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: ZA613K
Property number: TSB122

Author: Together Housing 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.
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Final Report

Project information

- **ZA reference number:** ZA613K
- **Location of property:** BB9, Lancashire
- **Lead participant details:** Together Housing, Albert Road, Colne, Lancashire, BB8 0RY
- **Date report issued:** 12th January 2012

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1. Project details and directory

Role	Organisation	Contact Details
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Housing Pendle	Together Housing Group	Address: Colne Town Hall, Albert Street, Colne, Lancashire, BB8 0RY. Tel: 01282 873745
Architect	Broadway Malyan	Address: Riverside House, 2A Southwark Bridge Road, London, SE1 6DX Tel: 02072614200 Website: www.broadwaymalyan.com
Contract Administrator	Together Housing Group	Address: Twin Valley Homes, Prospect House, Wharf Street, Blackburn, Lancashire, BB1 1JD. Tel: 01254 269127
Main contractor	Wates Living Space	Address: The Royals, 353 Altrincham Road, Sharston, Manchester, M22 4BJ Tel: 0161 946 8800
Sub-contractor – Electrical, heating and PV installations	Aspect Plumbing & Heating Ltd.	32 Leeds Road, Knowsley Industrial Park, Liverpool, L33 7SE. Tel: 0151 545 1888
Sub-contractor – Heating Installations	Aspect Plumbing & Heating Ltd.	As above
Sub-contractor – PV Installations	Aspect Plumbing & Heating Ltd.	As above
Supplier -	Remploy Building	Bardsley, Oldham, OL8 3JB

Windows	Products	Tel:- 0161 627 3355
Sub-contractor – Internal wall insulation	M & H Joinery Ltd	Cotton House, Old Hall Street, Liverpool, L3 9TX Tel: 08707 542600

2. Introduction

The project initially came about as a result of a connection between Broadway Malyan Architects, who were seeking to test the low carbon retrofit market and Housing Pendle, a not-for-profit housing company who look after a number of homes in the Pendle area. The team was interested in investigating whether there could be common approaches to the sustainable retrofit of existing housing stock; particularly if it was vacant, and if there was an opportunity to undertake more major works, such as the joining together of two attached properties to increase the size of homes in appropriate locations. We were also keen to explore whether solutions which reduce energy consumption result in perceived and actual reduced energy bills for low income families.

This project intended to be a "tenure-neutral" whole house solution that could be applied to all typical terraced houses, particularly in an area of the UK that needs regeneration. The architects approached the social landlord to enter the Retrofit for the Future competition, to see what the results of an extreme retrofit might be, and to take from it some of the potential learning and techniques to apply to other properties owned by the social landlord.

3. Occupants

Unfortunately the property remains empty, despite actively marketing the property; both to let and through shared ownership opportunities.

When the property was purchased from the local authority there were planned improvements to the area as a whole, with regards to housing market renewal and regeneration. Unfortunately, much of the local authority's funding was recently cut, which has meant that environmental improvements and group repair works that were planned to neighbouring properties have been abandoned.

Feedback from viewings has been that potential customers are very excited by the property, the accommodation it offers and the technology retrofit; the area is the one thing that puts customers off.

We are still actively marketing the property through local agents and our usual B with Us letting systems, as well as marketing locally within the community.

4. Key dates

Event	Date
Project start date	April 2010
Planning application submitted	N/A
Planning permission granted	N/A
Building Regulations application submitted	January 2011
Building Regulations approval granted	February 2011
Contract for work let / signed	28th February 2011
Occupants moved out	N/A - Empty Property
Start on site	28th March 2011
Completion of retrofit	27th May 2011
Occupants moved in	
Monitoring system commissioned and operating properly	27th May 2011
Building defects corrected	27th May 2011
Building services and controls operating correctly	27th May 2011

5. Pre-retrofit property

The project was the retrofit of two properties recently joined together to form a larger property.

The houses are 2-storey 2-bed stone build solid wall terraced properties – one mid-terrace and the other end-terrace, with ground floor construction that is solid to the rear and timber joist and boards to the front. Both units originally did not meet Decent Homes Standards. However, during the joining of the properties, Decent Homes works took place, which included installation of a new kitchen, a new bathroom, rewire and decoration. The house is not listed or in a conservation area and is of the “hard-to-treat” variety - one of over 81,000 constructed like this particular property, pre-1919.

Although we had no energy bills available (due to the properties being vacant and, of course, having two separate sets of bills which were not available), we predicted that the property used 5,586 kWh per year for electricity and 21,505 kWh per year of natural gas for heating and hot water. SAP modelling suggested that CO2 Emissions were 46 kg CO2/m² per year, with a primary energy requirement of 238 kWh/m² per year.

This property was chosen because it was an opportunity to test whether a series of works could be undertaken to two terraced houses that also originally needed Decent Homes works. The area is one of large family demand in an Asian heritage community. The landlord intended to work in partnership with the local authority to review the work done in the “group repair” programmes and block enhancement schemes such as the Decent Homes programmes, which have generally had a positive effect in terms of property aesthetics but have not had very ambitious goals for energy conservation in general.

6. Design

The original design for the retrofit was to adopt an incremental approach to carbon saving, starting with reducing operational energy demand, delivering energy efficiently and generating energy using tried and tested renewable technology. In terms of initial insulation plans the proposal was for a cold roof; a high performance aerogel “super insulation” system to be installed internally to all envelope and party walls, and the suspended ground floor to be insulated. An air tightness target of 3 m3/(h.m2) at 50 Pa and reduced thermal bridging would be met by best practice measures, and secondary glazing would supplement recently-installed double-glazed windows. Low energy lights and appliances would be partly powered by the electricity as a by-product of a gas micro combined heat & power (CHP) unit – providing 1kW of electricity per hour that can be used in the home while providing up to 24kW of thermal output for space heating & hot water. The installation of a Mechanical Ventilation with Heat Recovery (MVHR) unit and associated ductwork would ensure decent air quality and recovery of useful heat, and 5 square metres of rooftop solar thermal (evacuated tube) panels would contribute to the pre-heating of hot water being delivered into the house through the micro-CHP system.

On the whole, only a few changes occurred throughout the construction phase that had effects on the original plans summarised above. These changes were a result of both rising supplier cost issues, and a detailed investigation that showed previous retrofit work had not been carried out to the standard expected.

Firstly, the cost of the aerogel insulation increased quite dramatically after the Phase 2 application had been submitted. This made it impossible to keep to the retrofit budget and we had to adopt a different strategy for internal insulation, which was the biggest change. We mostly opted for sand and glass internal wall insulation that is made up of rapidly renewable and post-consumer materials. This did increase the thickness of the insulation, which had the negative effects of space loss but the positive effects of a probable reduction in airborne sound transmission. In spaces where there were issues with tight space (e.g. the hallway and bathrooms), a foam-backed plasterboard was used.

The second main change was how we approached the windows. After investigating what had been installed in the Decent Homes work programme we discovered that some of the glazing had been installed “inside out”, which would have made it difficult to access and replace the original glazing should it need to be replaced once secondary glazing frames had been installed. On visiting the property, there was evidence that balls had been kicked against the glass and there is an unfortunately high risk of someone smashing through the

glass, particularly when the building is not occupied. The team therefore looked into replacing the two layers of glass with three layers whilst keeping the original frames, which actually turned out to be possible and a better option than the secondary glazing. Internal insulation reveals had to be maximised to account for the potential heat loss through the uPVC frames and the trickle vents were insulated from the inside and then taped.

The third change was essentially additional works; again a result of poor installation carried out previously. Where the envelope was supposed to have been insulated it was discovered not to have been; the worst effect of this was above the kitchen window, where moisture marks had started to emerge as a result of a damaged timber lintel that had been covered up, causing a thermal and moisture bridge from the outside in. Some walls had to be stripped back completely to be insulated properly and intermediate floors had to be insulated completely, as these had not been done at all.

7. Construction details and lessons learnt

Construction details

Procurement Method: Single Stage Tendering

Contract type: JCT Intermediate Building Contract 2005 Revision 2: 2009.

Contract Structure: Management contractor with most trades sub-contracted.

Sub-Contractors: 5no. sub-contractors.

Specialist Installers: Aspect Plumbing employed to install the solar thermal panels, MVHR and modify existing heating and hot water systems.

Specialist Equipment Suppliers: Wattbox – monitoring system, specified in all TSB projects nationwide.

Site Supervision: Wates Living Space had a full time site manager. Contract administrator made regular site inspections.

Role of Architect: Full design for retrofit works.

Lessons learnt from the project

As we completed this property after TSB052 we brought all the ideas which improved the efficiency in that property over to TSB122. Our air test results at TSB122 were excellent: we achieved a score of 1.64m3/m2.hr.

8. Commissioning and occupancy

BAXI Ecogen Micro CHP Boiler - This was already installed in the dwelling. However because the unit had to be taken down and removed to store whilst to building works were being carried out , and due to the complexity of the unit, the Baxi commissioning engineer attended and set up and re-commissioned the unit at the commissioning stage

Wattbox Controls - Wattbox installed and commissioned the controls system. There have been no known problems with the controls.

Solar Thermal Panels - Commissioning carried out by Aspect Plumbing & Heating Limited who installed the panels. There have been no known problems with the solar panel installation.

Plumbing & Heating - Commissioning carried out by Aspect Plumbing & Heating Limited who installed the plumbing & heating works. There have been no known problems with the Heating and plumbing operations.

Electrical Works - Commissioning carried out by SWJ Electrical Services who carried out the electrical installation. There is a problem at the moment with the first floor lighting circuit tripping, which is in the course of being sorted out.

MVHR System - Commissioning carried out by Aspect Plumbing & Heating Limited who installed the MVHR System. There have been no known problems with the MVHR System.

The property is still unoccupied so there has not been an opportunity to gain any feedback as of yet.

9. Costs

Item Stage>	Design stage		Post-construction		Comments
	Materials	Labour	Material	Labour	
Management and administration					
Design (consultant, architect)		4,654.28			
Construction overall			**53,723.99**	**71,677.56**	
- Prelims				28,299.00	
- Fabric measures			21,710.68	27,617.35	
- Building services (conventional)			1,173.96	5,020.40	
- Low /zero carbon technologies including monitoring equipment			21,613.17	4,344.24	
- Windows & doors			7,888.69	2,629.57	
Occupant temporary housing					
Monitoring and reporting service					
R&D costs (please detail)					
Total out turn cost					**135,433.67** total including 8% profit

10. Wash-up meeting

A wash-up meeting was held on 18th August 2011 - a number of months after completion of the retrofit, once it had been occupied by a new tenant for a few months.

The meeting was attended by the social landlord (including contract administrator), architect and contractor (including project manager and site manager), and was used as an opportunity to discuss the project's challenges. Time was also taken to reflect on what was done and how it could be done better or differently in future. The meeting was structured around the contents of the final report, and all parties could input and comment on the responses to each section.

The team discussed the challenges that were faced, the potential for future working and the issues around tenancy and occupation experienced so far in the project. It was a good opportunity for the social landlord to describe the experiences of letting the property, and the issues of take-up of such a new and unfamiliar product by local people. A discussion that in itself was worthwhile; as the other members of the project team are not usually party to such insight. It was generally felt by all that the project was carried out with the same intentions as originally set out, and that it was clearly a positive outcome that the team was able to meet and reflect on the project with openness and honesty.

11. Doing it again

Definitely do again

Work as a genuine team to solve problems as the project went on. The combination of diligence by the site team and detailing by the design team resulted in a fantastic air permeability result of 1.6m3/m2.hr – a big improvement on the target of 3. Primarily, the measures that would be done again if the property was unoccupied and up for cyclical maintenance works would be the basic energy efficiency items – airtightness (but perhaps not to levels requiring MVHR), loft and wall insulation, windows, lights and appliances.

Definitely not do again

We would be highly unlikely to carry out works like this to a property that had recently undergone Decent Homes works; it would make far more sense to carry out the whole house solution properly when the opportunity is present.

Reduction of costs

The team generally felt that the costs of the measures could potentially pay back fairly quickly. However, the extra costs of rewiring and redecoration to allow for internal insulation was not cost-effective, but unavoidable. The monitoring and controls are fairly elaborate (though it is understood as a necessary item for this project).

Improvement of the design process

Bringing forward input from the supply chain would have improved the design process and would likely have resulted in a different supply chain. The insulation was a good practice example of genuine manufacturer diligence – the manufacturer visited the site and ensured the joiners were properly trained to undertake the work. Until the data is collected over perhaps two heating seasons it is not possible to assess whether the CHP does actually perform in line with the design criteria.

Improvement of the construction process

It would have been useful to bring in the energy companies to consult on meter moves and gas termination earlier in the timescale as this resulted in a number of programming challenges. A more intrusive survey earlier on would have allowed for changes in both design and programming of works.

It is worth noting that due to the poor performance of the joinery team, a different team was used and this had positive effects on the air permeability result.

Improvement of the commissioning and occupancy process

A single sub-contractor for mechanical and electrical may have been more effective, rather than what we adopted, which was essentially a nomination of suppliers. Due to the poor performance of an electrical sub-contractor, a new team was employed and this greatly helped the co-ordination of the commissioning process, which can often be segregated and full of issues over liabilities.

Efficiency gains from a larger programme of retrofits

Shared preliminaries and larger bulk purchases would obviously lower costs significantly. Space would need to be made for storage of goods in a neighbourhood retrofit programme. In terms of personnel, efficiency gains could be made by project management by conducting multiple site visits and in terms of contractors and installer, gangs of workers could work from property to property, reducing the time wasted due to inactivity between trades, e.g. waiting for plaster to dry.

Making replication at scale successful

Financial incentives along the lines of Feed in Tariffs, which have made PV installation, for example, far more common – almost off-the-shelf, would make replication on a larger scale more successful. There is also clearly a skills issue for the current workforce, who are on the whole currently underequipped to attend to such work at a mass scale.

12. Business benefits

The design team gained a lot of experience of using a new technology, and having the chance to try out this innovation in the context of the TSB programme was key. Several other retrofit projects and dissemination opportunities have arisen as a result of the project.

The designers expect to continue this kind of work, particularly whole house retrofit with the benefit of monitoring the post-occupancy data from this project.