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FLASH project

Draft Hindsight Review – Deep energy retrofit of a single terraced house at No 3. Passfield Drive

Institute for Sustainability

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1 Project Description

No.3, Passfield Drive is a 3-bedroom mid-terrace single-family house built in the 1960's. This retrofit project was designed to achieve the Passivhaus Enerphit standard for building retrofits. The project was carried out with the residents mostly in-situ. It was planned for occupancy by seven people and with a design strategy that considers: space heating through existing radiators, winter ventilation provided by heat recovery ventilation, water heated through solar thermal hot water with gas condensating boiler top up. Solar thermal provides some renewable energy generation and space cooling is achieved by means of natural ventilation.

2 Project participants

Project lead	**Southern Housing Group**
Client	Southern Housing Group
Architect	bere:architects
Mechanical & electrical consultant(s)	Alan Clarke
Energy consultant(s)	Alan Clarke
Structural engineer	Galbraith Hunt Pennington
Quantity surveyor	e Griffin Consulting
Contractor	AD enviro

3 Meeting Attendees

Represented Organisations	
Project Lead/Client	Southern Housing Group
Architect	Bere: architects
Contractor	AD Enviro

4 Findings from the Hindsight Review Meeting

The following provides an overview of the main findings of the hindsight review meeting that was undertaken for the project. The meeting format involved the use of a pre-prepared agenda listing all aspects associated with the project as a guide for discussion.

4.1 Project Aims

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

Southern Housing Group:

Southern Housing Group is one of the southern England's largest housing associations. The architects, who produced and specified the main features of the project, initiated the project. The property intervened was selected primarily considering the technical advice of the architects. They looked for a property of

relatively nondescript architectural merit with solid wall construction, avoiding cavity walls or conservation areas in order to reduce any obstacle in the retrofit process, particularly any obstacle to external insulation. The main aims highlighted by Southern Housing Group as the drivers for their involvement in this project were:

- This project was a vehicle to test and gain experience in a real life project where carbon reduction and energy efficiency improvement measurements can be applied to achieve the 80% targets.

- For the organisation, this project was an opportunity to establish a supply chain, up-skilling, and most importantly, gain experience of residents remaining in situ during the process of implementing energy efficiency measures.

- The experience with residents was an important point since Southern are primarily responsible to and for tenants. It is therefore crucial for them to understand the interests of tenants in trying to find an approach to retrofit that will inevitably impact a great proportion of their rental stock.

- Considering their rental stock, the client was interested in practical solutions for a major scale retrofit where decanting of residents is not an option. This project was a good example of real life circumstances were they may operate if a mass retrofit project is introduced.

AD Enviro:

- The contractor has been involved with Southern Housing Group in other projects. The scope of the work mainly included redecoration work and as part of the 'decent homes' scheme team.

- AD was mainly interested in the economic opportunities that this project may bring, thus it was important to gain as much experience as possible. This area was considered to be the prime area where future large scale injections of capital are to be allocated. There is an important business opportunity associated with this type of project, so gaining as much experience as early as possible will position them way ahead of their competitors.

- In the same way, they were interested in adding value to the services they provide through the experience they have gained working with Southern Housing Group.

- It was fundamental for them to understand the practicalities on site of such a project.

Bere: architects:

- As the main initiator of the project, bere:architects approached the client with the proposal. They were hoping to demonstrate the use of a low energy approach normally employed on new buildings in a retrofit situation. They were interested in developing prototypes for deep retrofits of social housing stock.

- They were interested in the application of Passivhaus energy efficiency measures, especially in occupied properties.

- The team had originally reviewed a Victorian terrace house split into flats, but the Technology Strategy Board funding required funded projects to be single family dwellings. No 3, Passfield Drive presented the opportunity to retrofit a single family house, and because external insulation was possible without planning constraints, it was decided that this building provided an ideal opportunity for retrofit with the occupants in-situ.

4.2 Design Challenges

This area of discussion aimed to discuss the design challenges and assess what worked well or less well, provide an understanding of why this occurred and possible routes to improve future projects. This was undertaken through the discussion of the design concept that was developed and the spatial alterations that were carried out. The main findings can be summarised as follows:

a-Passivhaus levels: The basis of bere: architects' proposal was to achieve Passivhaus levels in order to show how improved thermal comfort, reduced energy bills and lower CO_2 emissions can be possible in the social housing sector. To achieve this objective the architects proposed an increase of U-values of floors, walls and roof space, an increase of the air-tightness of the building, and replacement of existing windows with triple glazed Passivhaus windows.

b-Air-tightness and appropriated ventilation levels: To achieve Passivhaus levels it is necessary to provide high levels or air-tightness. This can only be achieved and maintained if a plentiful supply of fresh air is provided thus extract and fresh air was provided through a heat recovery ventilation system, installed in the loft.

c-Resident in-Situ retrofit: Implementing the refurbishment without decanting the residents was one of the main reasons the client chose to participate in this project, but was also a major challenge for the Client

and their contractor, and AD Enviro. They believed that understanding the impact of retrofits with in-situ residents is vital if a future mass retrofit programme is to be put in place.

4.3 Retrofit Strategy

The various retrofit strategies and measures employed for the building fabric and M&E services installed, and the challenges associated with their installation, were discussed in an aim to find possible routes to improve future projects.

4.3.1 Building and Fabric

The building used external thermal insulation and very high levels of building envelope draught proofing. The main strategies considered are listed below:

a- Wall insulation strategy

Approach:

- Given that the house was a mid-terrace property, external insulation was only used in the front and rear elevations.
- External insulation on the front and rear elevations was extended over a meter below ground level to create a thermal bubble beneath the ground floor slab. The idea was to make use of the constant temperature of soil, thus reducing or limiting the heat loss of the house through the floor.
- A thin layer of internal insulation for reducing cold bridging was installed on the initial 500mm of party walls including the stairwell.

Process:

- Although in this case the depth of eaves was sufficient for the installation of external insulation, it is recognized that installation of external insulation can become complex particularly on houses with short eaves.
- Two main issues arose from the installation of external insulation; first it was necessary relocate the rainwater down pipe on top of the insulation. Secondly, and in the same way, it was necessary relocate the gas meter a metre from its original location.

b-Floor insulation strategy

Approach:

- It was initially proposed that the existing concrete floor be removed and a new insulated concrete slab installed on the ground floor. However this solution was disregarded due to the disruption to tenants and the associated complications of removing the ground floor slab .
- The solution was to use vacuum insulation on top of the existing solid floor construction,boards which increased the height of the existing concrete ground floor by 30mm.
- The insulation was installed above a layer of foam (protection layer). It is important to note that this was an expensive but necessary solution and was applied since the size of the ground floor was quite small and therefore the additional costs were not a major proportion of the overall costs.

Process

- As a result of the increase of finished floor height due to the installation of insulation above the existing concrete slab, it was necessary to adjust the height of the first few steps on the main staircase.

c- Windows and openings

- The possibility of naturally ventilating the house through a stack ventilation approach and windows with inbuilt heat recovery system was initially explored. However as the technology applied to these new type of windows and technology was explored and found not to be technically convincing, the architects decided to adopt a more conventional Passivhaus approach.
- Triple glazed windows were therefore used with a U-value of 0.8 W/mK.

d- Other works

- The rear extension that accommodates a small toilet was completely rebuilt. Kitchens and bathrooms were also upgraded as part of the 'Decent Homes' programme.

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

- Two main problems were observed that jeopardized the delivery on time of this project. Interaction with utilities companies and external conditions of the ground.
- As mentioned before, the installation of the external insulation involved moving the gas meter, which was located on the external front wall. This simple task was delayed simply because of the long period of time the utility company took to approve and carry it out. This is especially important in a one off project. Therefore, the involvement and performance of utility companies will be crucial in the success of a mass scale retrofit project.

- Even though a correct initial survey was undertaken before commencing the retrofit work, it was not possible to foresee the problems caused by the ground in the rear garden. The ground of the rear garden became water logged during the winter so it was at first not possible to set up the scaffolding for the installation of external insulation since, it could not support the weight.
- It was highlighted that it is essential to source materials and installations from reliable suppliers. In this case the company that was applying the wall insulation went out of business a week before the insulation was due on site and a new company needed to be employed. In addition internal changes required a redesign of the vacuum floor insulation which has to be made to site dimensions. As a result the delivery of this product was also delayed. In a mass scale project these delays can be very disruptive. Thus a minimal change can affect considerably the overall schedule of the project.

4.3.2 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. The main findings can be summarised as follows:

a- Systems:

Strategy:

- As one of the main strategies was to achieve a draft free building it was necessary to provide an appropriate ventilation system as air infiltration through the fabric is negligible
- The ventilation system used in this property was a heat recovery ventilation system installed in the roof space. It is a standard system that provides fresh air to the living room and bedrooms preheated by exhaust air from bathrooms and kitchens.
- The heat recovery ventilation system is operated with a control panel located in the kitchen. The system allows operating the system with various velocities of the fans including a boost to remove humidity or odours when cooking or when using the bathroom.
- Part of the plan was to include a solar thermal system to provide hot water. It was necessary to review the existing services to check their efficiency and decide whether it was necessary to improve them.
- During summer the solar panel will provide the majority of hot water required in the house. In winter this will be supplemented by a small gas boiler
- The boiler therefore serves as back up for the solar tank and provides top up heating when necessary. The boiler is operated with a thermostat located in the entrance of the property.

b- Monitoring Equipment:

- The monitoring equipment installed was a standard kit that records internal temperatures, humidity and CO_2 levels, and gas, water and electricity consumption.
- In addition as solar thermal was installed, equipment was also installed to monitor the heat output from the solar thermal panel, the flow rate of the heat exchange liquid, power usage for the pump, and the amount of day-light received (using a pyranometer).

The scope for future technical improvements in the process included:

- As mentioned before, the architects in conjunction with an engineer from ARUP had explored the possibilities of providing ventilation through natural means using mainly a stack ventilation approach and specially designed air supply windows. However this alternative was not possible given that the windows with an inbuilt heat recovery system were not yet commercially available and could not demonstrate the required efficiency. It is important to highlight the role that new technologies may play in future retrofit projects, maybe providing better energy solutions at lower costs.
- One of the challenges of this project was to install a heat recovery ventilation system in the roof space, without affecting the air-tightness membrane installed there.
- The decision to install the large ventilation system in the roof space was also a non-technical issue related to the space available for storage. The tenants had moved to this property before the retrofit primarily because they needed more space, however with the retrofit scheme they had to compromise some of their useful space for storage (loft) for the installation of the ventilation heat recovery system. Although the tenants understood the needs of the project it may become an issue for other projects where space is not available.
- There was a problem regarding the monitoring equipment since most of the equipment was supplied from different manufacturers and installed by the main contractor. In addition, none of the professionals working in this project had previous experience in installing this type of monitoring equipment. It is recommended that in future projects external dedicated companies deal with the installation and commissioning of this equipment

4.4 Client Review

This area of discussion included the review of the installation stage and final outcome of the project from the perspective of client and tenants. The main findings can be summarised as follows:

- The client's view of this project was really positive and something they would like to repeat
- Even though there were some initial doubts regarding the implementation of the retrofit in an occupied property, potentially interrupting many of the daily activities of this family, in the end they felt that it was worth the effort given the final result,
- Southern Housing Group felt they were, as a result, in a better position in terms of explaining or selling the retrofit programme, not just from the experience gained from the communication with residents but with neighbours who were always aware of what was happening.
- They recognized that the project could not have been a success if it was not for the good will and patience of tenants. There were times when tenants were pushed to the limit, mainly related to delays on the construction.
- The client team believe that with the completion of this project a number of their initial objectives were achieved. The most important of these was the alleviation of fuel poverty, which not only affect tenants but directly their own long term financial sustainability. If payment of fuel bills becomes difficult for tenants, payment of the rent may also be affected.
- Although they knew this was an experimental project and that some issues may arise, they felt safe from the beginning with the appointment of the contractor, due to their good credentials and more importantly their motivation, commitment and dedication. They believe they have strengthened their relationship for future projects.
- They think it can be a positive strategy to offer extra incentives not specifically related to the energy efficient measures to convince tenants to take part in this type of project. However at the same time they believe people understand that all these measures will directly economically benefit them (especially in the case where tenants are very sensitive to even minimal increases in energy bills).
- Although a formal handover was provided to the tenants, Southern Housing Group were not initially sure who was responsible for the handover. In this case, the architects constantly informed the tenants about the technicalities of the retrofit and technologies used. A simple handover was given every time a new technology was installed, in addition a final session was organised at the end of the project.
- A final 'user guide' was provided, where each technology is briefly described; what each does and also their location indicated in a house plan. This was mounted on a board in a cupboard for future users if tenants change.

The scope for future technical improvements in the process included:

- Regarding the liaison with tenants, it was recommended to pre-establish a strategy for liaison with resident and neighbours; what to do and how to deal with them, what should be communicated or included and the definition of who would be responsible for liaising with tenants early on. If all project partners are to liaise with tenants, a proper strategy must be put in place to guarantee good coordination between them.
- It was also recommended that a weekly meeting be scheduled. However it was also noted that this type of practice might be quite extreme or difficult to put into practice in a large scale project.
- In this case and given the location of the property and type of property, it was also necessary to liaise with neighbours.
- An important role in the liaison with tenants is the one played by the site foreman, who not only has to deal with technical issues but at times with more personal family daily activities. In this case the in-site workers helped residents to deal with activities that were not part of the refurbishment programme; movement of furniture for example.
- Handovers should be initially specified and designed taking into account how it will be done and who will be responsible for it. It would be good to consider as part of the handover the technical parties that will be involved in the maintenance of systems. Housing associations for example may consider defining from the beginning the companies that will give maintenance to the systems.

4.5 Design information provided and installation stage

This section reviews information provided by other project partners and includes suggestions on how to improve information for costing and construction. The main findings can be summarised as follows:

- Good communication between all partners was maintained during the development of the project. Regular site meetings were established from the beginning of the project.
- There was appropriate information provided from architects; architectural details, specifications and drawings. Information was always available even when modifications were necessary due to change of materials. If for any reason a new supplier or product different to the one initially specified was required new drawings were rapidly provided.
- Architects were more involved in the project than usual given the level of specifications involve.
- It is important to consider extra time for any contingency occurring in projects.

The scope for future technical improvements in the process included:

- Although the performance of the sub-contractors in general was good, there was a delay in the delivery of insulation. The sub-contractor was busy with other projects and did not respond on time to this project, which was not anticipated by the contractor. The main contractor felt that they were lenient with the supplier (re: contract and obligations). This particular case, which was solved, may become a major problem if a mass- scale retrofit project is initiated. As the architect indicated, there won't be enough suppliers to cope with the demand of a massive scale retrofit project. Many questions related to this came up in the meeting; Are there currently enough suppliers in the market? Are all suppliers economically and technically prepared to cope with a mass-scale retrofit project? Is there any way to motivate them on smaller projects?
- In this way one of the lessons of this project is to know that suppliers participating in a project will be reliable. Or at least to know that the construction company can cope with specific task if a supplier fails to provide a service.
- Good terms and conditions agreement must be necessary, not just in term of the supply of products but quality of works. Is there any way to have insurance and legal measurements in place?
- It is necessary to ensure in a mass- scale retrofit project, the ability of the architects to provide new specifications and drawings in case of changes.
- In the same way as there were concerns related to number and quality of suppliers, there was apprehension related to the labour of sub-contractors. There had been cases where cheap labour (provided by subcontractors) had delayed the project. A case was mentioned where insulation that was not glued properly to walls. Capacity, preparation, and speciality of sub-contractors to undertake projects such as this may play against effective retrofit projects. It is highlighted that this is an industry-wide problem that has to be considered in a larger scale project.
- Is there any way to assure the proper operation of the systems specified and installed for a minimum number of years. Who should be responsible of this?

4.6 Cost control

This section reviewed issues surrounding ensuring cost certainty and the reduction of the cost of retrofit. The main findings can be summarised as follows:

- In general the project was completed on budget, although many extras were included, i.e. it was decided to redecorate all areas.

- There were various items that were not included initially in the budget, such as new flooring, which may occur in any retrofit work. Nevertheless, most of the extra costs were absorbed by all partners involved in the project, on the understanding that this project was a learning opportunity for all partners.
- A massive scale project may result in a lower cost per retrofit project.
- One cost that was not budgeted for related to the additional time spent on site and the extra work given by the professionals involved in the project, which would hopefully be avoided at a larger scale.
- A significant reduction in the cost of a project would be expected at a larger scale not only because of economies of scale but also because of time efficiencies It is important to bear in mind, that suppliers will act differently for a major project (responsibility).

Aspects that would require improvements to be made included:

- Good performance of suppliers and sub-contractors may reduce considerably the cost of retrofit projects.
- New technologies today may become cheaper in a couple of years.

5 Meeting wrap up

The wrap up session aimed to highlight the most important aspects of the project, through a process of summarizing and prioritising each meeting participant's individual feedback regarding the most and least successful aspects as well as the aspects that were viewed to be most applicable to mass roll-out of retrofit.

Successful aspects: What went well?

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

- **Project outcome**: Achieving final air test and creating a successful living environment. Passive house approach / reliable energy savings
- **Improvement of the indoor environment**: New condensation free windows. Condensation disappeared due to the new windows installed and attention to cold bridging made possible by externally applied insulation
- **Collaborative work**: architects, constructors and client initially established weekly meeting
- **Learning experience:** Enhancing all partners' staff skills and knowledge of why/what and where of this type of work.
- **Knowledge transfer:** Demonstrating to tenants and the community the value of retrofit objectives

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 discussed. These can be listed as:

- **Whole house approach and levels obtained**: Fabric improvements (external insulation etc), windows replacements, air-tightness improvements, heat recovery ventilation system, solar thermal.
- **Undertaking a retrofit project without decanting residents**: The approach to try to keep the tenant in situ will be essential to scale–up. (note that there was in this project partial decanting of residents – as the children moved out at one point)
- **Use of known contractors and suppliers:** Contractors and suppliers with a long-term relationship with housing associations may facilitate and speed up the processes.
- **Site managers:** The use of a full time site manager provided by AD worked quite well in this project
- **The collaborative work approach**: Input between architects- designers and contractors

Less successful aspects: What did not go well?

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

- **Suppliers:** The poor-performing companies in the subcontracting and supply chain. There should be a list of alternative suppliers. The UK has a supply chain that can deliver, however, today it seems that this is not occurring. It is necessary to find systems to control their performance.
- **Monitoring:** The monitoring kit acquired was not easily integrated into the equipment installed in the house.
- **Standard insulation details** – insulation providers should make available flexible details for various projects.
- **Internal insulation:** difficult to install especially in limited spaces. (It should be noted that internal insulation was applied only to overcome cold bridges, such as in the party walls. This would not be required if the neighbouring buildings were also improved as part of a mass-retrofit of the complete terrace).
- **Heat recovery ventilation systems**: for limited spaces
- **Site surveys**: It is important for contractors to have a better understanding of work to be carried out (gas meter, drainage, underpinning) before moving to the site
- **Weather conditions**: Working over cold, wet months, which delayed the works.

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