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: ZA137W

Author: Greenwich Council

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

Technology Strategy Board
Driving Innovation

SBRI
Government challenges.
Ideas from business.
Innovative solutions.

Final Report

Project information

- **ZA Project reference number :** ZA137W

- **Location of property:** London SE7

- **Lead participant details:**

  Housing Services
  Greenwich Council
  The Woolwich Centre
  46 Wellington Street
  WOOLWICH
  SE18 6HQ

- **Date report issued:** September 2011

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1. Project details and directory

Role	Name & Position	Organisation	Contact Details
Property Owner			
Local Authority		London Borough of Greenwich	Address: The Woolwich Centre, 46 Wellington Street, Woolwich, London, SE1-8 6HQ Tel:-0208-854-8888 Website:www.greenwich.gov.uk
Design Team			
Architect		Levitt Bernstein	1 Kingsland Passage London E8 2BB Tel: 0207 275 7676 Website: www.levittbernstein.co.uk
Services Engineer		Sustania	12a Kingfisher Court, Bridge Road, East Molesey, KT8 9HL Tel: 0208 099 6601
Passivhaus advisor (Feasibility stage only)		Healthy Home	
QS		Quantity Surveying Services, Greenwich Council	
Site diary		University of East London, MSc student	
Contractor			
Main contractor		Apollo Property Services Group Ltd	Address: Apollo Property Services Group Ltd Conquest House Church Street Waltham Abbey Essex EN9 1DX Tel: 01992 650333 Email: Website: www.theapollogroup.co.uk

Sub-contractor – electric	Electroplan Contracting Ltd	Unit 2, Kings Eight, St. James Road, Brentwood, Essex, CM14 4LF Tel: 01277 210893
Sub-contractor - heating	See MVHR installer	
Solar thermal installer	Spec 21 Ltd	Unit 2, Chiltonian Ind. Est., Manor Lane, London, SE12 0TX Tel: 020 8852 0921
Supplier - windows	The Green Building Store	Heath House Mill, Heath House Lane, Golcar, Huddersfield, HD7 4JW Tel: 01484 461705
Genvex/Vanvex installer	total home environment	Swallow House | Cotswold Business Village | London Road | Moreton in Marsh | GL56 0JQ DDI: 01608 653069 | T: 0845 260 0123 | F: 01608 652490| www.totalhome.co.uk
MVHR installer	total home environment	Swallow House | Cotswold Business Village | London Road | Moreton in Marsh | GL56 0JQ DDI: 01608 653069 | T: 0845 260 0123 | F: 01608 652490| www.totalhome.co.uk

2. Introduction

This project was successful out of three properties Greenwich Council entered into the first stage of the Retrofit for the Future competition. As a 1920s semi-detached 2 storey house with solid wall construction, it represents a common housing typology not only in the borough of Greenwich, but also across the whole of the UK. It is therefore a useful model for testing replicability of the measures used to meet the competition targets. The property was also identified by the council as appropriate for their extension programme to reduce overcrowding in the borough. Therefore the remit of the project was also to include enlargement from a 3 bed house to a 5 bed house.

Our step-by-step strategy was to test how far we could push the performance of the building envelope to achieve the maximum energy use savings through insulation and air tightness. We used Passivhaus standards as a target. We then used other measures such as energy efficient appliances, increased daylight and a drying area to further reduce consumption. Finally, we aimed to provide the reduced energy required by renewable sources. It was also important for the solutions to be practical and easy to build and for the house to be easy to use and run by future residents. Anecdotal feedback from the residents to do with their comfort and ease of use is seen as a significant part of the data which will be collected in order to analyse the lessons learned from the retrofit.

3. Occupants

The property came into the project as a void in need of major refurbishment. The previous tenants had attempted to carry out structural alterations without permission and had removed supporting walls and chimney breasts without providing structural support.

On completion of the project, the property was advertised as a special “one off”, five bedroom property that had undergone major energy saving measures. Prospective tenants were invited to bid for the property under the Council’s Choice Based Lettings system but there was a caveat that interviews would be held to select the most suitable tenants for the property from the short list of successful bidders.

Five families were shortlisted and interviewed to identify which family had the most commitment to energy conservation and carbon reduction.

The successful family were very ecologically aware and were already advocates of saving resources where possible. The energy saving measures that the successful tenants currently employed were: only washing with full loads, filling the kettle with just the amount needed, showering rather than bathing, wearing layers of clothing rather than turning the heating up, putting washing on the line rather than using a tumble dryer, putting lids on kitchen pans and reducing the amount of heat required to cook, use of CFL lamps, recycling of waste, keeping windows shut in winter, switching electrical appliances off at the wall (not leaving items on standby), keeping the fridge defrosted, not running water while brushing teeth, closing curtains in the evening and avoiding unnecessary journeys. The new tenants were also able to demonstrate a good level of understanding of new technology, which will be invaluable as we have innovative appliances heating the home and the water and providing continuous ventilation. Adults and children from the successful family attended the interview. All the family were able to demonstrate awareness and understanding of the need to reduce carbon emissions and the targets of the project. The family showed a great willingness to work with us to make the monitoring stage of the project a success and said that “if this project helped inform the country of how to proceed with the retrofit programme, then they would feel that they had contributed positively to reducing the country’s energy demands”.

4. Dates

Event	Date
Project start date (when was the first proposal discussed or agreed)	June 2009
Planning application submitted (if appropriate)	2 March 2010
Planning permission granted (if appropriate)	27 April 2010
Building Regulations application submitted (if appropriate)	2 March 2010
Building Regulations approval granted (if appropriate)	18th June 2010
Contract for work let / signed	April 2010
Occupants moved out (state if they remained or property was empty)	Property was vacant
Start on site (site set up)	May 2010
Completion of retrofit	June 2011
Occupants moved in	Aug 2011
Monitoring system commissioned and operating properly	July 2011
Building defects corrected	June 2011
Building services and controls operating correctly	June 2011

5. Pre-retrofit property

Street frontage

Rear of house

The property was built in the 1920s and was a three bedroom, semi-detached, two storey house. It is not listed or in a Conservation Area. It is of solid 9” brick wall construction with a brick plinth and rendered walls. The hipped roof was re-covered relatively recently with clay plain tiles and had three chimneys. The windows had been replaced with low quality UPVC windows. Ground floor construction was in situ concrete slabs, with timber upper floors. The house was uninsulated apart from minimal loft insulation. The house faces east-west front to back, with the side elevation facing north. It sits on a sloping site, sloping up from the front garden towards the rear.

The property was selected by Greenwich Council as being representative of a significant proportion of their housing stock. They identified that over 6000 similar solid wall properties are within their ownership, in terms of both age and construction. They were also aware that this type of inter-war semi-detached property is very common across the UK, both in private and public ownership, and so lessons learned would apply to a large number of similar properties. It was also vacant.

The house fell into the council Extension Programme and part of the exercise has been to add two bedrooms and associated living space to help address local overcrowding problems. This too could be replicated in other similar properties with sufficient garden space, in tandem with the retrofit works. A lack of larger family homes for affordable rent is a current issue in most London boroughs

6. Design

The original retrofit proposals sought to upgrade the external walls, floors and roof to Passivhaus standards of air tightness and insulation. This was to be done using external insulation and render to walls, insulation at rafter level in the roof and removal of ground floor slabs to allow for insulation below a new concrete slab. Triple glazed windows were also to be installed. Particular attention was to be made to party wall junctions and chimneys to ensure a continuous line of insulation. Secondly, energy efficient appliances and other measures, such as increased daylight into rooms, were to be used. The two storey extension enabled us to include larger window and door openings. Lastly the reduced energy requirement for heating was to be met by renewable sources – combined air source heat pump and MHVR for space heating and hot water, supplemented by a solar thermal panel. Again, the new extension allowed us to include a south facing roof slope for the solar panel which was not possible with the original roof configuration.

These proposals did not change significantly before the start on site while the detailed design was developed between the architect, engineers and contractor. Light tubes originally intended to run down the existing chimney flues to help light the backs of two rooms were omitted when the flues were found to be too small.

During construction some modifications were made to the original proposals as more detailed information about the house became available:

- The Vanvex unit, originally intended to be located in the roof space alongside the Genvex, was found to be slightly too tall for the space and was relocated to the kitchen.
- The roof insulation was designed to run at rafter level, partly due to the Vanvex position, but also due to the potential to use the roofspace in the future for storage or as an additional room. Once the Vanvex location was moved, it was decided to move the line of insulation and air tightness to the ceiling level. This also enabled the ait tightness detailing at eaves/ceiling to be simpler and more easily achievable.
- The two chimneys independent from the adjacent house were taken down to help reduce the risk of cold bridging and improve air tightness.

The measures employed in this retrofit were chosen by the design team to maximise energy reduction and provide air tightness to Passivhaus standards. The heating and hot water are both based on air source heat pumps with additional solar thermal adding to the hot water, and as such are all renewables . The solar thermal panels were fixed to the new extension hip roof as there were no other southerly facing elevations on this property.

The super insulation of the whole house was chosen to allow the heat demand to be reduced to such a level that the renewables would be able to meet the demands of a six bedroom house.

Triple glazed eco-passiv windows and doors were chosen to provide the level of air tightness required under Passivhaus.

7. Construction

The project was negotiated with one of the Council's framework contractors on the Decent Homes / Extension Programme, under a bespoke PPC.

The contractor, Apollo London, is a partner of Greenwich's with a long working relationship. Apollo are a management contractor, most labour is subcontracted with the addition of specialist contractors appointed for each of the new technologies and bespoke products.

It was agreed that manufacturers' approved contractors would install and commission all bespoke products such as air source heat pumps, windows, insulation and render system. All contractors were appointed by Apollo London. The rationale was that these were new technologies and that we wanted to be sure that maintenance and warranties would not be an issue.

The specialist equipment was all named in the specification created by the design team. Each manufacturer had an approved installer list. In the case of the windows (Green Building Store), the manufacturer appointed the installer. In other cases, such as the render system, a list was supplied and Apollo appointed a contractor from the approved list of installers. The air source heat pumps were a named supplier in the specification which was Total Home Environment; Apollo were happy to use them.

Apollo had a permanent non working supervisor on site at all times. The architects were on site regularly and were a phone call away.

The Council's Project Manager and Building Surveyor were on site several times a week in the early and end stages with less visits during the middle of the project.

Lessons learnt.
One of the biggest issues for this project was the air tightness requirement. Both the client and the contractors had never worked to this level before. The architects suggested a meeting with the BRE to understand the issue. This meeting really was the turning point of achieving the standard that we were aiming for. The BRE explained in detail how every tiny crack in every substrate would add the air leakage. We had also not realised the air leakage problems that we would have with the 1st floor joists that were built into the walls.

The result of the meeting was that we would double seal every junction and every joint in the build. The ceilings would become our air tight membrane and every entry and exit point would also be sealed such as cable entry points screw fixings. We arranged for both SIka and Dow Corning to visit and recommend sealants appropriate to the job. Dow Corning specified one silicone, one acrylic sealant and one foam, all of which were designed give good adhesion and be highly modulus to provide a good air tight seal.

The original design called for 200mm of insulation to be fitted at rafter level in the roof but this presented us with significant problems trying to provide an air tight seal around the eaves. It was decided to move the insulation to the joist level and use the ceiling below to provide the air tight seal.

Where new partitions were placed, the ceilings were installed prior to the walls to reduce air leakage. Electrical fittings were fitted surface mounted so that we could achieve a good seal to the wall and cables, although in hindsight we would recess these should we repeat the process.

The majority of the house was re-plastered in wet plaster or plasterboard and skimmed; this was vital part making the house air tight.

The project would not have achieved the air tightness targets without the permanent on site supervision to ensure that trades were working according to specification.

Working with small scale manufactures provided its own issue with companies not geared up to supply to strict deadlines. Some manufactures did not know if they had stock or when they would get stock of key components to the programme. It also became clear that small manufactures were not used to providing certain insurance guarantees that our contractor Apollo London required to be able to place them on their list of approved suppliers and contractors.

8. Commissioning and occupancy

The commissioning was carried out by each installer or the manufacturer. This process went relatively well, with a only a small amount of hiccups. We had a issue in linking the solar thermal to the Vanvex water store in so much that these two were installed by different companies. Originally when commissioned the solar thermal panels were not cutting out the temperature sent to the hot water and as the water was not being drawn off (Vacant property) the hot water reached dangerous temperatures.

We had problems with the data logging as there was not much information form the TSB nor the EST. We chose the “off the peg” package from the EST with additional kit purchased through BSRIA. Unfortunately the EST’s database AMME was not ready in time and no one knew when it would be ready. It was difficult to contact the EST or the TSB on this matter and consequently we dealt mainly with BSRIA and Orsis.

The commissioning of the data logging equipment has shown issues with reliability in so much that BSRIA and ORSIS have both been back several times as equipment either stops working or fails.

The new tenants have been given instruction / training on how to operate each piece of equipment and what to do and not do with the structure of the building. We have provided easy to use manuals and have also given a contact telephone number for the teams involved in the project.

Periodic interviews will occur to ensure that the property is working correctly and the tenants are happy with how their home performs .

9. Costs

Item Stage>	Design stage		Post-construction		Comments
	Materials	Labour	Material	Labour	
Management and administration	0	14000	0	4000	
Design	0	27000	0	0	
Construction overall			0	0	
- Prelims	0	0	0	0	
- Fabric measures	12000	10000			
- Building services (conventional)	90000	6000			
- Low /zero carbon technologies	54000	10000			
- Consequential costs	0	0	0	0	
Occupant temporary housing	0	0	0	0	
Monitoring equipment	5000	0	0	0	
Monitoring and reporting service	Inc in above	0	0	0	
R&D costs	0	0	0	0	

10. Wash-up meeting

Due to the nature of the contract and the number of meetings held throughout the project to discuss each issue, we did not feel that there was much to gain from holding a wash up meeting as all issue had been discussed, as well as what we would do next time.

11. Doing it again

We would be very happy to repeat the whole scheme again with a careful look at what technologies are required for which property.

The whole process has given us a bigger insight into retrofit, with the good, the bad, and the ugly issues. The energy saving targets can be very daunting the fist time you attempt this type of project, but as we have gone through a huge learning curve we could improve how we work on future schemes. We now have the working knowledge to resolve specific issues and go forward in a much bolder way than before as we know what works and doesn't work.

We would potentially use each of the technologies used in this scheme again but we are not sure we would purchase from small scale manufacturers due to the time delays in supply issues.

The design of future projects would benefit form the lessons learnt on this scheme and a lot of time and resources could be saved by not having to go around the same circles again. Savings could be achieved in delivery with a large reduction in construction time as we would select suppliers carefully on their ability to deliver and hold ups due to technical problems would be minimised.

If we had consistency of retrofit projects, the workforce would need less supervision and would be able to produce the extreme finishing levels without being reminded as often. Repetition would also drive down cost as work could be produced faster with less labour and material cost could be reduced by manufacturing in larger quantities, achieving "economies of scale".

The key to replication on a large scale is very specific energy saving measures applicable to the property. We would only use the measures that give the best results for the money and not use the more expensive solutions that may only help save a little bit more. Know what is practicable to achieve and stick with it. Always be open to new innovative technology as things are moving all the time. What is not possible or financially viable today may well be possible and viable tomorrow.

Finally, the results of the monitoring process may well lead others to move forward on the retrofit agenda when they see the carbon reductions that are possible in a variety of archetypes.

12. Business benefits

As a local authority, we have benefitted from the positive publicity that this scheme has generated for us throughout the industry and through local press and open day events. Greenwich are proud to have been involved in this energy saving pilot scheme and will look to take lesson from this when managing its future asset programme.

Apollo London have made at least one significant new business lead and opportunities from their own publicity and through our open day where we invited local companies, practices and Housing Providers to attend along with partners and professionals in the industry via the FLASH programme and Housing Quality Network (HQN).

Many representatives of our suppliers were on hand during the Open Day and those that were not present had their literature on display. All visitors that attended the Open Day were handed literature that they were interested in and any special requests were sent by email after the event.

The value of business our partners and us are expecting as a result of this project over the next five years is not currently available. However, Apollo London are currently tendering for works for a company that visited us on our Open Day!