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: ZA358Y
Property number: TSB059

Author: Metropolitan Housing Partnership

The work reported here has been funded by the Technology Strategy Board under the Small Business Research Initiative (SBRI) under the Retrofit for the Future programme. This project is one of nearly 90 projects funded under the programme. Further information on the programme can be found at: www.innovateuk.org/retrofit

Technology Strategy Board
Driving Innovation

SBRI
Government challenges.
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Final Report

Project information

- **ZA reference number:** ZA358Y

- **Location of property:** Tottenham, N8

- **Lead participant details:**

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  Improving life together

- **Date report issued:** 31 August 2011

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1. Project directory

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2. Introduction

The property that has been part of this Retrofit for the Future competition is a mid-terrace, Edwardian street property. It is part of Metropolitan Housing Partnership's (MHP's) social housing stock in Haringey and typical of much of its stock in this area.

MHP's Neighbourhood Investment Unit (NIU) has successfully refurbished nearly 300 of these hard-to-treat homes in the borough to levels exceeding the Decent Homes Standard and typically achieving carbon reductions of 45%. The NIU works closely with the residents of the home to support them, involving them in the refurbishment of the property and also other community investment programmes such as healthy eating, sports programmes and employment initiatives.

The NIU already had a wealth of experience in managing 'whole-house' transformations by installing a complementary, cost-effective range of energy saving measures. By taking the existing approach and expanding it to the aims of this competition, MHP aimed to provide a template for achieving even greater reductions in its standard retrofit works.

The project team for this competition was drawn from previous successful collaborations on award-winning schemes and, from that, a commonly shared interest in sharing learning and a commitment to better understanding the performance of our green homes once in occupancy.

In examples of both major refurbishment projects and within new build developments, MHP has experienced the challenges of trying to support residents to close the gap between the designed performance of greener homes and the actual performance achieved in situ.

The project team were clear that they wanted to avoid an over-complicated technological solution that relied heavily on the end-user understanding often complex and confusing systems and controls. The project team wanted to deliver for MHP and the competition an example of a whole house approach to retrofit based on the application of Passivhaus principles, prioritising insulation of the fabric, achieving excellent air tightness with minimal space heating requirement, whole house heat recovery ventilation and a focus on simple systems and controls to make it easy and intuitive for the residents to operate.

There was also a clear commitment and desire within the project team to gain experience from the programme and learn new techniques and skills, using the programme as a springboard to deliver affordable (for the resident), very low carbon homes to the people most in need and at greatest risk of being in fuel poverty.

3. Occupants

The occupants of the home are new, following the retrofit of an empty/void property. However, having earmarked the property for this competition, and following success in phase 1 of the competition, MHP was able to involve the intended resident from the outset of phase 2 the project.

By maximising tenant involvement in the project, we have ensured that they accepted and understood the need to monitor the property whilst they live there and appreciate their obligations in that regard.

The property underwent major structural works, and was therefore empty throughout the time of the works. There is no way the property could have been occupied during the works phase.

At the outset of the project we selected the intended resident following an interview process with prospective tenants from the waiting list. All eligible families were presented with an explanation of the project and details of the benefits and conditions (i.e. a very low energy house, extremely low energy bills; but a delay before moving in and the requirement to allow monitoring, both discreet and direct, over the course of the project).

The requirements on the tenants in terms of access, care of monitoring equipment and participation in monitoring and evaluation work were detailed in a tenancy addendum that the tenants sign up to prior to occupancy. These requirements were discussed and well known from the recruitment stage, but inclusion in the tenancy agreement will help guarantee success in achieving the monitoring requirements of the project.

The successfully chosen resident was a mother and her two children. They were involved from the design stage, throughout construction including project meetings and on completion of the project they moved in.

They have continued to be involved and very accommodating of a number of open days, of the monitoring of the project and indeed some additional testing of the use of a number of home information panels – testing different approaches to informing the resident on their energy usage / estimated monthly bills. This resident ‘self-monitoring’ (and demonstrating how this will save them money) we feel is a very important component of the wider monitoring strategy and indeed the needs of the competition.

Occupants before and after the retrofit:

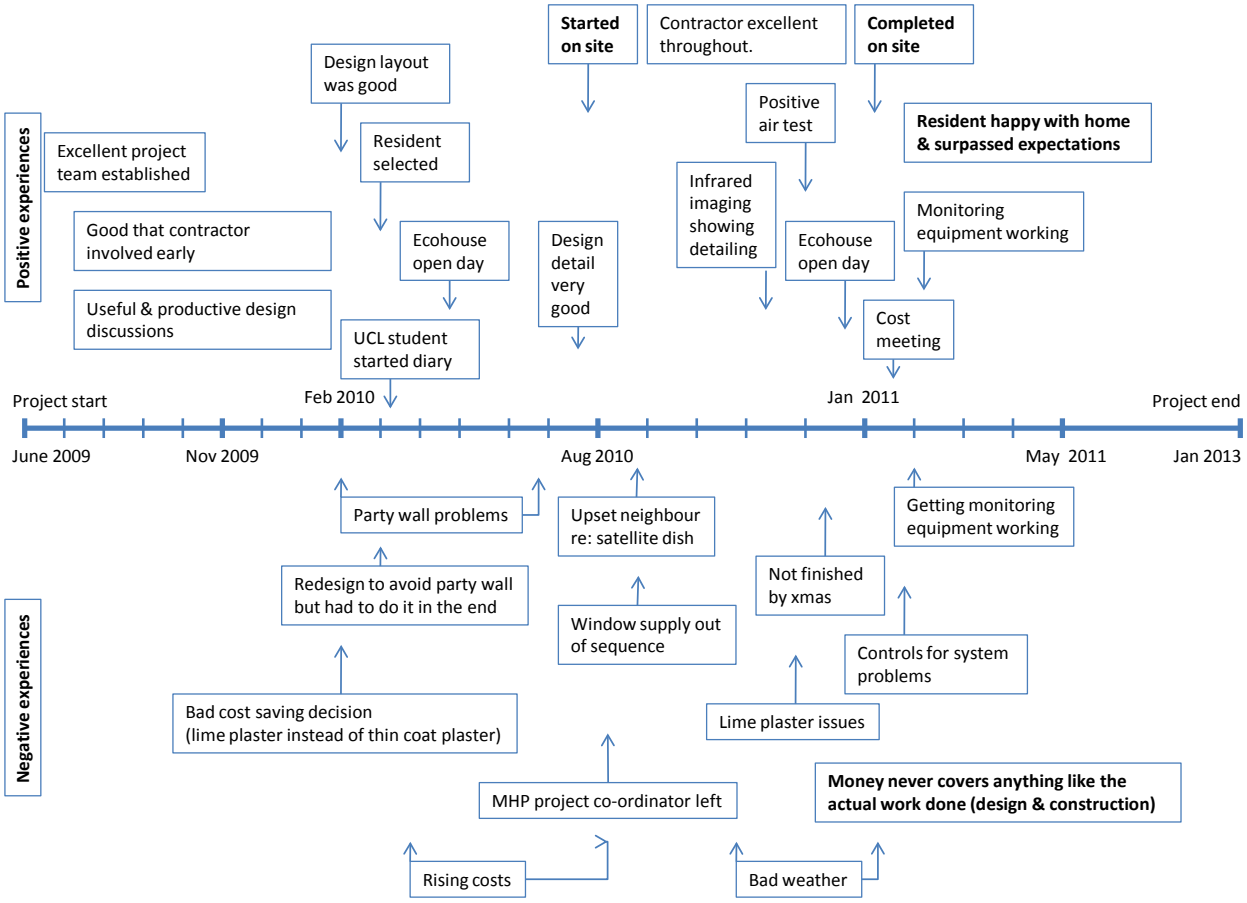
Age band	Number before retrofit	Number after retrofit
Under 5 years	0	0
5-16 years	0	1
17-21 years	0	1
22-50 years	0	1
51-65 years	0	0
Over 65 years	0	0

Please state if (yes/no):	Before retrofit	After retrofit
Married couple / partners	No	No
Couple / partners with children	No	No
Any disabled persons	No	No

4. Dates

Event	Date
Project start date (when was the first proposal discussed or agreed)	June 2009
Planning application submitted (if appropriate)	May 2010
Planning permission granted (if appropriate)	July 2010
Building Regulations application submitted (if appropriate)	N/A
Building Regulations approval granted (if appropriate)	N/A
Contract for work let / signed	July 2010
Occupants moved out	Property empty
Start on site	August 2010
Completion of retrofit	January 2011
Occupants moved in	January 2011
Monitoring system commissioned and operating properly (minor problems remain)	February 2011
Building defects corrected	12 month defects from Jan 11
Building services and controls operating correctly (ongoing checking)	May 2011

Diagram showing the project timeline



Note, this timeline was completed as a group exercise at the project wash-up meeting

5. Pre-retrofit property

At the start of the competition the property was derelict and empty, having suffered major fire damage. The property was chosen as it was to undergo major structural works within the NIU work programme to bring it back into occupancy for social renting tenants. The property therefore presented an opportunity to refurbish the project to a higher standard, achieving the 80% carbon reduction target, using MHP funding already earmarked for the house and additional funding from the Retrofit for the Future competition.

The property is a single Edwardian terrace house of approximately 109m^2 floor area. It was divided into two one-bedroom flats, but as a result of this project it was de-converted into one three bedroom dwelling as part of MHT London's programme of providing large family units in North London. Like large numbers of houses in the area and across the country, it had:

- 225mm solid brick walls (originally detailed around sash windows) with bay windows to the front
- Timber floors including suspended ground floor
- Pitched slate roof with one slope (to the rear) facing south
- A large rear extension which reduces daylight into the rear room of the main house and increases the external envelope significantly to the rear, where external insulation is visually acceptable
- A large part of the external envelope is party walls shared with neighbours
- Heavily ventilated chimney stacks passing through rooms and roofspace
- High levels of air permeability, resulting in draughty and cold internal environment in winter
- Inefficient boiler providing inadequate space and water heating, resulting in high energy bills to resident

The property is situated within a conservation area in the southwest of the London Borough of Haringey. Haringey has over 224,000 people living in 11.5 square miles. Overall Haringey is the 10th (out of 354) most deprived district in England and ranks in the top five most deprived districts in London.

6. Design

The main design principle guiding the project was a whole house approach achieved through detailed application of Passivhaus principles, prioritising insulation of the fabric, preferably with natural materials, achieving excellent air tightness with minimal space heating requirement, and a whole-house heat recovery ventilation. Working with natural insulation materials where possible was considered an effective approach, as they deal with moisture in the fabric better and have lower embodied energy.

The property is part of a well liked street terrace, with a compact footprint and shared party walls. The brickwork of the street elevation is an integral part of the look of the conservation area. The strategy was therefore to internally insulate this elevation. In contrast, at the rear, with the extension, there is a much greater surface area and fewer concerns about fitting in with the visual integrity of the area so external wall insulation was used.

The project was extensively modelled using the Passive House Planning Package 2007 (PHPP) software, and the Carbon Impact Assessment outcomes below are outputs from the PHPP model. The modelling reflects the energy required to keep the home at an internal temperature of 21°C (set by the Technology Strategy Board Competition standards).

6.1 Modelling

Our initial goal was to achieve the Passivhaus standard for space heating demand of 15 kW/sqm/yr. However, following detailed PHPP modelling of the existing house, once we had fully explored the limitations of the existing thermal fabric, orientation and form of the existing building, this aim proved beyond the scope of the retrofit refurbishment.

The modelled energy targets for the property are:

	Space Heat Demand (kWh/m^{2}a)	**Primary Energy Demand** (inc. Appliances) (kWh/m^{2}a)	**Heat Load** (W/m^2)	**CO_2 Emissions** (kg/m^{2}a)	**Air-tight Target** @n_{50} (h^{-1})
Property pre retrofit	253	326	-	74.3	17
Property post retrofit	32	88	16	18.3	1.0
Passivhaus Enerphit Standards*	Max. 25	Max. 120	-	-	1.0

* Quality-Approved Energy Retrofit with PH Components - Criteria for residential-use refurbished buildings, as of 17.08.2010

Both SAP and PHPP calculations give a primary energy value of 90 kWh/m^2/yr that more than met the target of 115kWh/m^2/yr. The CO_2 target given by SAP is 14 kg/m^2/yr and under PHPP is 17 kgCO_2/m^2/yr. Below is a summary of the carbon emission reductions based on the existing house, also calculated using PHPP.

Key design assumptions (carbon emissions reduction)

Heating: 96% carbon emissions reduction
The heating demand for the house was reduced drastically (by over 90%) through a high level upgrade of all the thermal fabric together with a high air-tightness. The residual heating demand will be served by a gas/solar thermal system providing warm air through the MVHR. The PHPP model shows that the space heating demand can be satisfied through the supply of air heating.

Domestic Hot Water: 60% carbon emissions reduction
The energy supplied has been halved by the use of high efficiency integrated solar thermal gas boiler system that also contributes to the space heating through the MVHR system.

Auxiliary Electricity: 50% Carbon emissions reduction
Energy use for auxiliary electricity has been reduced by reducing the heating load on the boiler and the input of the solar thermal, which balances the additional energy needed to run the MVHR and associated pumps.

Household Electricity : 36% Carbon emissions reduction
A++ rated fridge freezer, gas cooking and 100% energy efficient lighting has reduced energy for this demand.

Cooking : no reduction
We have retained gas cooking, as in the PHPP modelling this had a smaller carbon impact than electric cooking.

6.2 Detailing issues

Accurate site information
Once we had accurately drawn plans and sections of the house, we could more accurately model the heat loss of the thermal envelope, and tailor details and junctions. This was particularly important in terms of addressing and minimising thermal bridges. Key junctions where we were unable to remove thermal bridges, such as internal solid walls bearing on the existing slab, were modelled in THERM, their impact minimised cost-effectively where possible, and their heat loss added to our PHPP model.

Wall construction and insulation
We were aiming for low U-values using ‘breathing’ / natural building materials for issues of carbon sequestering, low embodied energy, and as a means to deal with moisture within the construction fabric and internal atmosphere of the house.

We sought internal insulation solutions and researched possible insulation materials including wood-fibre, sheepswool, hemp and cellulose insulation (recycled newspaper). As yet, none of these products come in a rigid panel form that could achieve the U-values we were targeting, so we adopted a timber frame approach to hold the insulation.

We initially considered using I-beams as our internal lining frame to contain the insulation to minimise the amount of timber bridging the insulation. However, throughout the project we were working closely with a contractor who was costing the project, and to keep within budget and the cost of the wall lining down, we 'down-specified' to using timber battens and counter-battens, with insulation full-filled between. The advantage of this is that the contractor finds it very quick and easy to install on site, using standard sections. To overcome the thermal bridging of the timber battens as they cross, we then internally lined the insulated framing with a continuous woodfibre insulation board.

This layer of insulation had two advantages: firstly, it brought our U-value to target; secondly, it protected the air-tight membrane within the build-up from being unintentionally punctured. We used the woodfibre board as a carrier for internal lime plaster.

Doors and windows

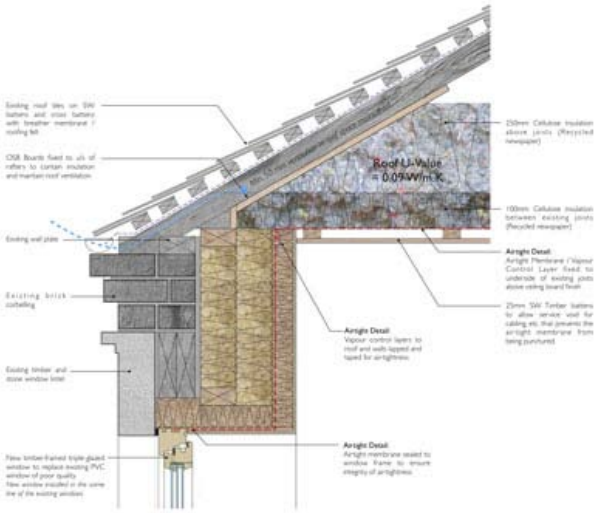
Located in a conservation area, although not itself the main focus of the designation, the property had timber double hung sash windows. These had been replaced with UPVC windows, some of which were fire damaged. A sympathetic conservation officer allowed the new triple glazed timber replacement windows. The windows are Green Building Store Passvhaus certified Ecopassiv triple glazed. Internal insulation to the front wall retains the brickwork finish to the front elevation. We promised we would find a copy of the Edwardian triple panelled front door to replace the damaged modern one, so that the elevational composition with its two front doors is retained (one door now leads to an extremely useful external store).

Thermal bridges

The mixed construction creates a second 'thermal bridge' where internal and external insulation meet, and this has been carefully detailed with an overlap. Other bridging points have been designed with an insulation overlap, where the internal brick walls are taken up through the floor for instance.

Because the external insulation is such a deep layer, the rafter ends of the roof have had to be extended to overhang the insulation, in this case this is not a problem as the roof covering was being replaced. At the ground level the insulation has to be extended well below ground level, to overlap the floor insulation; it is not possible here to form a continuous layer of insulation.

Diagram showing section through the internal insulation strategy used to preserve the facing brick work:



Ventilation, heating and hot water

In spring, summer and autumn the windows can be opened for fresh air, but during the winter, this would allow all the carefully retained heat to be lost. Instead a heat exchange on the ventilation system removes the heat from exhaust air (extracted from kitchen and bathroom) and puts it into the cool fresh air - MVHR by Maico. This system is almost 90% efficient, so that only a small amount of heat is needed to keep the building and its occupants warm. Warmth is also provided by the people themselves and their electrical goods, like the fridge and television.

A small amount of heat can be delivered with the fresh air (to bedrooms and living room) while small (gas fired) radiators are provided as back-up in case they are needed when temperatures fall. This is one of the things which will be monitored to see how often or if the radiators are needed.

Hot water is provided by the same gas boiler, a Rotex GSU 320, and by solar thermal panels on the south facing rear roof. The kit takes up far more space than conventional systems, and whilst space was found in this property it could be a major problem for scaling up in social housing, and for small houses and flats generally.

Residents

The new residents have been involved throughout the design and construction phase. Living in the house will be a very different experience from their previous flats. We are really pleased that they have been very interested in how the retrofitted building will work, and they will be important partners in helping us to understand this, over the two year monitoring period.

The control systems have been designed to ease operation, and monitoring includes both energy used and temperatures and humidity experienced, both in the house and within the building fabric.

7. Construction

Management

The main components of the project team, the architects and contractor, came together at the start of the project to develop the proposal. They were a team that MHP had previously used from our existing framework for other new build development projects. This project therefore arose from a previous established working partnership. The project was not tendered, but was agreed on a fixed price (within the budgets of the Retrofit for the Future bid). This meant an element of shared risk and indeed the contractor did incur some additional costs as a result of underestimated costs of some materials.

The contract was a standard JCT minor works contract. Importantly, Sandwood have a directly employed labour force covering most trades, including the specialist installation of the main technologies. However some additional advice and support was required for installation of some elements.

The site was supervised by Sandwoods clerk of works who was on site. The architect retained an interest throughout the project, but the signing off of works was managed by MHP's own neighbourhood investment unit and our senior surveyor.

Build tight

The contractor and all the trades on site have embraced the air-tightness issue and really committed to the principle of building air-tight. One carpenter said he'd been having paranoia dreams about whether he'd taped and sealed his framing properly.

However, keeping in mind which layer is acting as the air-tight layer, and the importance of a continuous 'line' is a challenge. Any gap was sealed, plugged and taped, even if it was not related to the air-tight layer, as a 'belt and braces' approach e.g. a service penetration through an externally insulated wall was air-tight taped to the external face of the EPS insulation, even though the internal plaster is the air-tight layer. We took it as evidence of the real pride and enthusiasm with which the contractors took on the retrofit challenge and the energy targets.

Mid-construction air-tests, and additional taping were vital to push the build to achieve our air-tightness targets. For example a small amount of air flow was felt through the staples that fixed the airtight membrane to the timber framing to the walls - as a belt and braces approach, the team taped over the line of staples to all walls and ceilings.

The final air test results are provided below. The results are shown with 'standard' sealing and with some 'additional' sealing to the ventilation plant area. A pressurisation and a depressurisation test have been completed in each case to produce an average in accordance with Passivhaus.

Whilst tests did not get under 1, before the project started the team debated whether to try and get under 5. Therefore it is felt that to get a result under 2 is pretty exceptional.

Unit	Air Permeability $m^3/(h.m^2)$ at 50Pa	Air change rate m^3/h/volume of building
Pressurisation	2.22	2.08
Depressurisation	2.84	2.66
Mean of pressurisation and depressurisation	**2.53**	**2.37**
With additional sealing – Pressurisation	1.54	1.44
With additional sealing) – Depressurisation	2.23	2.08
With additional sealing - mean of pressurisation and depressurisation	**1.89**	**1.76**

Drying out
For the internal woodfibre insulation, we used a lime plaster finish straight onto the walls. However, to save on costs, rather than the proprietary thin-coat finish system, we used standard lime-hemp plaster mix. This gave real problems on site because of drying out times. As the house retrofit progressed, and the house became more air-tight, drying times were elongated, and the plaster stayed soft for several weeks, which led to the plaster being bumped and damaged during the remainder of the construction.

Directly employed labour
Sandwood Design and Build is a contractor that directly employ most of its staff and who are really committed to sustainable construction. It is clear that control of the site team, continuity of trades and retaining the commitment to building tight, was enhanced because of the directly employed staff. Furthermore the architects have worked with Sandwood many times, and have developed a good partnership approach.

Snaking Ducts
Installing the MVHR unit and the metres and metres of ducts needed proved a challenge for the service installers. There is never an ideal duct route when retrofitting ducting to an existing house, and the house had a rear extension that changed in level, which meant we had awkward junctions and boxing-out to negotiate and plan.
In hindsight we would recommend planning and drawing out each duct and associated silencers to scale when planning an installation, as both installers had trouble fitting the kit in the space allocated, which were considered generous at the design stage.

8. Commissioning and occupancy

The handover process of the property, from MHPs perspective, has followed the format we normally carry out for major works, i.e. to carry out a visit for snagging, re-visit property to de-snag and then finally the handover, all with the contractor.

In terms of handover to the occupants, as detailed earlier, they were aware of the retrofit measures through the interview process. At handover they were provided training and information on what cost saving elements were installed at the property. This has been, to some extent, an iterative process with both the MHP team, the architects and the contractors on site (towards the end of the project). There has been a high level of interest in the property, and an unusually high level of visits, open days etc. To this end, the new occupants have been fantastically accommodating, and in return have had quite high levels of support to get used to the property. Further information and guidance has continued over the first few months, particularly now with the monitoring equipment being installed and a small project with some students testing ‘real time’ energy displays in the property.

It is proposed that the monitoring equipment built in the property will be left in place and continued to be used after the two year period.

Included in the tenancy addendum is explicit reference that the occupants do not carry out any DIY works before notification to MHP. As the principles of the property are so focused on an air-tight membrane, it is important that no works are undertaken that compromise this.

9. Costs

All elements of the project, including the build contract, were delivered on fixed price contracts. This helped MHP share the exposure to risks and potential cost overruns. In many instances the fixed price was a lower value, as time was given in kind, acknowledging that all the project team members valued the project as an important learning experience. This is reflected in the comments section of the original budget below.

The contractor did experience unexpected and significant cost overruns on a number of items and a summary of these are provided in the following tables. This was a cost to the contractor due to the fixed price nature of the contract.

There were two main elements to the build cost of the project, the non retrofit building costs and the retrofit building costs.

The non-retrofit building costs are the works that would have been required to the building even without the Retrofit for the Future programme. In this case this included converting the property from two self contained flats to a single house and the repairs associated with the major fire that had occurred previously. The retrofit building costs represent the extra costs associated with meeting the requirements of the Retrofit for the Future programme and the 80% carbon reduction target.

Original budget

Item	Design stage		Post-construction		Comments
	Materials	Labour	Material	Labour	
Management and administration					
Design - Architect		£10,000		£15,080	+ £3,120 in kind
Design – Building Services		£5,000		£8,960	+ £3,000 in kind
Design – Modelling		£1,000		£1,000	
Construction overall					
Retrofit build cost			£89,410		
Non retrofit build cost			£90,000		
Rent loss	£3,196		£4,157		
Landlord costs (staff time)				£3,596	+ £5,000 in kind
Monitoring equipment	£0		£3,500	£3,000	+ £1,500 in kind
Monitoring and reporting service	£0			£4,000	
R&D costs (please detail)	£0				
Expenses	£300		£400		

Budgeted retrofit build costs

Item	Budgeted cost
Insulation/Air tightness	£31,300
Windows	£10,600
Mechanical	£7,800
MVHR	£5,200
Solid ground floor	£6,200
Waste Water Heat Recovery	£1,000
Prelims	£5,120
Other ancillary works	£22,190
Total	**£89,410**

Overspend on build costs

Item	Budgeted cost
Non-retrofit additions	
Carpentry	£9,000
Retrofit additions	
Wall finishes	£10,000
Mechanical	£9,000
Ventilation	£3,000
Prelims	£14,000
Total additions	**£45,000**

Commentary on overspend

- Prelims: required supervision by a more senior person for longer than estimated as there was so much extra new kit and a need for a high level of control of the project.
- Wall finishes: as detailed earlier, there was an attempt to save costs but in the end it was not a cost saving measure
- Mechanical heat recovery: The certified system that was bought was more expensive than estimated, and the complexity of the installation added to the cost. In hindsight the team reflected that a less complex kit would have been sufficient to achieve similar results and would have been cheaper, simpler to install and easier to understand (in use).
- Due in part to the weather and other factors there was overspend on the carpentry element. This is made more complex, as labour is directly engaged and so at this period it was a conscious decision by the contractor to employ additional resources to this project to occupy the labour force.

Overall the triple glazing (despite delays in delivery) and the external insulation were both considered to have provided good cost value.

10. Wash-up meeting

The following notes are from the wash up meeting held on 12 May 2011, at MHP's offices in Wood Green. Representatives from MHP, Anne Thorne Architects, Sandwood, UCL and the Technology Strategy Board were in attendance.

Timetable
There were some delays to the start of construction and also during construction. Before getting on site, issues with party wall agreement (with a neighbouring property) delayed start on site by nearly two months. Once on site, the two main delays arose from late delivery of the triple glazed windows and adverse weather conditions at the very latter stages of the project, impacting on both drying times for some of the internal finishes and also for a period, staff being able to get to the site. The project was intended to be completed before Christmas but this was not possible, and the holiday shut down added a little more to the delay.

Anticipated outcomes
Some cost asides, the project has very much achieved the intended outcomes, broadly to timescales. The new tenant is very happy with the new property and it has exceeded her expectations. It is noted that energy use (from the first few months data), is currently a bit high. Some elements of the system are still to be checked again (e.g. the Rotex system) and the resident will likely need to be supported further in getting the best use (some of the changes / messages required need to be reinforced). It is noted that the solar thermal is provided as a back-up and covers a small risk of periods where the passive approach will not provide sufficient heat and hot water. Given the limited risk of this occurrence there is questionable benefit in having installed the solar thermal system.

Costs
It was good to see the detail of how much it costs to achieve an 80% reduction. The project raised the value and importance of air-tightness. The team felt that the concrete floor turned out to be a good cost decision. However this was not the case for the lime plaster (avoiding the proprietary thin-coat). The project highlighted the cost effectiveness of external insulation.

The team noted that the windows went in better than expected – but lack of UK production caused issues with supply. Likewise, delivery of other technologies (from overseas) was an issue, particularly in terms of support. However, on the positive side, the retrofit competition has changed the market, for example cost of typical MVHR reduced from £5k to £1k.

Skills
The project team reflected that we tried to do almost too much, and take in new approaches in too short a time. However, both architects and contractor learnt a lot about the detailing of this level of retrofit. The work on air-tightness was raised as an area of consideration for other MHP schemes. How do we embed the same level of commitment and understanding of the importance of air-tightness into mainstream programmes (new build & retrofit).

All of those involved have picked up lot of skills. For Sandwood this is particularly beneficial

given the directly employed labour, and ability to take that to new work. The skills remain within the company.

As it was all so new to Sandwood/MHT, it has been a challenge to take that through to conclusion (in terms of very informed handover) for the new resident. It is a big step change for everyone involved. At least in this instance the resident is aware of the limitations and aware that we are all learning together. It was useful as a research opportunity for students and for the UCL department.

Learning

The group reflected on the use of blinds inhibiting solar gain. The use of blinds, and keeping them closed (for privacy) during the day, negates/limits solar gain. Should this be accounted for in the modelling?

The MVHR Rotex system was used because it was a certified Passiv system. However it was (is) very complicated and in hindsight a more standard system may have been preferable.

We were very keen to have simple controls but this issue remains, particularly with the Rotex system. This raises concerns, not just for the resident, but also as an issue of overload of information and new systems for contractors and fears for management team once back in MHP mainstream. On this element it was reflected that it would have been better and helpful for Kingshaw to have been involved for longer into the project.

Thermal imaging was good – it would be good to do some more. We could also have done more to anticipate future needs e.g. an electric socket in the garden would be good (front or back e.g. for electric car charging) and an external water tap to avoid future works that may break the air tight seal of the house.

Highlights of initial learning now the property is in use

- Blinds & windows
- How hot residents like the house (more than 21°C)
- Number of TVs
- Internet is expected
- Beware of cable/satellite TV providers
- Smoker standing at the doorway – ruins air tightness modelling

11. Doing it again

Negatives
There are three main areas where the team reflected that they would have done things differently to achieve the same or better results

- Use of the standard lime-hemp plaster mix gave real problems on site because of drying out times. On reflection we would not avoid the use of a proprietary thin-coat finish system. It did not save costs in the long run.
- There was a design decision to use Passivhaus certified products, although we knew we could not achieve the full Passivhaus standard. On reflection we would not give so much focus on certified products, rather look at the broader market for the best products for our particular needs.
- Give further consideration to the heating system – reflecting the on-going cost, use and maintenance requirements.

Positives
The project highlighted the value and importance of air-tightness. It is something that the team will be looking to embed into their respective work areas.

There was broad agreement on the value, cost effectiveness and ease of using the external insulation. This is one measure that MHP felt it could afford to incorporate into appropriate standard works as it looks for next steps in its retrofit programmes.

One of the best parts of the project is the monitoring element. The project team recognise the value of this. There was already a strong commitment, and established working collaborations on the monitoring. The project team are all committed to improving post occupancy evaluations from the installation of monitoring equipment in future projects and developments. However it was noted that that the requirement of 5 minute data readings was very high.

The resident was very involved and this has been a key part of the success of the project. However it was reflected that if she left the next resident may not have the same level of knowledge and commitment. It is a challenge that is noted by MHP.

Finally, the TSB was commended by the project group at the wash up meeting for a sensible and well set up competition and programme. It had been positive experience for all of the respective members of the project. It was also broadly agreed that it worked well because it focused on practical delivery and was not an academically focused exercise.

12. Business benefits

Metropolitan Housing Partnership
The Retrofit for the Future project gave MHP an important opportunity to test the very limits of retrofit. We have a long standing commitment to low energy retrofit refurbishment. Despite the tough economic climate, we continue to deliver projects that demonstrate our commitment to developing exemplar low carbon homes, whilst focusing on cost effective, replicable projects that work for our customers. This project has been an invaluable learning opportunity. Lessons learnt are being applied into our existing and planned major refurbishment programmes.

Anne Thorne Architects
For ATA, there have been approximately a dozen leads resulting from involvement in this project. It is difficult to predict if they will result in secured new business. However, the main change has been to the way ATA do projects. They now use PHPP for all projects because it is such a good analysis tool, providing a lot of feedback information which they feel gives more weight to the advice they give. Whilst it is very difficult to value possible business, ATA have estimated it at circa £100,000 over the next 5 years.

Sandwood
Sandwood have already taken on the work on detailing from this project and are using it for future proposed works, particularly the detailing around thermal bridging. They recognise that the work has helped on the energy side of the building work they undertake. It has helped reinforce the value and benefits of the directly employed labour force. Whilst it is an expensive resource, learning that the labour force has taken from the project that can be applied to future work is very valuable. At present they have not gained any further work as a direct result of the retrofit project.

UCL
It was the view that the whole competition was very positive from a research and learning perspective, recognising that there will be further education spin offs that will lead to more research. It was noted that this year there had been more applications for MSc courses within UCLs environmental design MSc courses, particularly for overseas students. This was unusual, and whilst it cannot be attributed solely to the retrofit competition, does suggest the growing profile of the issue and its potential as a future career.

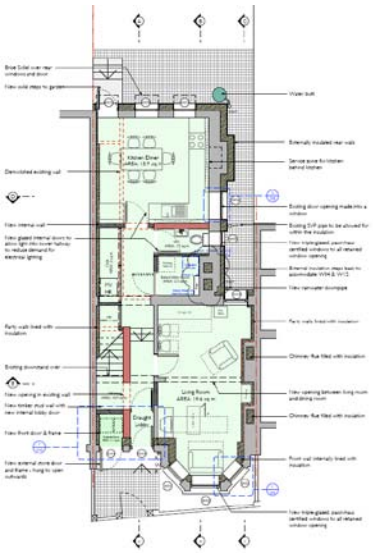
13. Project images

Before

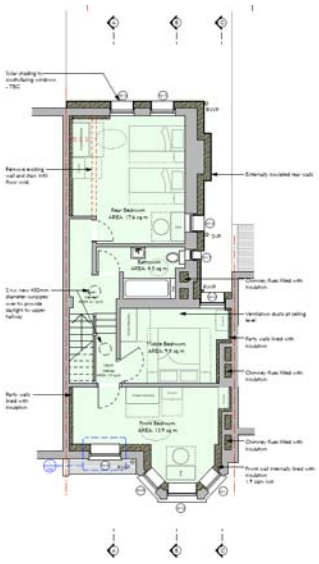
After

Rear elevation

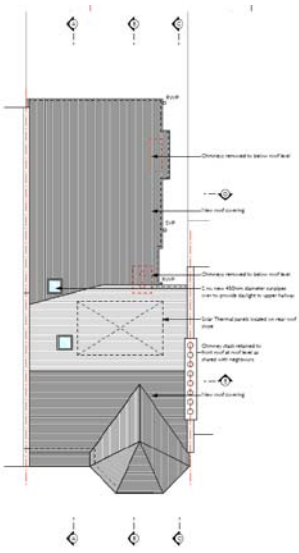
MVHR



Ground floor



1st Floor



Roof