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: ZA616J
Property numbers: TSB104, TSB105

Author: Peabody

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Technology Strategy Board
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Government challenges.
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Final Report

Project information

- **ZA reference number:** ZA616J
- **Location of property:** London, N15
- **Lead participant details:** Peabody, 45 Westminster Bridge Road, London SE1 7JB

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1. Project details and directory

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Design Team			
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Contractor			
Main contractor		**Wates Living Space**	Head Office: Wates House, Station Approach, Leatherhead, Surrey, KT22 7SW www.wates.co.uk
PV installer		Southern Solar	

2. Introduction

Project Aims

This section summarises the aims of retrofit project as stated by each of the organisations involved. The most important overall findings that came out of the discussion were:

- Due to the nature of the project, all participants viewed it as a research and learning opportunity rather than a primarily commercial venture. From the contract administration point of view, this project was a huge learning curve in terms of the technical aspects and technologies involved.
- As designers, the architects were most interested in realism as an approach. While the technologies used were an unusual combination, they were all highly usable and relatively simple techniques.
- The project was also considered to be an opportunity to investigate the resident-side impact of retrofit and sequencing of works in occupied properties.

The various organisations involved and their specific aims can be summarised as:

Peabody

Peabody is a large Registered Social Landlord providing affordable housing in London. As the main client, the aims highlighted as the main drivers for involvement are:

- From the contract administration point of view, this project was a huge learning curve in terms of the technical aspects and technologies involved.
- The main goal was to deliver a project that would move their properties into the future and assist tenants in understanding “what they got” through the resident liaison role.

HTA Architecture:

- The architect had been involved with the project from the earliest stages with the client. This involved setting and investigating the various options, securing funding and undertaking preliminary SAP assessments.
- A couple of different sites from within the client’s portfolio of properties were assessed in the selection process.
- As architects working in the housing industry, there is an interest in investigating what it takes to decrease emissions by 80%. This project was therefore considered to be an opportunity to learn lessons that could be transferred to their other work.
- As designers, the architects were most interested in realism as an approach. While the technologies used were an unusual combination, they were all highly usable and relatively simple techniques. Similarly, the insulation approach was relatively straight forward and the buildings considered to be “rather ordinary” buildings that were improved through the process of retrofit.

David Miles and Partners:

- The M&E consultant was involved at the design stage, rather than at concept.
- The intent behind their involvement was to see where the future of M&E design was going to be.

Wates Living Space:

- For this project , the contractor was involved in the original conceptual stage of the scheme. This involvement carried on throughout the project; however, different employees were involved at different stages.
- In general, the contractor has been involved with various Retrofit for the Future projects, with involvement in a total of 9 projects overall. The company strategy was to be involved in projects that used various approaches and techniques. This was to ensure that, as an organisation, they could learn a variety of techniques and specifically take the opportunity to expose site teams to this type of work and experience.
- The contractor's experience of thermal improvement retrofit work was in general not to the extreme that the Retrofit for the Future projects were and tended not to include some of the technologies used in these projects (they were more likely to be used on new-build).
- Since much of the contractor‘s work is carried out in occupied properties, the project was also considered to be an opportunity to investigate in the resident-side impact of retrofit and sequencing of works in occupied properties.
- As an organisation, there is also interest in the associated POE work and an interest in the upcoming Green Deal. This project was considered to be a method by which to understand technologies, costs and scaling up of measures in practice in preparation for its introduction.
- The contractor also aimed to investigate how far the Retrofit for the Future budget could be pushed (multi house vs. single house project to see the effect of scaling up the work) and communal solutions for small blocks of terraces.

Philip Pank Partnership:

- The involvement of the Quantity Surveyor was to initially look into the budgets of the project produced by the contractor and advise on the costings.
- The Quantity Surveyor had no previous experience in retrofit; the only other experience in this area was in the field of PV roof installations.

3. Occupants

The residents were the same before and after the project and remained in situ throughout. Four different properties were improved during this project: one property was occupied by two elderly people, whilst the other properties each had four adult occupants.

4. Dates

Event	Date
Project start date (when was the first proposal discussed or agreed)	Spring 2009
Planning application submitted (if appropriate)	26/4/10
Planning permission granted (if appropriate)	28/5/10
Building Regulations application submitted (if appropriate)	October 2010
Building Regulations approval granted (if appropriate)	October 2010
Contract for work let / signed	October 2010
Occupants moved out (state if they remained or property was empty)	Remained
Start on site	18/10/10
Completion of retrofit	23/4/2012 (Certified practical completion)
Occupants moved in	N/A
Monitoring system commissioned and operating properly	Ongoing
Building defects corrected	Ongoing
Building services and controls operating correctly	Ongoing

5. Pre-retrofit property

The project comprised a short block of four different terraced properties (2 end terraces and 2 mid-terraces) constructed in the 1970s. The retrofit project was carried out with the residents of all houses remaining in-situ throughout and involved the use of communal systems for water and space heating and optimised solar thermal systems. The insulation strategy for the masonry cavity walls (with solid concrete party walls) aimed to use external insulation in addition to the improvement of air airtightness to a challenging target value of $2m^3/m^2/hr$.

The estate was selected to be in contrast to Peabody's other Retrofit for the Future project on a traditional 19th century individual property. The specific properties were chosen where it was possible to get agreement by residents of four adjacent properties to participate.

6. Design

Building and Fabric
The main design intention was to apply fabric measures to minimise the sizing of the MVHR and heating systems that were to be installed. This can be summarised as follows:

Wall Insulation Strategy

Approach:

- The architect's design strategy involved targeting very high levels of insulation and to maximise the use of external insulation as the buildings would permit. This was to ensure the levels of disruption for the residents were kept to a minimum. This was considered to be the strategic approach that was to be applied to as many projects as possible.
- External insulation is more viable when undertaking the retrofit of blocks of houses, since

it does not leave outstanding thermal bridging.

- The approach was also used since the properties were not listed.
- The contractor often carried out external insulation works in a “pepper pot” approach; however, in this particular case, since all the properties belonged to one client, the approach made sense.
- The insulation also went down below the DPC level to reduce thermal bridging.

Materials:

- The insulation used was phenolic foam with 2 layers of 19mm Kingspan. A Permarock external render system was also added with Permarock detailing for the sills.

Process:

- The council insisted on the project obtaining planning permission for the external insulation works (among other things). This was due to the extent by which the facade was brought forward. This was considered to be an arguable case by the architect, who felt that it was not necessary, and introduced additional delays at the start of the project.
- It was considered that planning policy guidance was not yet sufficient in this area of work.
- In this property, there were no eaves to bring the insulation up against. Therefore, a box gutter was designed to enable this without the need to extend the eaves. This solution was considered to have potential for wider application.
- It was noted that it is important to consider lighting issues with deeper window reveals that result from using external insulation.
- Window reveals must be considered when undertaking external insulation to avoid issues with thermal bridging. For this, during design stage, wood or UPVC internal linings were considered.
- Since the insulation extended down beyond the DPC level, trenches were dug around the properties down to the level of the foundations.

Floor Insulation Strategy

- No floor insulation was used in this project since all properties had solid concrete ground floors. This would have entailed the use of solid floor insulation that required the removal of flooring, which was not considered to be a viable or practical option in the case of in-situ residents.

Loft Insulation Strategy

Approach:

- All properties had a shallow loft with a shallow pitch which had to be cleared out. The lofts only provided a tight confined working space of about 1.1-1.2m after the addition of a 200mm Celotex layer and boarding to allow for the mains to be passed through.
- The storage space in the lofts was decreased as a result of works, but residents were given a more usable boarded space with lighting. Although loft spaces are not always deemed to residents, they are likely to be used for storage. This is therefore an important aspect to consider when insulating lofts.

Windows and Openings:

- The design intention was to introduce very good windows manufactured in the UK; however, various issues surrounding the installation occurred.
- The windows were delivered 5 weeks late with a further 5 week delay due to incorrect dimensions of many of those delivered.
- The windows have since been installed. However, quality issues concerning the draught stripping and (means of escape) hinges have been reported. A similar installation of

these windows on another project showed problems when thermal imaging had been carried out; therefore it was considered that there was an endemic problem with product itself.

- The installed composite street door expands in summer months due to the heat and cannot be opened.
- “Window failure” caused by problems with the draught stripping was reported to be a common occurrence.
- In addition, many window hinges are unable to bear the increased load of the triple glazing.

Other works:

- The internal impact of using external insulation was underestimated and redecoration work was required since doors and windows were brought out. This mainly concerned internal carpet and tiling works (difficult to match existing ones).
- A new kitchen was installed for one of the properties under the Decent Homes programme.

7. Construction

- Procurement: Negotiated with a framework partner
- Contract type: JCT Minor Works
- Contract structure: Management contracted wholly contracted to one sub-contractor
- Sub-contractors: All trades
- Specialist equipment suppliers:
  MVHR – Vaillant
  Solar thermal – Viridian Solar
  PV – Southern Solar
- Site supervision:
  Site manager – part time
  Peabody clerk of works – visiting inspections

The contract was negotiated with a framework contractor.

The scope for future technical improvements in the process of upgrading the building fabric included:

- In terms of programme delivery, the initial programme was scheduled for 16 weeks but extended to 12 months. The initial programme was considered to be too ambitious and the lead in period too short.
- Various issues that occurred on-site resulting in this included:
  - A last-minute product change (solar thermal) which resulted in a knock-on compatibility issue
  - Weather issues that affected wet trades
  - Slab and foundation redesign was required
  - Problems occurred with window supply chain and dimensioning
  - Internal redecoration works were required
  - The plant room construction was considered to be the critical issue in the delay. This delay could have been improved if the plant was stand-alone (rather than using a building wall - delay insulating that wall).
  - Various gas supply delays which resulted in the contractor being pulled off-site

for 3 months

- The extent of the additional redecoration works should have been considered early on in the project design stage.
- Various issues with the quality and supply chain for the window manufacturer affected the outcome of the project. It is important for UK supply chain to develop to enable the support of mass retrofit.
- It was difficult to engage the council planning team with specific aspects of the project. Planning permission was obtained for various aspects since the plant room was added, walls were brought out and the external appearance of the property was changed (render used and colour changed).

M&E Services

This area aimed to assess the aspects related to M&E services and possible routes to improve future projects. This was undertaken through the provision of an overview of the environmental strategy and the assessment of heating and hot water services, electrical services, and monitoring installation used. The main findings can be summarised as follows:

Systems:

Strategy:

- A communal plant room was designed for the houses and fitted at the end of the terrace. This resulted in some minor design and construction problems. In this case, there was space adjacent to one of the properties; however, in other cases, some additional land or accessible roof space would be required, which would prove to be problematic. Issues of planning permission as well as legal aspects such as future ownership would have to be considered.
- In the original proposal, the original radiators were to be reused in conjunction with the new systems to minimise the impact of the retrofit. However, they were eventually removed since they were no longer correctly sized for the (much reduced) demand.
- An interim changeover period where the services were changed occurred. Temporary electric hot water heating was provided to each property.
- No major electrical systems improvements were introduced. Only energy efficient light bulbs were fitted.

Installation:

- With a communal plant room containing a single gas boiler and large hot water cylinder at one end of the terrace, service ducting was passed through the roof space of each property and comes into what was once the airing cupboard.
- Hot water use was reduced due to the use of low energy equipment. Since a large cylinder is required for water storage for a solar thermal installation, this was problematic due to a lower volume of water used than in a standard installation.
- Hot water fill appliances (dishwasher and washing machines) were installed as part of a research project. This was only introduced as the later stages of the project which resulted in programming issues.
- In terms of renewables, both solar hot water solar and PV panels were used. The solar thermal installation was in particular considered to be highly successful. The roof level was not raised, but planning permission was obtained for the installation (as a procedure). The process was straightforward and no issues were reported.

- A large number of meters were installed for the complicated metering system adding an additional layer of complexity. This was partially due to the detailed information required for the affiliated research project (hot fill appliances). The large number of meters resulted in a loss of space. Billing will be provided to residents via one statement and the setup of the distribution of the solar hot water is still to be worked out.
- A new cupboard over the stairs houses the MVHR unit for each of the properties, which takes up a large amount of space. Issues with the “humming” sound produced have been reported.
- The use of a communal boiler simplifies the maintenance schedule for the client. However, the MVHR installation for each property will be maintained and cleaned by the client.
- Issues were reported in the interface between the installation and controls for the boiler. The cylinder had to be ordered from Germany (additional 3 week lead in) and was too large to be considered a residential cylinder and was therefore classified as a commercial installation. This required that additional safety features be installed.

Monitoring Equipment:

- The main issue with the bespoke monitoring equipment sourced from the different manufacturers was “getting the equipment to talk to one another”.
- The right information to address this issue was not made available to the installers at the time, but has since been addressed.

The scope for future technical improvements in the process included:

- The presence of an M&E services consultant on board throughout the project was considered to be essential. It was suggested that an on-site M&E co-ordinator could be brought on board to assist in this case.
- The use of communal systems was considered to be a difficult option for small scale application. Micro-scale systems and renewables were preferred.

The option to bring a hot water pipe into each property would have improved the current complex systems setup (rather than individual gas supply for each property).

8. Commissioning and occupancy

- From the on-site perspective, the problems surrounding the implementation of the project were understood by the client.
- Although the tenants had been patient given the extended programme delay period, the client had tried to appease them through carrying out some extra works within the property.
- Some tenants were unsure of the modern look of the projects and had concerns on how the project would impact their lifestyle.
- The tenants were considered to be generally dissatisfied with the process which was considered to be a missed opportunity for the project. While some of the tenants were happier with the outcome of the project than others, after the six month period, all tenants had noticed the impact of the insulation and windows. It was expected that after the upcoming heating season, their satisfaction would improve when the effect of the installed systems were fully operational.
- One of the tenants reported problems of overheating; this was considered to be due to

changes in behaviour as they had previously not used heating extensively. Some tenants have also reported that their electricity bills are higher; this was attributed to the temporary switch over period where electric water heating was used. These were the two tenants who were most dissatisfied with the process.

- Various ongoing works are still being implemented and the project was considered to have lost momentum.
- The appearance of the property was greatly improved and commented on by passers-by.
- No handover had yet taken place and was considered to be an ongoing process. The systems and the information will be conveyed to the tenants on an individual basis through a “crib sheet”.
- The only issue expected in the handover was explaining the difference between the old and new systems installed.
- It was also mentioned that the tenants who previously had only electric heating might not use the heat recovery systems and revert to plugging in electric heaters when they were cold.

The scope for future technical improvements in the process included:

- Various aspects to mitigate the issues with on-site delays should be investigated for future projects.
- The construction schedule was too ambitious. A more realistic programme time should have been set up and external works (plant, etc) should have been completed before undergoing any internal works in the properties.
- The seasonality of external works should also be considered in planning the implementation of future project.

9. Costs

Item Stage>	Design stage		Post-construction		Comments
	Materials	Labour	Material	Labour	
Management and administration					
Design					
Construction overall			£195,723	£85,370	
- Prelims			£3,100	£27,769	
- Fabric measures			£29,080	£15,659	
- Building services (conventional)			£5,919	£2,536	
- Low /zero carbon technologies			£157,624	£39,406	Includes new communal boiler installation, and insulation/walkways to loft space. External insulation/windows and associated works
- Consequential costs					
Occupant temporary housing					
Monitoring equipment					
Monitoring and reporting service					
R&D costs (please detail)					Various. Still being submitted to Peabody.

The costs for the project exceeded the predicted budget by approximately £30,000. This was generated through the issues previously discussed such as the utility and window problems. The contingency budget in the original costing was less than this amount.

This number was expected to go down as costs were recovered from other sources such as the Decent Homes and hot water fill appliance research projects, as well as through a complaint submitted to National Grid to recover the costs incurred through the delay in utilities.

Commercial absorption took place on the part of all project partners to allow for the project to be completed as planned. However, the project was considered to be a research project and absorption therefore was expected.

The scale of the works as a multi-house project was completed within the same budgetary limitations as a single house. External insulation was one of the factors that helped keep costs down.

It was also noted that, in the past 12-18 months, technology costs (primarily for renewable technologies) decreased as volumes and competitiveness increased. This was considered to have a potential impact on future retrofit projects.

Aspects that would require improvement included:

- The small scale nature of the project – still considered not replicable in future large scale projects
- The target required by the project (80% reduction in emissions) was not considered to be financially viable. It was more likely that a target of 60-65% reduction would be aimed for in future projects.

10. Wash-up meeting

Meeting held 8/9/2011. The discussions are covered throughout the report.

11. Doing it again

There were issues surrounding implementing design information and installation and the practical challenges of retrofit (access, working with residents in-situ, interaction of trades etc), construction success stories and difficulties, co-ordination of trades and subcontractor performance. This includes:

- The design proposal was comprehensive and had been successful in obtaining the required funding.
- The inclusion of a diverse set of residents on one project is considered to be a highly successful aspect of the project.
- The design of the project was relatively straightforward and information was well communicated from the architect. Design meetings were held to discuss any issues that occurred before commencing on-site. Some minor details on the gables were changed as a result.

The scope for future technical improvements in the process included:

- Continuity in personnel between design and implementation stages is essential. In this particular project, this did not occur for all stakeholders and resulted in communication issues (concept to implementation).
- Improved communication to trades and the client (resident liaison/contract administration) regarding why particular concepts are undertaken and installations chosen is required.
- The boiler manufacturer documents were in German and therefore difficult to understand on-site.
- Increased M&E involvement for the duration of the project was required to improve communication in that area (where most issues occurred).
- Specialist sub-contractors (PV, mechanical and solar thermal) and general subcontractors were used. Their performance was in general good and coordination was satisfactory. With the exception of the communication difficulties previously mentioned

for the boiler controls, communication was in general considered to be sufficient.

Successful aspects: What went well?

The most successful aspects of this specific project included both fabric and mechanical installations, as well as the strategic processes and outcomes. These can be listed as:

- **External insulation and wall render:** This was deemed to be a successful "generic" solution to insulating properties in general. It was also considered to be cost-effective and improved the appearance of the properties.
- **Scale of project**: The project aimed to carry out works on multi-scale properties, which was a successful approach and one that was more realistic in terms of the scope for future works.
- **MVHR:** The installation of the MVHR in all properties was considered to be a credible solution.
- **Resident involvement:** The early involvement of the in-situ tenants of the 4 properties (who were not handpicked) was essential in gaining experience in dealing with differing requirements from various tenant family types.
- **Project Experience:** The experience in gaining funding and the learning aspect of the project are considered to be highly useful for future work.

Repeatable aspects: What would be applicable to mass scale-retrofit?

The aspects of the project considered to be repeatable for retrofit on a mass scale were can be listed as:

- **Scale of project**: The multi-scale property approach, allowed the investigation of scaling up of retrofit measures and the investigation of communal services as a strategy. This approach was more likely to be used in future retrofit projects.
- **External wall insulation:** It is noted that external insulation is more likely to be used in the case of mass-scale roll-out given the relative simplicity of its installation.
- **Solar Thermal Systems configuration:** The solar thermal installation is considered to be successful and an application that has high applicability.

Less successful aspects: What did not go well?

The aspects of the specific project considered to be less successful can be listed as:

- **Programme implementation and timing:** Late procurement and appointment of contractor, short procurement periods, late design changes and a tight programme of work. A longer lead in period would be recommended.
- **Limited availability for M&E consultant:** The M&E consultant was only involved at the design stage, once the project was up and running. The consultant was only available on-site for a limited scope of work.
- **Communal plant room:** The communal plant room construction was considered to be the critical issue in the delay and a complicated option for only a few dwellings.
- **Metering systems:** The use of the highly complicated and numerous metering systems