residents on the retrofitted technologies in their homes, providing residents with a good understanding of how their homes work. At the Retrofit for the Future property, the residents really benefitted from a tutorial from the Architect to understand just how their new home works. Over the next five years, Hyde aims to educate and empower our residents with issues of sustainability to result in a reduction in the cost of energy bills and to make greater use of the private and communal outdoor environments. Hyde will provide advice to help residents save energy and live sustainably, interacting with an increasing number of residents year on year.