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: ZA571W
Property number: TSB100

Author:
BBP Regeneration Ltd

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SBRI Government challenges. Ideas from business. Innovative solutions.

Final Report

Project information

- **ZA reference number:** ZA571W

- **Location of property:** ME11, Isle of Sheppey

- **Lead participant details:**
  BBP Regeneration Limited
  Corinthian House,
  279 Tottenham Court Road,
  London,
  W1T 7JR

- **Date report issued:** 15th April 2011

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1. Project details and directory

PLEASE NOTE ANOTHER REPORT IS PROVIDED FOR THE OTHER PROPERTY WITHIN THIS RETROFIT PROJECT, TSB087

Role	Organisation	Contact Details
Employer's Agent	BBP Regeneration Ltd	Address: Corinthian House, 279 Tottenham Court Road, London, W1T 7JR Website: www.bbpregeneration.co.uk
CDM Co-ordinator Clerk of Works	Amicus Horizon	Address: PO Box 322, Sittingbourne, Kent, ME9 8PQ Website: www.amicushorizon.org.uk
Employer's Sustainability Consultant	Daedalus Environmental Limited	Address: PO Box 1268, Maidstone, Kent, ME14 9NH Website: www.daedalusenvironmental.co.uk
QS/Cost Management	WT Partnership	Address: AMP House, Dingwall Road, Croydon, CR0 2LX Website: www.wtpartnership.com
Main contractor	Swale Heating Ltd	Address: Heard Road, Eurolink Ind Estate, Sittingbourne, Kent, ME10 3SA Website: www.swaleheating.com
Electrical installation	Swale Heating Ltd	As above
Central Heating	Swale Heating Ltd	As above
Solar thermal	Swale Heating Ltd	As above
PV installer	Swale Heating Ltd	As above
External Insulation	Downs (Insulation + Electrical Ltd)	Unit 16 Poulton Business Park, Poulton Close, Dover, Kent, CT17 0HL
MVHR	CSS Environmental Ltd	Unit 17 Hopewell Business Centre, 105 Hopewell Drive, Chatham, Kent ME5 7DX
Windows / Doors	DWL Home Improvements Ltd	Queenborough Business Park, Main Road, Queenborough, Kent, ME11 5DY

2. Introduction

This project came about as the first pilot phase of a wider regional retrofit project, which aims to retrofit a total of 1,500 homes over the next few years. This will help ensure that the existing properties, which are adjacent to a masterplan area of 2,000 new and highly efficient dwellings, are brought up to similar standards.

The project is a partnership between the local authority, RP Amicus Horizon and local community groups, with support from other professional organisations helping to facilitate the works. The team felt it would be beneficial to compare similar comprehensive retrofit solutions in two different property types, in order to maximise the potential for replicability, and so two properties were selected from AmicusHorizon's stock. This report focuses on one of these properties, TSB100; further details on the second property, TSB087 can be found in a separate report.

It is hoped that the RftF project will be able to demonstrate replicable technologies delivering comprehensive energy and carbon savings to residents, alongside the financial savings that are critical to a highly deprived location.

3. Occupants

Occupants were the same both before and after the retrofit, and occupied the property during the retrofit period.

The occupants were keen to engage with the project and the benefits that would accrue, and all members of the family were keen to understand the technologies and measures that were being installed. Indeed, the resident was taken to the other property within this TSB project, TSB087, to explain the process and some of the technologies involved. They had no prior real experience or knowledge of sustainable energy issues, measures and technologies that would influence the performance of the building however.

The make-up of occupants before and after the retrofit:

Age band	Number before retrofit	Number after retrofit
Under 5 years	1	1
5-16 years	2	2
17-21 years	0	0
22-50 years	1	1
51-65 years	0	0
Over 65 years	0	0
Please state if (yes/no):	**Before retrofit**	**After retrofit**
Married couple / partners	No	No
Single parent with children	Yes	Yes
Any disabled persons	No	No

4. Dates

Event	Date
Project start date (when was the first proposal discussed or agreed)	TSB approval confirmation 27/01/2010
Planning application submitted (if appropriate)	N/A
Planning permission granted (if appropriate)	N/A
Building Regulations application submitted (if appropriate)	05/08/2010
Building Regulations approval granted (if appropriate)	ditto
Contract for work let / signed	01/06/2010
Occupants moved out (state if they remained or property was empty)	Tenant remained in occupation throughout
Start on site	01/06/2010
Completion of retrofit	Sectional completion achieved on 15/09/2010
Occupants moved in	N/A
Monitoring system commissioned and operating properly	30/10/2010
Building defects corrected	Ongoing
Building services and controls operating correctly	Ongoing

5. Pre-retrofit property

TSB100 is a 1950's built semi-detached property, with a GIFA of approximately 83m^2. It has two storeys with 3 bedrooms, one bathroom, has cavity wall type construction, and prior to retrofit operated a back boiler heating system.

Although monitoring of the property was not carried out prior to retrofit, the resident was able to provide copies of some energy bills.

The property was selected from a shortlist of three property archetypes in the area. Tenants from these properties were interviewed about the project proposals, as well as about their views on work being carried out whilst remaining in the property. The project came about as a pilot phase of a wider AmicusHorizon retrofit project, which aims to retrofit a total of 210 homes in the area over the next few years.

6. Design

The following is a list of the key technologies and measures that were originally proposed to be installed in the property:

• Baxi 9kW biomass pellet- a combined stove and boiler delivering space and hot water heating in winter months.
• The Wattbox controller- a newly developed control system which monitors and learns residents' occupancy.
• Kingspan K5 external insulation to filled cavity wall to create wall U-value of 0.2
• Spacetherm C (aerogel nanotechnology) ground floor insulation – 10mm of the Spacetherm blanket is equivalent to 30mm of mineral wool insulation, producing increased benefit with minimal practical disruption
• 2No. Baxi SolarFlo in-roof solar thermal panel collectors providing hot water in summer months. Collector area of 2.32m2 per panel.
• 1.6kWp (8No. Sharp 200Wp) PV panel system
• 93% efficient Appendix Q rated mechanical ventilation and heat recovery unit - providing retained heat within a more air tight structure.

The PV panel specification was amended to Grovit panels. This was done due to the Swale Heating pricing and understanding of PV installations, in that the Swale Heating engineer was trained and the company supported by Grovit for the projects. All other items remained as per the specification.

There were difficulties with installation of the thermal insulation and the windows; both in terms of the window profile (which had to be brought forward to match the external render) and in the need to fit very deep window sills to allow for this movement in the profile. Multiple discussions took place in respect of the side and upper reveals, where one of the solutions was simply to make the openings smaller or cut out and re-profile the windows. There was no intention to make openings smaller, and so windows were brought further out, requiring additional sills and making good.

The installation of the biomass boiler was problematic in that the contractor had not fully understood the servicing requirements for the product; we found out that a space of 500mm *either side* of the appliance was required. There were also issues with the flue, as insufficient materials were available for the installation (additional bends and fixings needed to be ordered). None had previously been installed in retrofit situations, or with a standard brick chimney. Ultimately, the chimney breast was removed and the flue re-routed to allow the boiler to be positioned further back in the lounge; in turn making better use of the living space by making it larger. A suitable base area for the appliance had to be supplied as a result however, a T-shaped marble hearth. Wall areas and ceilings were then made good and the top area where the flue penetrated the ceiling was boxed in for aesthetic reasons.

Externally, fencing to the rear of the property had to be removed to accommodate the external insulation to the building, and alternative means of support had to be found; the original fencing was attached to the wall and we didn’t want to have more penetrations to the insulation than was absolutely necessary.

The porch roof also needed trimming. In essence a concrete slab of approximately $3m^2$ with an overlapping edge, the edge had to be trimmed off using a diamond cutter to enable the external insulation to be installed without allowing a thermal bridge to penetrate, and the guttering to be fixed securely.

The team agreed to maximise the potential for replicability and believed that it would be beneficial to compare similar comprehensive retrofit solutions in two different property types. Although there was some variation in the technologies used for the main heating system and the wall insulation, in the main the products and measures installed were the same. With the balance of hindsight this was perhaps a step too far given the extent of the works and associated budget; nevertheless, two exemplar refurbishments were completed within the available budget.

The technologies were selected on the basis of a combination of applicability and innovation – neither of the two main heating systems in the different properties had been installed in other properties on a commercial basis within the UK. We were keen to explore non-gas boiler type options, and the use of heat pumps did not, under the modelling scenarios, deliver the kinds of carbon savings necessary to warrant TSB investment. TSB100, whilst not ideally oriented (rear faced just beyond south east) did offer some potential for the installation of solar technologies, so these were included. The solar thermal panels in particular offered a good complementarity with the biomass system. Other insulation measures were chosen with a view to robustness (all well-established products) and guidance was sought from Kingspan as to any risks associated with condensation and moisture transfer, in particular with regard to the use of external wall insulation on a cavity wall base. The cavity was also filled. Reducing air tightness to less than 5 also required improved ventilation, provided by an Appendix Q rated MVHR system.

The changes from the initial design and specification had to be implemented as a result of a lack of detailed information from the manufacturer of the biomass system, in particular in relation to access for maintenance and servicing. The work to accommodate the external wall insulation was simply a question of ensuring that details were developed that minimised the risk of thermal bridging at junctions, reveals, etc.

7. Construction

Procurement
Swale Heating were selected as a local company, and one of the building owner AmicusHorizon's pre-tendered framework contractors via the South East Consortium.

Contract type
An amended form of JCT Standard Form of Design and Build Contract 2005 was implemented, incorporating Revision 2 and including Contractor and Sub-Contractor Warranties.

Contract structure
Main contractor with direct labour covering most trades plus some sub-contractors.

Sub-contractors
As in Section 1.

Specialist installers
As in Section 1: all specialist subcontractors were engaged via Swale Heating.

Specialist equipment suppliers
As in Section 1.

Site supervision
Clerk of Works, with daily visiting inspections.

Role of design team
The design team were retained to provide ongoing advice and support to the contracting team as the work progressed. The employer's agent signed off the works and WT Partnership certified the payments to the contractor.

The biomass boiler presented particular challenges for the reasons outlined above. These were in the main issues relating to the use of a new technology and, as a result, the lack of experience with regard to its installation. Nonetheless, decisions should have been made more quickly about the fate of the chimney and the most effective means of getting the boiler in. The decisions over cost were most problematic – by delivering two very different properties for the same budget there was little room for costly works, however this was the route eventually pursued as there was no other option.

The biomass boiler is no doubt fit for purpose - it has been working well since installation – but perhaps with hindsight, knowing that we could not recess it sufficiently into the chimney space due to maintenance requirements, we wouldn't do the same thing again. In this property it was simply too big and we wouldn't want to replicate that solution elsewhere. That said, the resident is overjoyed with it and sees it as a real feature.

The biomass boiler is not readily available, nor are the supporting parts, and the supplier had not thought through the consequences of installation in a UK retrofit environment, where installation processes are very different to mainland Europe.

The resident was informed of the need to transport pellet from the delivery location at the front of the property to the rear storage hopper, and then again into the boiler hopper as and when required. In this scenario this solution was fine but again, without understanding of the resident, or indeed their physical ability to do so, then this solution would not have been possible.

There is clearly also a need for the contractor and the building owner to have continued dialogue with regard to specific products, including the use of solar panels where alternative solutions can be specified. There was some discrepancy between the expectations of AmicusHorizon in terms of the amendments to the roof and those that were necessary to install panels of this type.

The external insulation threw up additional challenges for AmicusHorizon, not least in that additional fencing and landscape costs needed to be met. To the rear of the property the existing decking needed to be removed to accommodate the render, and this was replaced with paving. These landscaping issues were not sufficiently addressed in the original design.

8. Commissioning and occupancy

Commissioning of the following systems was necessary:

- Biomass boiler – challenges addressed as per the previous sections.
- Wattbox control system – some small software glitches that were quickly rectified using an upload of a later version of the software.
- MVHR – most difficult element was getting the MVHR completed – problems getting it into different places. It was not sufficiently 'off the shelf' and all parts needed to be special ordered from Vent Axia and there was always a 24-48 hour wait for delivery.
- Renewable energy systems – commissioned in accordance with requirements of the MCS, no problems discovered.

The tenant was in occupation throughout and had an active interest in the works as they progressed. As a consequence she was kept fully informed by the main contractor at each stage of the process of installation, who was careful to explain what was happening and how the technology worked. The control of all the technologies is handled by the Wattbox, and as such a training session was undertaken by Wattbox on completion to ensure that the systems will be operated smoothly. The resident has also been provided with a copy of the H&S file and a contact number should any concerns arise

9. Costs

In the main, the costs pre and post retrofit were largely as expected. The deviations arose as a result of the unforeseen changes outlined above. For example, the removal of the chimney within TSB100 incurred additional labour costs. However, because the contract was design and build, a fixed price was provided by Swale Heating the main contractor. Any deviations from that price therefore either had to be absorbed by Swale Heating or, in some circumstances (such as the chimney), were negotiated at the discretion of the Employer's Agent.

This would certainly be our preferred route in the future if we were to carry out a project like this again, because whilst inevitably there may be some pricing of risk initially, there is more certainty overall in the wider project costs. What remains a challenge is the issue of VAT – there is very little clarity from HMRC on what VAT rates apply to different elements, materials labour etc, and we relied on Swale Heating to provide guidance. It would be very useful if HMRC or the TSB (or preferably both) could provide a definitive guide to the VAT in retrofit projects.

10. Wash-up meeting

A wash up meeting was held with the whole team present on the 21st of March 2011. The content of the meeting has been described elsewhere in the report.

11. Doing it again

Would definitely do again
AmicusHorizon – given the choice the RP would do it again and definitely with an occupational tenant. This is thought to be better in the long term for the operation of the property and the engagement of residents in the issues surrounding sustainable energy. This is also despite the fact that the decanting cost can be significant for the building owner if it is required that residents for a period of time need to be moved into another property. For short periods B&B accommodation would be fine, and a lower cost.

In order to facilitate replicability (this house type is typical of much of AmicusHorizon's stock) there is a necessity to fully understand the property typology and the works schedule. More work needs to be undertaken initially as a building owner therefore, in order to better understand the possible implications of the retrofit.

Swale Heating, the main contractor, would do it again and the process has helped considerably on understanding costs. They wouldn't perhaps do it again in the same way, but have learnt a phenomenal amount about the design implications and costs of:

- Insulation
- Flooring
- Construction details
- Glazing
- Acting as main contractor and as lead contractor to subcontractors
- Better commercial situation
- Planning of works and integration of activity

Would definitely not do again
The team decided they would not install this biomass boiler again in a property of this type/size, where a chimney still exists.

Reduction of costs
If we'd done a lot more detailed survey work physically prior to the start of the project, costs would have been saved through better planning and the avoidance of unforeseen circumstances. In practice it will always be a balance between causing greater disruption (especially in occupied premises) and making assumptions at design stage. The cost of technologies has also fallen, even since the completion of this project, and therefore costs would be further reduced on later projects.

Improvement of the design process
Again, this links to the above point about more detailed survey for whole house retrofit – the better the starting point for information, the better the design will be and the lower the risk. Having now gained the experience of this retrofit (in conjunction with the TSB087 project), the process will only get better over time.

Improvement of the construction process
Works on the TSB087 property enabled better operation and smoother processes on TSB100, as many of the technologies were the same and the design implications could be

better anticipated. The residents of TSB100 also benefited from TSB087 as we were able to use it as a show house to increase understanding of the technologies and the construction process generally.

Improvement of the commissioning and occupancy process

No comment here – please see the TSB087 report with concerns about the need for and implications of Choice Based Lettings.

Retrofit at scale

In order to make a project of this type replicable, it would be necessary to reduce costs down to a practicable level: on a per unit basis this would need to be in the region of £20,000. This would need to be achieved through a combination of the following:

- Repeated use of technologies and increase in knowledge
- Specification by ***installers*** not manufacturers – this helps with knowledge of the product and speed of installation
- Greater collaboration between and with known partners, so that the delivery model is understood by all parties
- Greater investment in more in-depth surveys
- Greater investment in community engagement from a very early stage
- There also needs to be clarity over the issues regarding maintenance; whose obligation it is and how it will be paid for on an ongoing basis. This is particularly challenging in a low income private household.

12. Business benefits

For AmicusHorizon, benefits are based around having a greater understanding of the need for education about new technologies. Information on these technologies needs to be properly worked through with residents; on Sheppey the Green Doctor approach is being used to help with this.

All parties felt that innovative products and their impacts, whilst vital, need to be more comprehensively understood before they're employed as part of a scope of works. Having now completed the work, there is a much better appreciation of the technologies used. The simple fact that the parties have now all been through the process means that things would be done differently in the future, design challenges more quickly overcome, and issues better anticipated. Inevitably, this will have a clear benefit in efficiency terms in future

Will the RftF project provide a competitive advantage? Yes, insofar as the project will be actively used as a case study of practical experience in retrofit, and should help to demonstrate competence and ability in this emerging field.

It is clear that using the TSB project as an example of completed, complex whole house retrofit works will be of vital importance in selling services in the future, but it is too early to know at this stage what the overall benefit will be and what leads will emerge as a result.

13. Additional information

At this property there were concerns over the interventions of neighbours – questions were asked of the resident such as

- “So how come you’re getting all this work done then?”
- “Why am I not getting this?”

These questions are inevitable, especially given the extent of the work and the fact that the neighbourhood is characterised by high number of social rented properties. We are fortunate that this was the first pilot phase of a much wider retrofit project, so whilst not all properties would benefit in the same way, at least neighbours could be informed of the wider intentions so that they didn’t feel left out. In this way, it would be useful if future projects like this were part of a whole community retrofit, as this helps the engagement process and reduces the risk of any animosity between neighbours.

The Clerk of Works was also concerned about the number of vehicles and the amount of time being spent on site, in terms of disturbance to neighbouring properties, and again future projects would need to spend more time engaging residents as to the purpose of the project.