Technology Strategy Board
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# 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: ZA614G
Property number: TSB052

Author: Together Housing

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.
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# Final Report

**Project information**

- **ZA reference number:** ZA614G
- **Location of property:** BB8, Lancashire
- **Lead participant details:** Together Housing, Colne Town Hall, Albert Road, Colne, Lancashire, BB8 0RY
- **Date report issued:** 3rd October 2011

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## 1. Project details and directory

| Role | Organisation | Contact Details |
|---|---|---|
| Lead Participant | Together Housing Group | Address: Colne Town Hall, Albert Street, Colne, Lancashire, BB8 0RY.<br>Tel: 01282 873745 |
| Housing Pendle | Together Housing Group | Address: Colne Town Hall, Albert Street, Colne, Lancashire, BB8 0RY.<br>Tel: 01282 873745 |
| Architect | Broadway Malyan | Address: Riverside House, 2A Southwark Bridge Road, London, SE1 6DX<br>Tel: 02072614200 |
| Contract Administrator | Together Housing Group | Address: Twin Valley Homes, Prospect House, Wharf Street, Blackburn, Lancashire, BB1 1JD.<br>Tel: 01254 269127 |
| Main contractor | Wates Living Space | Address: The Royals, 353 Altrincham Road, Sharston, Manchester, M22 4BJ<br>Tel: 0161 946 8800 |
| Subcontractor – Electrical Installations | Aspect Plumbing & Heating Ltd. | 32 Leeds Road, Knowsley Industrial Park, Liverpool, L33 7SE.<br>Tel: 0151 545 1888 |
| Subcontractor – Heating Installations | Aspect Plumbing & Heating Ltd. | 32 Leeds Road, Knowsley Industrial Park, Liverpool, L33 7SE.<br>Tel: 0151 545 1888 |
| Subcontractor – PV Installations | Aspect Plumbing & Heating Ltd. | 32 Leeds Road, Knowsley Industrial Park, Liverpool, L33 7SE.<br>Tel: 0151 545 1888 |
| Supplier - Windows | Remploy Building Products | Bardsley, Oldham, OL8 3JB<br>Tel:- 0161 627 3355 |
| Subcontractor – Internal wall insulation | M & H Joinery Ltd | Cotton House, Old Hall Street, Liverpool, L3 9TX<br>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. 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 learning and techniques to apply to other properties owned by the social landlord.

## 3. Occupants

The property was vacant and unoccupied at the point of undertaking the retrofit project. The previous tenant had been evicted and left the property uninhabitable. Upon the void inspection a number of other issues were identified with the property, mainly dry and wet rot, structure failure of the rear wall at the point of connection to a single story outrigger kitchen, issues with the roof and part wall with an adjacent property.

The property could not have been occupied during the works due to the extensive works required in addition to the retrofit works.

Because the property was empty and we didn't have a tenant immediately ready for housing, and the property required a lot of work over and above what would normally be expected to bring the property into a habitable condition, it gave us a unique opportunity.

TSB052 is a typical 2 up 2 down stone built terraced house which is typical of 70% of the local housing stock in the Pendle area. There is a large rental market of this type of property in the town and indeed in the area immediately surrounding the subject property. These properties are typically hard to heat with little opportunity to complete cavity wall insulation or external wall insulation. Having the opportunity to complete such extensive internal insulation improvements, would not have been possible had the property been occupied.

Housing Pendle promotes the letting of its available housing through B with Us which advertises the availability of property across East Lancashire and is a system which is shared by other active RSL's in the area.

Housing Pendle marketed the property with a full explanation of the technologies and their benefits, but with the proviso that access and training in the properties benefits would be needed.

At the time of writing, the property is in its second tenancy following completion of the work.

Make-up of occupants before and after the retrofit:

| Age band | Number before retrofit | Number after retrofit |
|---|---|---|
| Under 5 years | 0 | 1 |
| 5-16 years | | |
| 17-21 years | | |
| 22-50 years | 0 | 1 |
| 51-65 years | | |
| Over 65 years | | |
| **Please state if (yes/no):** | **Before retrofit** | **After retrofit** |
| Married couple / partners | No | No |
| Couple / partners with children | No | No |
| Single parent with child | No | Yes |
| Any disabled persons | | No |

## 4. Key dates

| Event | Date |
|---|---|
| Project start date | April 2010 |
| Planning application submitted | N/A |
| Planning permission granted | N/A |
| Building Regulations application submitted | 15th October 2010 |
| Building Regulations approval granted | 29th October 2010 |
| Contract for work let / signed | 20th January 2011 |
| Occupants moved out | N/A - Empty Property |
| Start on site | 18th October 2010 |
| Completion of retrofit | 25th February 2011 |
| Occupants moved in | 21st March 2011 |
| Monitoring system commissioned and operating properly | 25th February 2011 |
| Building defects corrected | 18th February 2011 |
| Building services and controls operating correctly | 25th February 2011 |

## 5. Pre-retrofit property

The property was an unoccupied 89sqm 2-bed stone build solid wall mid-terrace house with a half solid, half suspended timber ground floor construction. A currently un-insulated loft space was accessible by stairs but not suitable for habitation due to tight access restrictions. To the rear of the property is a yard with a detached stone store and the front elevation of the property immediately joins the street with no “privacy strip” between front door and public pavement. The house is not listed or in a conservation area. This “hard-to-treat” house is one of over 81,000 constructed like this particular property, pre-1919.

Although we had no energy bills available (due to the vacancy of the property following an eviction) we predicted that the property used 3,779 kWh per year for electricity and 9,302 kWh per year of natural gas for heating and hot water. SAP modelling suggested that CO2 Emissions were 48 kg CO2/m² per year, with a primary energy requirement of 239 kWh/m² per year.

## 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 warm 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 1 m3/(h.m2) at 50 Pa and reduced thermal bridging would be met by best practice measures, and energy efficient triple glazed windows with low u-values would replace existing (or broken) poor performing windows. Low energy lights and appliances would be partly powered by 0.9 kWp roof-mounted photovoltaic panels, which also would feed the installation of a whole house exhaust air heat pump system for primary central heating with integrated thermal store (for domestic hot water to sinks, baths, taps) and acts as a MVHR (mechanical ventilation with heat recovery) system.

A number of changes occurred throughout the construction phase that had effects on the original plans summarised above, whilst the team attempted to maintain the original design intent.

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 of up rapidly renewable and post-consumer materials. This did increase the thickness of the insulation, which had the negative effect of space loss, but the positive effect of a probable reduction in airborne sound transmission. In spaces where there were issues of damp and tight space (e.g. the hallway and stairs), a foam-backed plasterboard was used, fixed with adhesives where the walls had to be “tanked” at ground floor due to the newly-discovered moisture issues.

The second major change was more detailed investigation with the building control officer regarding the use of the loft space, which would previously have been used as a potential extra bedroom. The staircase leading up to it was too steep and narrow to be maintained and the resulting headroom was very low; hence, instead of insulating the roof at rafter level it was insulated at joist level, meaning that it became a cold roof rather than a warm roof. This obviously reduced space significantly but did help to reduce some of the issues

surrounding potential thermal bridging at the junction between ceiling, eaves and external walls.

The third major change was more of a design decision surrounding space usage. This was a two-bedroom, two living-room house with a very small kitchen housed in an annex or outhouse. It was decided to position the heat pump in the annex space where the kitchen was, turning it into a utility room, and convert one of the living rooms to a kitchen with space for some dining. This seemed to be a better and more contemporary adaptation for the house, allowing for a much-improved kitchen whilst housing the rather large heat pump, which replaced the smaller boiler, which was connected to the now terminated gas supply. The heat pump that was installed was a newer model than originally anticipated, and this was due to the availability of the models from the supplier.

## 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 subcontracted.

**Subcontractors:** 5no. Subcontractors.

**Specialist Installers:** Aspect Plumbing employed specialist sub-contractors to install the Nibe System.

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

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

**Role of Architect:** Full design for retrofit works.

**Lessons learnt from the project**

We experienced some minor issues with the air test at this property due to the age and construction of the dwelling. Following the first air test which did not meet the target we went back to the property to reseal around all windows, doors, skirting to walls and floors as shrinkage had occurred through the natural 'drying out' of the property. We also fitted putty pads to all sockets in the property. All of the above work did improve the air test results.

Originally we were going to convert the roof space and insulate to create a habitable room, however due to the existing staircase being unsafe and not meeting current building regulations we decided to remove the staircase completely and close off the roof space, creating a cold roof.

We also had to change the location of the kitchen in TSB052 due to the Nibe system being installed. The only place it could practically go was in the existing kitchen, therefore we relocated the kitchen into the dining room and created a kitchen diner; the property had two ground floor rooms so this proved to be a more practical location for the kitchen. However, this means that the property now has a dining kitchen with only 1 room for general living.

## 8. Commissioning and occupancy

**NIBE Exhaust Air Heat Pump including supply & extract ventilation -** Commissioning carried out by NIBE commissioning engineer. There was a small problem with control settings on the NIBE Unit at the beginning, but a further visit from the NIBE Commissioning Engineer ironed out the problem.

**Wattbox Controls -** Wattbox installed and commissioned the controls system and instructed the tenant on how to operate the system. There have been no known problems with the controls.

**PV Panels -** Commissioning carried out by IGEN who supplied & fitted the PV panels. There have been no known problems with the PV panels.

**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 Tricon Electrical Services who carried out the electrical installation. There have been no known problems with the electrical operations

**Intruder Alarm -** Commissioning carried out by SWJ Electrical who installed the intruder alarm. There have been no known problems with the intruder alarm system.

The plumbing and heating subcontractor personally made a number of visits to the property after occupation, and any queries that the tenant had were hopefully answered.

## 9. Costs

| Item Stage> | Design stage | | Post-construction | | Comments |
|---|---|---|---|---|---|
| | Materials | Labour | Material | Labour | |
| Management and administration | | | | | |
| Design (Consultant Architect) | | 42,642.00 | | | |
| Construction overall | | | 48,723.47 | 48,760.01 | |
| - Prelims | | | | 19,038.00 | |
| - Fabric measures | | | 13,299.46 | 10,702.33 | |
| - Building services (conventional) | | | 487.50 | 621.66 | |
| - Low /zero carbon technologies including monitoring equipment | | | 19,501.71 | 3.131.98 | |
| - Windows & doors | | | 4,902.30 | 1,057.46 | |
| | | | | | |
| Occupant temporary housing | | | | | |
| | | | | | |
| Monitoring and reporting service | | | | | |
| R&D costs (please detail) | | | | | |
| Total out turn cost | | | | | 105,282.16 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, and once the property had been occupied by a new tenant for a few months.

It 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 and take the time 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, where 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 this far for this 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. Aligning trades did save money, e.g. repairing the roof whilst re-pointing and installing PV. 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**

The change to the heating system does not appear to be cost-effective or space-efficient. The heat pump essentially requires a utility room to house it and the ductwork was a lot of work. Whilst gas prices are less than electricity it probably makes sense to keep the gas connection.

**Reduction of costs**

The heat pump and associated changes to the radiators and pipe and ductwork, and 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, based on the input. 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. The heat pump manufacturer was the opposite, and did not supply very useful design input.

**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.

**Improvement of the commissioning and occupancy process**

A single subcontractor for mechanical and electrical may have been more effective, rather than the approach we adopted, which was essentially a nomination of suppliers.

Understanding the impact of the property having a prepayment meter and the need to ensure that this was ‘always topped up’ caused some problems with the allocation of the

property.  This wasn't anticipated and only came to light as we were about to let the property.

**What 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 doing 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 a skills issue for the current workforce however, who are on the whole currently underequipped to attend to such work at a mass scale.

Promotion of the benefits of the technology in simple terms to the man on the street is needed: potential customers were very wary of the property's benefits as much of the technology is unknown and not understood, even within the trades.

## 12. Business benefits

**What lessons have been learned that will benefit the participants' businesses in terms of innovation, efficiency or increased opportunities?**

The design team gained a lot of experience in using a new technology, and having the chance to try out this innovation in the context of the TSB programme was key.

Understanding the simplest measures have made the biggest impact in terms of the work required, disruption to customers (as normally homes are occupied during works). Understanding the benefits of the insulation and managing the air tightness of the property, has resulted in bids for other funding to complete wall insulation works to other properties within the control of the business.

**How many business leads and opportunities has the project stimulated for participants?**

Several other retrofit projects and dissemination opportunities have arisen as a result of the project.

Housing  Pendle is part of the Together Housing Group who have just successfully installed over 1000 solar PV systems in homes across its management.

Housing Pendle is also in the process of installing air source heat pumps to a sheltered scheme, in part due to the learning and participation in this scheme.

**What value of retrofit business do you expect as a result of the project over the next 5 years?**

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.