Technology Strategy Board
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Technology Strategy Board

Retrofit for the Future

Project Final Report

Revision 23, July 2012

Includes Monitored Data Analysis

Hounslow Council

Passivhaus Retrofit

Hounslow Homes
Managing quality homes for London Borough of Hounslow

bere:architects

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Retrofit for the Future, Final Report, Rev 1

Project Information

- **ZA reference number** = ZA522P
- **Project name** = Hounslow Council Passivhaus Retrofit
- **Location of property** = Hounslow, London, TW3
- **Lead participant details** =

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  - http://hounslowpassivhausretrofit.retrofitdiaries.org/

Contents

Project details and directory

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Introduction

The case study house is a detached house (apart from an adjoining single storey extension) which has undergone a deep retrofit by a housing association's in-house maintenance team. It now stands as a successfully completed prototype low energy retrofit.

Using the Passivhaus Planning Package, bere:architects took a fabric-first approach to the retrofit. The monitored data (appendix 6 & 7) demonstrates that this approach has worked very well in achieving a massive reduction in overall energy consumption, mainly by means of reducing the Specific Space Heating Demand of the house. Furthermore, winter and summer comfort and indoor air quality have all been greatly improved. The occupants of the house have long-term health problems of a nature that make them particularly vulnerable to poor air quality. The greatly improved air quality after retrofit has also lead to symptomatic health improvements.

This project has produced great benefits for the occupants. If widely replicated, these benefits have the potential to be extended to the national economy, the environment and even national security. The skills needed to undertake the work are not difficult to learn, and are widely applicable to post war solid-wall building stock.

A key feature of the project was the use of external insulation, which can be applied without major disruption to the lives of the occupants, and without reducing the internal dimensions of rooms. The latter point is an important consideration where a proposal to use internal insulation forces a choice between fabric enhancements and retaining sufficient space for a much-loved piece of furniture tucked between a chimney breast and an external wall.

Hounslow Homes see an urgent need to protect their tenants from fuel poverty and to deliver the health benefits of affordable winter comfort, so they were keen to find out how to improve the energy efficiency of their existing housing stock without the need to decant tenants from their homes. Hounslow Homes' vision is to play a role in contributing to a vibrant, inclusive, safe, healthy and sustainable modern London borough. The social, environmental and financial benefits of reduced energy consumption and carbon emissions from the properties it manages will be fundamental to achieving these goals.

Occupants

The tenants, ~~s of 87 Grove Road,~~ Mr and Mrs O'Donnell, stayed in occupation for the duration of the building improvement works. They are an elderly couple with considerable health problems, but the fact that they were able to stay in situ throughout the retrofit improvements, and that Hounslow Homes were able to adjust the works schedule if the work seemed to be causing the O'Donnell's any worries, is one of the significant achievements of the project.

Occupant profiles before and after the retrofit:

Age band	Number before retrofit	Number after retrofit
Under 5 years		
5-16 years		
17-21 years		
22-50 years		
51-65 years		
Over 65 years	2 (Mr and Mrs O'Donnell)	2 (Mr and Mrs O'Donnell)
Please state if (yes/no):	**Before retrofit**	**After retrofit**
Married couple / partners	**Yes**/No	**Yes**/No
Couple / partners with children	Yes/No	Yes/No
Any disabled persons	One occupant has mobility problems due to ill health	One occupant has mobility problems due to ill health

Open communication channels through the design and construction phases of the project built trust between the tenant, the design team and the construction team. When coupled with early clarification of expectations for what was required during the monitoring and building evaluation phase, this translated into easier follow-up with the tenants. Hounslow Homes knows that involving residents in the management of their homes is vital to delivering better housing services and improving their quality of life. Hounslow Homes Tenant Liaison Officers dealt with the tenants on all matters concerning improvements to their home. Fostering early buy-in from the tenants to the project was fundamental in delivering the project without the tenants needing to move out of their home.

Both the Design Team and Contractors were thoughtful in their engagement with Mr & Mrs O'Donnell; sharing information, always answering any questions or concerns that they had, discussing how the construction phase was progressing and its impact upon their daily lives during the works. Early on in the works, Hounslow Homes discussed and agreed the requirements for access post-construction and the design team provided post-occupancy training to enable Mr & Mrs O'Donnell to make best use of the ventilation and heating systems. The purpose of this was to help them achieve both the best energy savings and the best health benefits from their retrofitted home.

Mr & Mrs O'Donnell seemed excited at the prospect of participating in this project and were exceptionally cooperative and accommodating of the experimental nature of the work. To show their appreciation, Hounslow Homes gave them an award for 'Outstanding Contribution to Innovation' at their 2011 tenants awards ceremony. In fact Hounslow Homes and their in-house maintenance team also deserve an award themselves, for looking after their tenants with such obvioius care and affection.

The O'Donnells understand that a post-occupancy monitoring period is essential to record the impact of the retrofit, and to develop a cost/benefit analysis with a view to advising on future retrofits. The tenants have communicated to us that they are keen to allow the ongoing recording of information, as they would like the knowledge gained from this retrofit to contribute to learning for the greater good, while at the same time they look forward to benefitting from greater thermal comfort and enhanced quality of life. They have also agreed to participate in post-occupancy evaluation interviews, which should provide valuable feedback on tenant comfort and satisfaction.

Dates

Event	Date
Project start date (when was the first proposal discussed or agreed)	01/06/2009
Planning agreed to be permitted development	20/11/2009
Building Regulations - Building notice application submitted	05/02/2011
Contract for work let / signed	10/01/2011
Occupants remained in property	-
Preliminary Thermal imaging and air testing	03/06/2010
Start on site	07/02/2011
First construction phase air test	05/06/2011
Final construction phase air test	04/10/2011
Completion of retrofit	30/07/2011
Monitoring system commissioned and operating properly	28/08/2011
Building defects corrected	Yes, although monitoring shows that solar energy production is lower than normal, and this is being check April 2012
Building services and controls operating correctly	28/08/2011

Pre-retrofit property

The house is a 3-bedroom, detached, single-family dwelling built in the early 1950s. It is made of solid masonry and is typical of a large proportion of the UK housing stock, as well as Hounslow Homes' stock. Double-glazed UPVC windows had previously been fitted in the house, but still it remained cold, draughty and uncomfortable for the elderly occupants. Ventilation grilles in external walls had been taped over, but still contributed to the cold and damp experienced in the winter months, and in the summer months, these grilles created a route for the transmition of noise and dust from aircraft and road traffic.

The house is located in Hounslow, which is close to Heathrow airport, and it is not located within a conservation area. We wanted to complete a retrofit with using external insulation, so the fact that this house was free of planning restrictions against the use of external insulation was a big bonus. The house offered a great opportunity for transformation of both its comfort, and its energy use.

Whilst there has been funding to install cavity wall insulation for some years, (CERT and SHESP), little so far has been provided for deep retrofits incorporating external wall insulation. The holistic approach that we wanted to take included replacing the windows, adding loft insulation, carrying out a boiler upgrade, a re-wiring upgrade, adding a heat recovery ventilation system, upgrading the kitchen and providing an accessible bathroom – all done whilst the residents remained in full occupation of the house.

The pre-retrofit house had ventilation grilles direct to the outside air on the front and rear elevations. Although taped over, they wasted a lot of heat and created uncomfortable, draughty conditions in Winter. The O'Donnells suffered from cold draughts before the retrofit of their house, describing "cold gales everywhere" from the hall, to the front bay window to the vents in the bedrooms.

BSRIA conducted an air test prior to work commencing on the retrofit. This showed the house to have an Air Permeability of 6.2m^3/hr/m^2 @ 50 Pa. Surprisingly the draughty pre-retrofit house would have complied with current UK building regulation minimum standards with regard to air permeability! An additional air test of the building was also performed by Paul Jennings confirming a similar air change rate result of 6.3ach^{-1} (using the Passivhaus units of measurement).

The house was also assessed prior to the retrofit works using the Passivhaus Planning Package to determine the specific heat demand requirements of the existing construction. This assessment showed that the house would require 442kWh/ (m^2a) specifically to heat it, if it were to maintain internal temperatures of 21°C. It is unlikely that the house was ever routinely heated to 21°C before retrofit, because the amount of fuel required would have been excessive.

Design

bere:architects employed a whole house retrofit solution to make the home more comfortable, healthy and cheaper to run.

The retrofit works comprise:

- Passivhaus levels of insulation:
  - 240mm EPS external insulation to North, West and South sides of the house. (240mm extended one meter below ground to reduce cold bridging of the ground slab adjacent the external walls.
  - It was only possible to apply external insulation to the first floor of the east elevation due to the neighbour's single story extension which abuts the east elevation. Wood fibre insulation was applied internally to the walls of the ground floor to mitigate cold bridging in this area.
  - The attic contains 300mm of cellulose insulation on top of 105mm of mineral wool insulation.

- A continuous airtightness membrane was installed in the attic, sealed to a cementitious parge coat on the walls. Windows were sealed to the parge coat with membranes and tapes fitted continuously to avoid air gaps. Airtightness grommets were fitted to all service penetrations.

- Passivhaus, draught-free certified triple glazed windows and doors achieve 0.8 W/(m2K).

- Heat Recovery Ventilation system (HRV) with an operating efficiency of 92%.

- 150mm mineral wool insulation suspended between floor joists to ground floor.

- High performance insulation (0.038 W/mK at 40°C) to hot water pipes.

- Improved airtightness from 6.3ach^{-1} to 1.65 ach^{-1} at 50 Pascals as verified by the BRE.

- Roof-mounted solar thermal array with solar cylinder and new combi boiler.

The original proposal included removing the tiles and inserting a proprietary insulation system between the rafters and over the top of them to a total depth of 400mm. However this idea was dropped as it would not have been possible to do the works without the expense of a temporary roof. The final design utilised mineral wool insulation laid between the 1st floor ceiling joists with OSB boards on top, and cellulose insulation on the top of this. The original design proposals included a flexible air tightness membrane but this had proved difficult to achieve to a high standard on bere:architects' Tower Hamlets retrofit scheme and so it was decided to use OSB boards instead for the membrane. The OSB boards provided a working

platform for the works inside the roof. The board joints could then be taped to provide a continuous airtightness barrier. Duct and cable penetrations could also be sealed to the boards. Cellulose insulation was then blown in to the attic space on top of the chipboard.

The roof eaves were also extended to accommodate the additional thickness of the wall insulation. This was achieved through the addition of timbers to extend the rafters, requiring the removal of the lowest five courses of tiles. At the same time, the timber rafter extension pieces were lifted slightly to provide space for insulation over the top of the perimeter walls of the house. In order to reduce thermal bridging at this point a high performance PUR insulation board was fitted between the rafters and above the perimeter walls in order to provide a continuous insulated envelope over the top of the external walls.

The original proposals had included replacing the suspended timber floor with an insulated ground slab. After consulting with Hounslow Homes, and reviewing a number of options, the decision was made to instead use 150mm mineral wool insulation laid between the floor joists to the ground floor, supported on geo-textile membrane. This was done so that the disruption could be minimised and the floors could be insulated on a room by room basis, enabling the residents to remain in the house throughout the construction process.

A number of small changes were made to the design during the course of construction:

- The existing foul drain was too close to the side wall of the house on the West elevation to accommodate the proposed below ground insulation, so it had to be moved to enable the continuous application of external insulation below ground. A new rainwater soakaway was also created as it was suspected that the existing soakaway was silted up.

- It was necessary to re-wire the entire house due to the bad condition of the existing fuse board and wiring.

- Duct work for the heat recovery system was re-positioned on the first floor south east bedroom to avoid cupboard doors.

- Hounslow Homes also took the opportunity to carry out a number of other improvements to the house including refurbishment of the existing kitchen and the provision of an accessible bathroom with a walk-in bath / shower**.**

Using the Passivhaus Planning Package to model the improved building and expected energy demands, we estimated that the proposals will result in a reduced specific heat demand of 28kWh/(m^2a). This would represent a reduction of 95% compared to a pre-retrofit house heated to the same temperature.

Construction

bere:architects (working in conjunction with Hounslow Homes) led the bid to the Technology Strategy Board, and for this reason bere:architects were required to handle the money supply for this project.

There were some discussions between bere:architects and Hounslow Homes about the practicality of delivering the planned design. For example, there was deliberation over the roof detail and how the top of the wall would be insulated and how it was going to be made air-tight and accommodate the external insulation. bere:architects had originally proposed lifting the height of the whole roof to overcome the hard-to-insultate pinch-point between the walls and the roof, but Hounslow homes saw this as too costly, time consuming and also impractical with regards to the possibility of undertaking this on a much wider scale if it was required for a roll out across its stock. Eventually both parties came to a compromise agreement that included a wedge of internal insulation. If perfectly installed, it was agreed that this would provide reasonable insulation at the pinch-point.

The team's cost consultant, e-Griffin Cost Consultancy, produced a detailed cost analysis of the project and a schedule of works. Hounslow Homes' own Contracts Team was then asked to put a price against the schedule of works using as many of their internal resources as possible. The use of Hounslow's in house contracting team was fundamental to the objective of helping them to up-skill and to practice the delivery of an exemplar whole house retrofit.

Once Hounslow Homes had submitted a price against the schedule of works, the cost consultant evaluated this against private sector contractor prices and judged it to be a competitive price offering good value and it was agreed that the work could proceed. There was no procurement or specialised contract put in place. Instead Hounslow Homes would be paid by bere:architects (who would obtain the competition funds). Both parties were comfortable with this arrangement and keeping the administrative costs down enabled as much of the £150,000 to be utilised on the actual improvement works as possible.

The only subcontractors that Hounslow Homes needed to employ were those that applied the external wall insulation, commissioned the heat recovery ventilation unit and that carried out the air tests.

The design team were in close contact with Hounslow Homes' in-house contractor throughout the build and regularly attended site to inspect the work and arrange toolbox talks for the contractor on new equipment and installation techniques, particularly airtightness. The entire team also maintained close consultation with the tenants, and uploaded information on to the retrofit diary website.

The retrofit started on site in early February, by which time bere:architects' other Retrofit for the Future scheme in Tower Hamlets had already been on site for over three months. As a result, some of the early lessons learnt from the other project could be applied to the works on site in Hounslow. On the Tower

Hamlets scheme, below ground insulation works had delayed the erection of scaffolding and subsequent high level works. Hounslow's team therefore proposed to erect scaffolding first and then carry out the below ground insulation once the scaffold had been struck. The amendments to the below drainage runs were however carried out first in order to allow external soil vent pipework to be repositioned. Unfortunately a long-running dispute between the O'Donnells and the owners of the neighbouring building led to protracted negotiations for scaffolding access resulting in an overall delay to the works on site.

As previously mentioned, the difficulties of using a flexible airtightness membrane on the Tower Hamlets retrofit scheme resulted in the use of OSB board in the loft space of this project. Although this allowed work to proceed quickly in the roof, after the boards has been fixed down, the decision was taken to rewire the house. A number of additional penetrations therefore needed to be made through the OSB boards, each of which required sealing to maintain the airtightness barrier. The OSB board still needed to be sealed to the external walls, resulting in difficult taping and membrane details at the eaves. Upon completion John Thompson, the Hounslow site foreman, suggested that on future schemes it might be more straightforward to lift the roof timbers individually to allow a continuous airtightness membrane to be installed between the wall plate and joists, avoiding the need for taping that was difficult to make airtight around each individual rafter.

Experience of a poorly performing sub-contract installer of external wall insulation on the Tower Hamlets retrofit suggested that the Hounslow Homes team should monitor the application of this technology carefully. Early tool-box talks were carried out with the installers to show that much higher quality workmanship was required than the installers might normally be familiar with and to explain the level of performance expected of the product. In particular, the glue backing of the blocks was to be applied in such a way as to ensure that there were no thermal bypasses. As a result of careful pre-contract discussions, the installation of the external wall insulation was significantly more successful than the installation of the same technology at the project in Tower Hamlets.

Work generally progressed well on site in spite of the uninterrupted occupancy of the house. At times Hounslow's team recognised that the O'Donnells were becoming slightly overwhelmed by the works, particularly the room-by-room ground floor insulation, and scaled back their site presence to provide some respite. The additional upgrade works to the kitchen and bathrooms provided the O'Donnells an immediate benefit early in the construction process, and this helped maintain their interest and support.

However in different circumstances, the O'Donnells might have been less content to suffer disruptions. The kindness and obvious care displayed by the Hounslow Homes' site team and particularly John Thompson, the site manager, were absolutely crucial to the success of the project, as was the excellent tenant liaison team at Hounslow Homes. The entire team built up and maintained an excellent relationship with the residents, who were also exemplary in their appreciation of the work that was being done to improve their conditions and what this would do to improve their future health and comfort.

Hounslow Homes also kept a log of the build process.

Commissioning and occupancy

Open communication channels through the design and construction phases of the project enabled trust to be built between the tenant and both the design and construction teams. Both the design team and contractor were thoughtful in their engagement with the tenants; sharing information; making time to answer any questions or concerns that they had; and realistically striving to communicate how the construction phase was progressing and discussing its impact upon the lives of the O'Donnells.

Early on in the works we discussed and agreed our needs to access the building to evaluate its post-retrofit performance, and reassurance was provided that this would be non-intrusive and that only a passive involvement would be sought from the tenants.

Throughout the build process, Hounslow Homes ensured that the residents had all aspects of the project explained to them. Upon completion of the project, bere:architects provided the residents with an un-hurried explanation of how they could get the most out of the building's new technologies. This included training to explain to the O'Donnells how they could make best use of the ventilation system, maximising energy savings and comfort. A User Guide was produced, carefully designed to be easy and attractive to use, and mounted on a sturdy board. The intention of the User Guide was to make it easy to understand, with the help of drawings and photographs, the various equipment and systems installed in the house. The poster includes a brief description of the retrofit measures and the installed systems, to provide an overview of their operation; referencing the operation and maintenance manuals if further information is required. The poster is designed to be mounted within the boiler cupboard so that it does not leave the house if the occupants change. Hounslow Homes will also have a digital copy of the poster should they need to provide a replacement. During the handover meeting bere:architects will give a practical demonstration of the controls for the boiler and solar thermal controls. Replacing of filters in the heat recovery ventilation system will also demonstrated to the maintenance team from Hounslow Homes as it is understood that they will initially be taking responsibility for this.

As part of the retrofit for the future competition requirements, monitored data is being collected over a two year period in order to verify the energy savings made. The initial readings from this data indicate that the building is warmer in Winter than in previous years. More conclusive results will be possible once the property has been monitored throughout a heating season. This increased thermal comfort has been verified by anecdotal evidence from the residents who have stated that the house feels considerably warmer in cold periods; this is expanded on further in the Wash-Up meeting report. Hounslow Homes are aware that they may have to fine tune the building and its engineering services if noticeable problems are identified in the data analysis.

Costs

From the total project funding a nominal budget was set for the construction works, to allow sufficient funding for design and management fees and VAT. Working with e-Griffin Cost Consultants, bere:architects produced a costed schedule of works. Hounslow reviewed the specification and drawings provided by bere:architects and provided standard day rates for their labour force to complete the cost information. The final construction budget sum allowed for a small contingency of approximately 10%.

The final contract sum also included additional work which was to be funded directly by Hounslow Homes either to bring the house up to the Decent Homes standard or pre-empt future scheduled maintennace works. This included upgrades of the mains water supply and replacement of kitchen and bathroom fittings. Hounslow also decided to bring forward planned decoration works to minimise future disruptions.

The full final account figures are included as an appendix.

Item Stage>	Planned costs		Actual costs		Comments
	Materials	Labour	Material	Labour	
Management and administration		**£13,319**		**£13,319**	
Design		**£17,743**		**£17,743**	
Construction overall		**£104,621**		**£126,768**	total £123,601
- Prelims		£5,980		£5,980	
- Site clearance		£10,739		£10,739	
- Fabric measures		£61,227		£83,375	Increased due to cost increase on windows
- Building services (conventional)					Included in fabric improvements
- Low /zero carbon technologies		£13,272		£17,854	No split between materials and labour provided
- Other		£1,071		£1,071	Builders work in connection with services
- Consequential costs				£22,148	Upgrades to bathrooms kitchen and drainage
Occupant temporary housing		N/A		N/A	
Monitoring equipment		£4,582		£4,582	Includes solar thermal monitoring
Monitoring and reporting service					
R&D costs (please detail)					
Contingency		£7,750			Contingency used to cover additional window costs

Wash-up meeting

A ‘wash-up’ meeting was held on the 17th of October 2011, carried out with researchers from University College London, funded by the Technology Strategy Board.

The purpose of the wash-up meeting was to capture useful lessons learnt from the procurement stage of the works across a small selection of projects. Topics of particular interest were those that would benefit the design of future projects, and also that would be of use to policy makers. Of particular interest to policy makers are the opportunities for increasing efficiency and reducing costs.

Supply chain issues featured as topics of discussion; both in terms of supply of materials and in terms of the opportunities for increased expertise and efficiency amongst some specialist subcontracting techniques, such as external wall insulation. However while current planning policy effectively continues to obstruct the business opportunity around external insulation, it seems unlikely that anyone will be willing to put in the kind of effort that is needed to transform the vitally important external wall insulation sector, regardless of the urgency of the problem.

The minutes from the meeting have been included in appendix 3 to this report.

Doing it again

Hounslow Homes

If the £150,000 funding and the opportunity to work closely with bere:architects came up again, we would definitely undertake another whole house retrofit project. The whole aim of this project was to develop and demonstrate a whole house solution for a refurbishment that delivers deep cuts in energy use and carbon emissions, high levels of comfort, and attractive costs. Heavy scrutiny of the design by bere:architects ensured that we only installed those measures that were strictly necessary – thereby maximizing the use of the £150,000 budget and creating an integrated whole dwelling solution which addressed all the aspects of the home that can be used to cut carbon emissions, including insulation, heating systems, ventilation, white goods and control systems. Much of the work that Hounslow Homes has done to date on its housing stock has entailed the installation of isolated measures to improve the ‘energy efficiency’ in buildings, which has been traditionally straightforward and simple/small but effective carbon savers and in high volume. Technology Strategy Board funding has enabled us to undertake a 'radical refurbishment' and tested our capacity to deliver deep interventions which currently require high spend. In the long term – and looking at the fact that we will ultimately need to retrofit 16,500 homes - it’s now up to us to use this retrofit experience to develop sensible proposals in the middle ground. This

polarization on how much to spend on measures to save carbon however might end up leaving us in a difficult position when trying to find the most cost effective and efficient mechanisms for change as part of delivering the forthcoming 'Green Deal' measures. Unfortunately we simply cannot afford to retrofit all our properties to this exemplar standard, and it would also take far too long to achieve. bere:architects designed this build for us in such a way that we were able to get a better understanding of what measures were synergistic, certainly in terms of capital costs, and doing them at the same time on a wider roll-out scale would offer significant cost savings. For example, the costs of applying external wall insulation drops significantly if done at the same time as re-roofing, and results in a much more technically sound result.

bere:architects

bere:architects are currently working on a number of low-energy retrofits but this was our first opportunity to complete a retrofit using a whole house Passivhaus approach without planning restrictions against the use of external insulation. We wanted to demonstrate the huge and unmatchable benefits of external insulation, in terms of comfort, energy savings, long life and minimal disruption, and we wanted to show that external insulation can greatly improve the visual appearance of a drab brick building, so should be welcomed by planning authorities.

Most of our retrofit projects are carried out at the same time as general refurbishments, so the houses are normally empty during the works. If deep retrofits are to offer a solution for a programme of large scale improvements, we believe that a way needs to be found to carry out the work with the occupants remaining at home. This house was the first opportunity to complete a retrofit with the occupants in residence.

The performance results of the improved house are remarkable. They demonstrate that when a deep retrofit is carried out to a high standard, this creates very healthy and comfortable interiors in winter and summer, as well as the conditions for deep energy savings (see appendices 6 &7).

We would definitely use the same approach again to retrofitting social housing or any other form of housing. The opportunity to demonstrate this approach at a larger scale, on a greater number of houses, would be of interest. By increasing the scale of the retrofit project, we feel sure that it would be possible to significantly lower the investment cost of a deep retrofit. This is because the lessons learnt on the first one or two projects would enable further projects to be completed more quickly by a practiced team, and reliable, quick-response supply chains could be established to further help keep costs and wastage to a minimum. Further significant cost savings could be achieved by eliminating the need for some of the specialist subcontractors. The techniques of external insulation, for example, could easily be learnt by Hounslow's own carpenters who, with practice, could routinely carry out the work to a high standard and low cost.

We understand from the Wash-Up meeting that the Hounslow Homes implementation team believe that they would be able to reduce the labour costs for a single house by 20% as a result of the knowledge gained from this retrofit. We believe that much greater savings could be achieved by revolutionising working

practices and tailoring them to retrofit. But this will only happen once a stronger market for these services has been established.

The level of airtightness achieved was not quite as good as required for Passivhaus EnerPHit certification of the house. The fact that the occupants remained in the house restricted the amount of airtightness improvements that could be made internally.

Heat recovery ventilation was installed to provide ample fresh air after the cold draughts were eliminated. One of the successes of the project was to install this and commission it with minimal disruption to the occupants. HRV can play an important part in providing fresh air after the problem of cold winter drafts has been solved.

The updated PHPP assessment of the energy consumption of the house suggests that it should operate at close to EnerPHit levels which we hope to see confirmed by the ongoing monitoring. Bere:architects are also considering ways to further improve the airtightness of the house in order to try to obtain Passivhaus Enerphit certification.

Business benefits

There are numerous benefits arising from having completed this project:

Hounslow Homes as the ALMO:
The level of heating that tenants can afford directly affects their ability to pay rent. A tenant will almost always pay a utility company before they pay their housing provider. The difficulty that some tenants have in meeting their bills is increasingly becoming a significant worry for social housing providers.

Furthermore, the organisation's costs arising from complaints, repairs, voids and even legal action can be reduced where tenants are content and can pay their bills. It is also worth noting that energy efficiency improvements are likely to improve the asset value of a house.

A good reputation can be attained from being able to demonstrate that the organisation provides good quality homes that are affordable to heat and embody eco-retrofit installations.

Hounslow Homes as the Contractor:
Prior to undertaking this project, Hounslow Homes had never undertaken a whole house retrofit like this, primarily due to

- a perceived lack of ability to invest
- a perceived gap in design and energy performance of buildings (largely due to occupants not using buildings in the way intended)

- Insufficient capability and skills in the supply chain
- Risk aversion to new products, processes and services;
- The pressure of delivering an integrated systems approach for homes and communities.

Having now completed this project, the key benefits that have been realised are: a) Demonstration of working on a project of this scale has provided us with a holistic approach to a whole house retrofit. We are looking forward to working with the design team to capture and assess outcomes and provide independent results; b) Collaboration - the competition has provided us with opportunities for collaboration and cross-sector learning; c) Better awareness of the 'true' costs involved - We have also become aware of the ever increasing need to align public and private funding to maximise impact of interventions; d) Confidence building - we are hoping that the evidence base from this project will provide us with some confidence and help us plan accordingly the retrofitting measures we will look to deliver across the properties we manage.

The Residents:

The tenants have enjoyed much greater comfort and lower energy bills in their first months of occupation, and particularly over the winter months. The O'Donnells benefit as much from being able to afford adequate warmth in their home as from reduced fuel costs. This leads to the creation of a more comfortable and healthier home environment.

With the heat recovery ventilation system installed as part of the retrofit, the house is now receiving a plentiful supply of fresh, filtered air. Only one month after completion of the project, Mr O'Donnell noted an improvement in his breathing. This was of great importance to him as he suffered from chronic obstructive pulmonary disease.

Prior to the retrofit work commencing the residents had complained that it had felt like a gale blew through the hallway in winter and that the bathroom was significantly colder than the rest of the house. Now they are able to move from room to room comfortably without needing to put on additional clothes or turn on or adjust the heating.

bere:architects:

By far the greatest benefit to bere:architects from this retrofit project has been the opportunity to test Passivhaus retrofit measures at a domestic scale, and with external insulation.

The project has indicated that with practice it should be easy to achieve Passivhaus EnerPHit levels of energy efficiency and comfort.

We believe this project will be important in convincing RSLs that this level of improvement can be achieved with their existing stock. We have recently established a working group to assess the costs of building to the Passivhaus standard and the savings that can be achieved by increased volume and efficiency. The results from this retrofit will be used to contribute to that research.

Bere:architects also hope to continue their working relationship with Hounslow Homes, particularly investigating the potential opportunities for scaling up the retrofit approach.

Additional Information

The role of property management organisations, such as Hounslow Homes (ALMO), in influencing emission levels in their stock largely relates to their responsibilities to carry out maintenance and improvements to homes so that the homes continue to meet the needs of tenants. Refurbishment to reduce carbon emissions has to date been largely restricted to relatively low-cost measures (loft insulation, draught-proofing, etc). The installation of more costly low-carbon / micro-generation technologies and indeed whole house solutions by Hounslow Homes (and indeed other ALMOs, social landlords, etc) is still quite rare and is typically reliant on central government grant funding initiatives.

Until now, there has been no hard evidence that large energy savings can be achieved by a deep retrofit. The low-cost measures usually adopted rarely achieve the predicted energy and carbon savings (typically around 15%) because people who cannot afford to heat their homes understandably want to take the opportunity of improving their comfort after retrofit. The benefits of low cost retrofits are therefore almost entirely absorbed in improving winter comfort conditions. Whilst this is highly desirable, it will not contribute to lowering UK carbon emissions.

By contrast, monitored results from this project and interviews with the O'Donnells show that a deep energy retrofit as demonstrated by this project has the ability to increase comfort and energy efficiency, and reduce carbon emissions.

The Technology Strategy Board is a business-led executive non-departmental public body, established by the Government. Its role is to promote and support research into, and development and exploitation of, technology and innovation for the benefit of UK business, in order to increase economic growth and improve the quality of life. It is sponsored by the Department for Business, Innovation and Skills (BIS).
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