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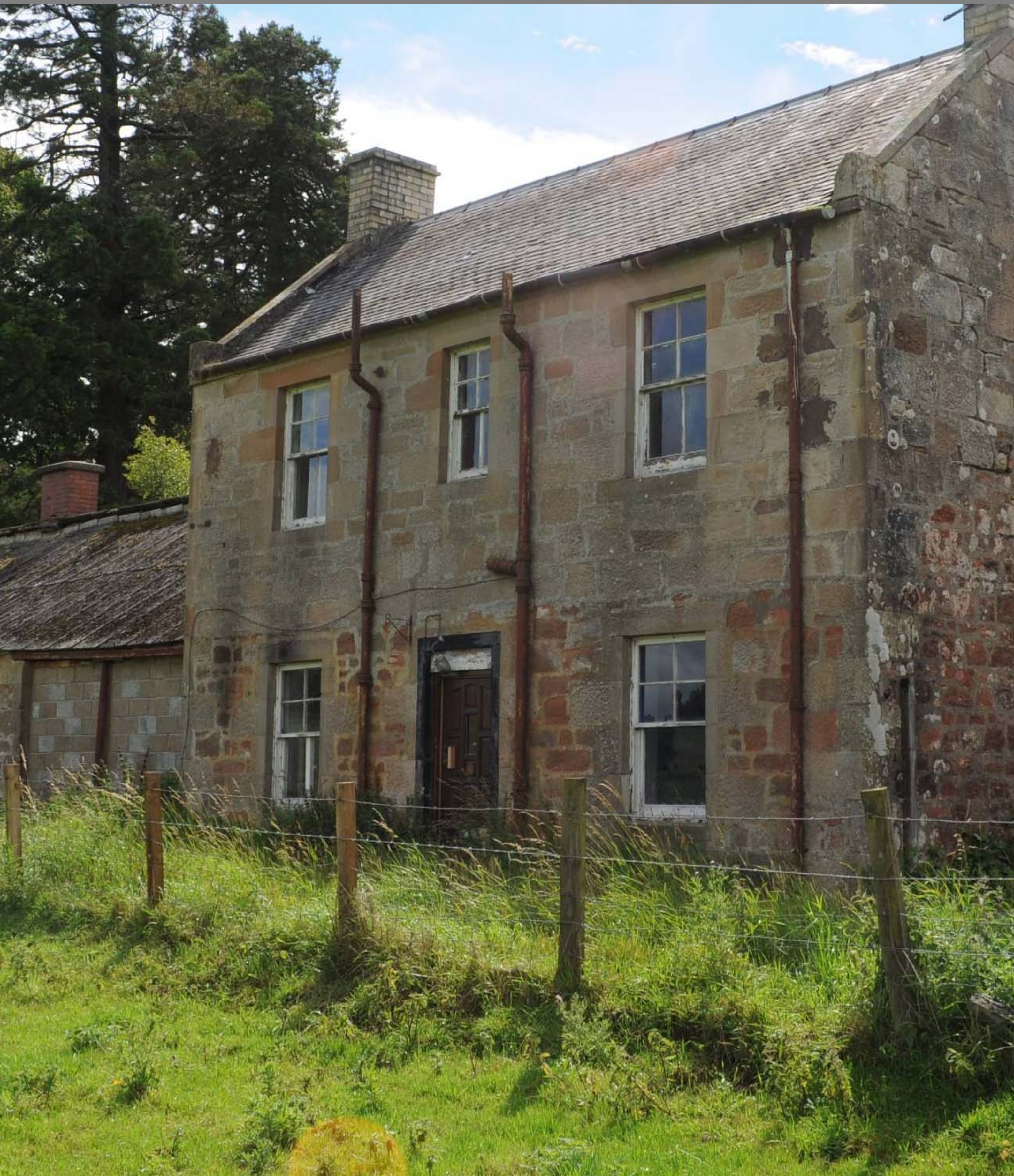
Garden Bothy, Cumnock

Upgrades to walls, floors, windows & door



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You can contact us at:

Historic Scotland
Conservation Directorate
Longmore House
Salisbury Place
Edinburgh EH9 1SH

Phone 0131 668 8600
Email hs.conservationgroup@scotland.gsi.gov.uk
Web www.historic-scotland.gov.uk/conservation

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Historic Scotland Refurbishment Case Study 8

Garden Bothy, Cumnock

Upgrades to walls, floors, windows & door

Moses Jenkins

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Acknowledgements

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DUMFRIES HOUSE

GCU Glasgow Caledonian University

1. Introduction

The aims of the trials at the Garden Bothy, which are reported here in this *Refurbishment Case Study*, can be summarised as follows:

- To test, in situ, a range of energy efficiency improvement measures
- To further demonstrate the applicability of vapour permeable materials in a traditional building
- To provide a replicable whole building refurbishment case study

An important element of the energy efficiency improvement research work carried out by Historic Scotland during recent years has been to trial a range of measures in situ, monitoring specific interventions after having been installed in a building. This gives a more realistic indication of the performance and limitations of a material or measure than had it been tested in a lab or modelled using standard computer software. Another guiding principle behind the research on site is that any building element being improved should maintain vapour permeability. Vapour barriers should not be created when energy efficiency fabric upgrades are being carried out in a traditional building.

Building on the above aims was a desire that the building could be used as a case study for the sensitive upgrade of traditionally constructed properties in the future. All the measures used at the Garden Bothy were executed by contractors from the local area and were reasonably straightforward to carry out. This was important as, to be truly replicable, it must be possible to source the appropriate professionals with relative ease. Cost was also a consideration; an initial plan drawn up for the work came to over £200,000 and, had this been followed, the upgrades would have been beyond the reach of most building owners and could seldom have been replicated. The in situ monitoring of the Garden Bothy is on-going at the time of publication of this report . The results of these measurements will be published in 2013.

2. The site

The building being discussed in this *Refurbishment Case Study* is the Garden Bothy on the Dumfries House Estate, Cumnock, East Ayrshire (Fig. 1). It is a two storey building with a living room and kitchen on the ground floor and two bedrooms and a small bathroom on the upper floor. The walls are formed of sandstone rubble masonry, except from on the rear elevation which is lined on the outside with brick, forming part of the walled garden. Originally, all internal walls were lined with lath and plaster. This had been lost throughout the ground floor rooms due to previous extensive refurbishments, although it had survived more or less intact in the upper floor rooms. A number of workshops are built onto one gable end, reaching the level of the first floor.

The property, whilst not derelict by any means, had suffered the effects of at least five years of inoccupation and many years of limited maintenance prior to this. This had led to water ingress at several points and subsequent damage to building fabric. The measures taken to rectify these problems are discussed in section 4 (*Enabling Works)*.

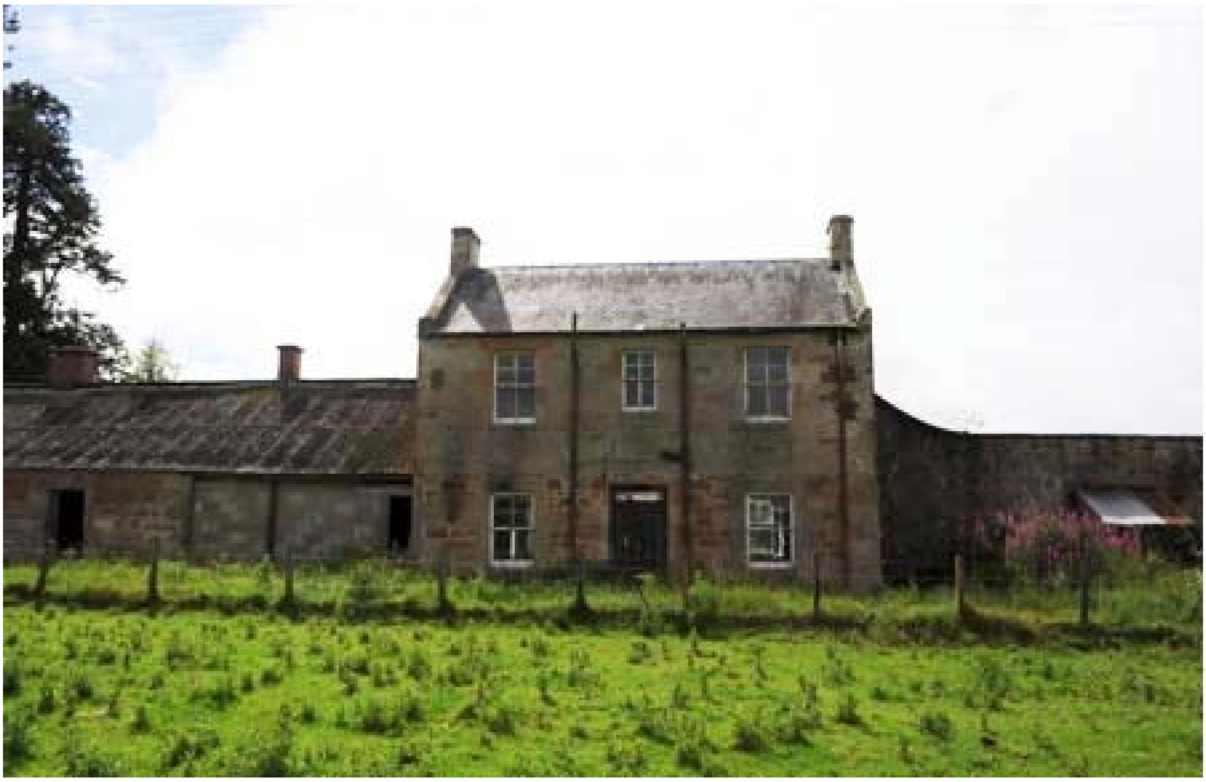

Fig. 1. The Garden Bothy, Dumfries House Estate, East Ayrshire, prior to upgrades

3. Pre-intervention thermal performance

Pre-intervention thermal performance was measured in late 2011 and in 2012, and the results will be published together with the currently on-going post-intervention measurements in 2013.

4. Enabling works

Whilst planning the energy efficiency improvements it became apparent that a number of tasks were required to bring the building up to a sufficient level of repair to allow the subsequent improvement work to be carried out. The main aim of this work was to prevent water ingress. Repairs were carried out to the roof, involving the replacement of missing slates, new lead flashing where required, the replacement of defective rainwater goods on both the front and rear elevations, and the formation of lead gutters at the skews.

Masonry repairs were carried out to all external walls (Fig. 2). This involved repointing with lime mortar and, on the rear elevation, the insertion of reinforcement to cracked areas of brickwork. The repointing work was executed using an NHL 3.5 mortar and covered an area of approximately 14 square meters (Fig. 3). Additionally, an area of wall adjacent to the front door was required to be made sound using reinforcing ties and limited repointing.

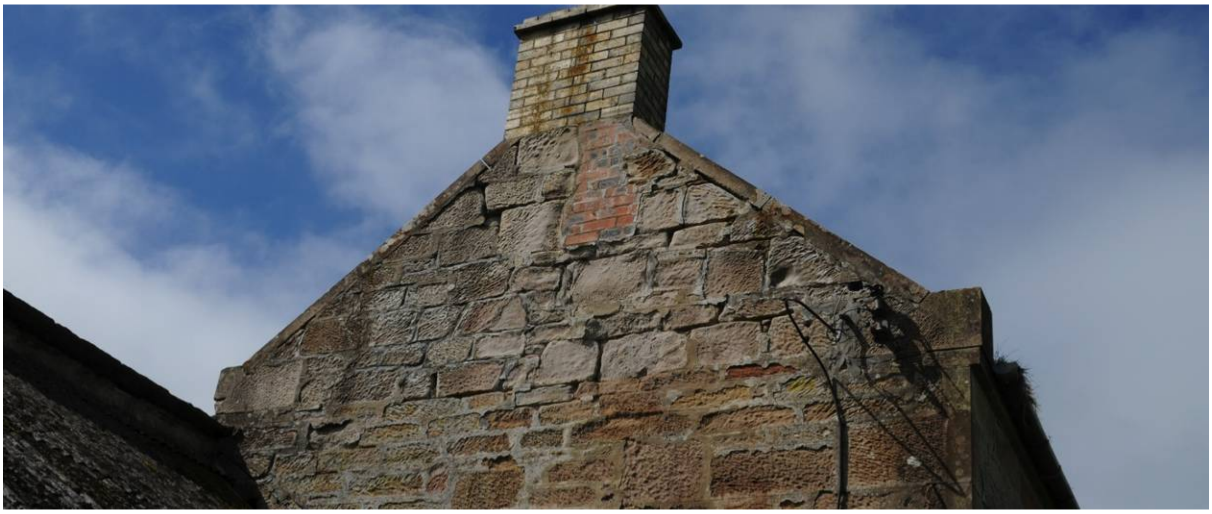

Fig. 2. The east gable end of the Garden Bothy, prior to enabling works

Fig. 3. Repointing masonry to prevent water ingress was a key part of the enabling works for the project which had to take place before any thermal improvement work could be undertaken

The roof and wall repairs are crucial to ensuring the success of the energy efficiency upgrade work. Had these repairs not taken place water ingress would have continued, causing significant damage not only to the building fabric but also to the insulation measures being installed. This was particularly true of the rear elevation where a combination of lost pointing and missing rain water goods had led to a significant concentration of water in the wall which would have rapidly degraded the subsequent insulation and clay finish. It should also be reminded that a wet wall does not perform as well as a dry wall in terms of heat loss. For both these reasons, maintenance and upgrade work to the walls and roof of a building to prevent any water ingress, as well as being good practice, should be seen as integral to energy improvement. All projects which seek to improve the thermal performance of a traditionally constructed building should, therefore, attend to such general repairs before any energy efficiency work takes place.

5. Internal insulation to the external walls

Measure 1 – Hemp insulation and clay board

In one ground floor room the original wall linings had been removed in previous refurbishments and replaced with plasterboard. This lining, along with all fixings, was removed and the walls were taken back to the stone masonry. The wall was then framed out and 50 mm of hemp board was applied between the timbers. Rather than applying plasterboard or a plaster skim coat over the hemp a more vapour permeable option was applied using clay board finished with a clay plaster. This was achieved by fixing 25 mm thick clay board to the timber and then applying two coats of clay plaster on top (Fig. 4). Finally, clay paint was used as a decorative finish. By using natural, vapour permeable materials for the insulation of the walls, humidity regulation would be improved humidity both internally and within the fabric of the walls, thus avoiding the risk of condensation and damaging moisture concentrations which may have resulted had impermeable materials been employed.

Fig. 4. Clay board in place over hemp board insulation ready to take clay plaster skim coat finish

Measure 2 – Wood fibre insulation and clay board

As with other rooms on the ground room floor, the kitchen also had no original wall linings. For the upgrade the existing modern linings were stripped away and the walls framed out and filled using 80 mm wood fibre insulation (Fig. 5). The finishing process again included clay board, plaster and paint, as above (Fig. 6).

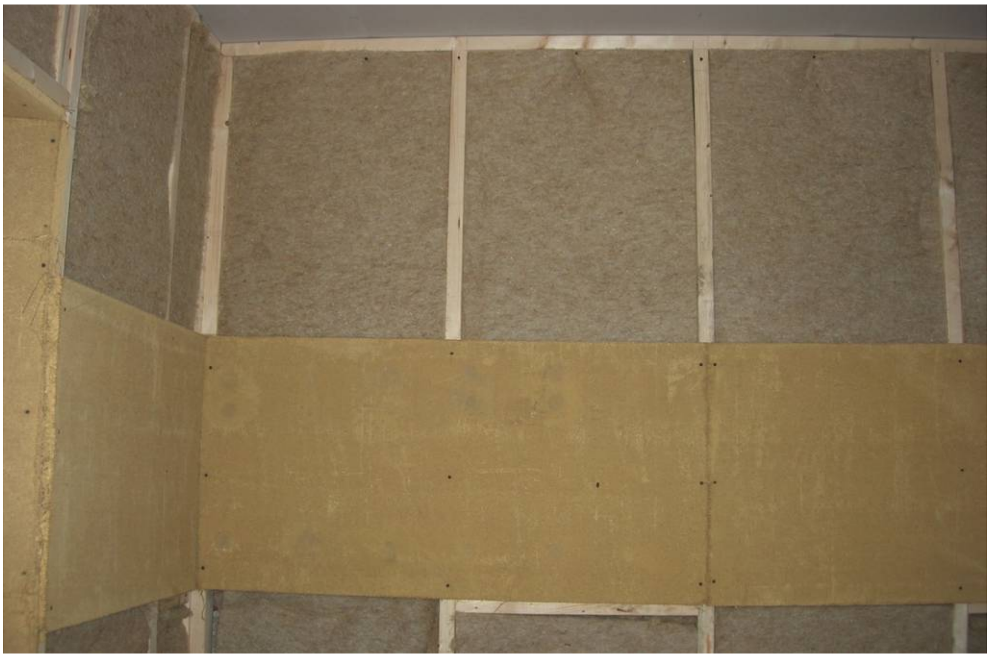

Fig. 5. Wood fibre insulation applied between timber straps with clay board being applied on top of this

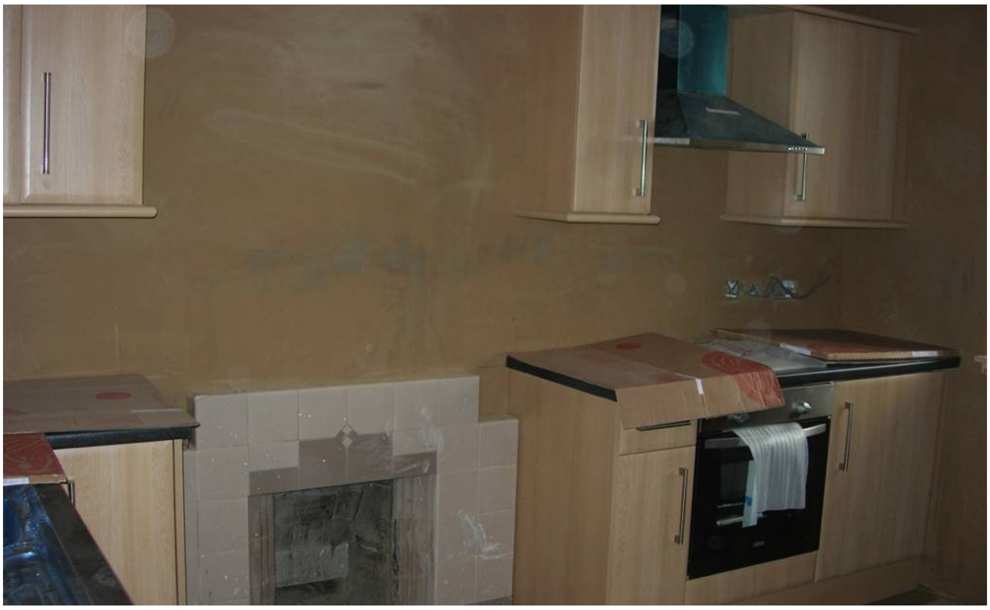

Fig. 6. The clay plastered walls with kitchen units in place

Measure 3 – Blown cellulose

In the two upstairs rooms original lath and plaster had survived. As the intention throughout the project was to retain as much original fabric as possible it was decided to employ insulation methods that would allow retention of lath and plaster wall linings. In the first room, the material used was blown cellulose fibre. This is the same material that has been used in previous Historic Scotland trials (see *Refurbishment Case Study 7: Sword Street*) where it was damp-sprayed directly to a wall.

In this situation the material was blown dry behind the wall lining through a series of, 26 mm diameter holes approximately every 200 mm across the wall. An important preparatory step to this being carried out was to ensure that the bottom of the wall was sealed off to ensure the blown insulation was contained within the space between the lath and plaster and the wall. This was achieved by temporarily removing the skirting boards and packing any voids with sheep's wool insulation. It is difficult to assess the thickness of insulating material applied as this will depend on the depth of cavity and unevenness of the wall, but is likely to be 30-40 mm. Thermal imaging after insulating confirmed that the full extent of the wall had been treated.

Measure 4 – Blown bonded polystyrene bead

In the other upper floor room a bonded polystyrene bead was blown behind the lath and plaster wall lining. Again, only a rough approximation of depth of material can be given but this would have been around 30-40 mm. Holes 26 mm in diameter were made every 200 mm to allow the material to be blown in. Whilst individual polystyrene beads are not vapour permeable, the material as a whole has been shown to allow bulk air to travel through its structure which is open cell. It could therefore be used safely in this situation without leading to the creation of a vapour barrier or damaging moisture build up in the fabric.

6. Improvements to the floor

In one ground floor room and the hall area the original floor had been removed and replaced by four inch thick un-insulated concrete. It is likely that the floor would have a poor thermal performance and it was therefore decided that this should be removed and replaced with insulated lime concrete.

Several types of insulating material can be incorporated into lime concrete, for example hemp and recycled glass material. In this case it was decided to use Lightweight Expanded Clay Aggregate (LECA). Some systems recommend the floor be laid in a solid mass whilst others recommend voids be maintained in and around the LECA, and the latter method was chosen.

The first stage was to excavate the concrete slab and subsoil (Fig. 7). This was a large job with around 16-18 tonnes of material excavated. A batter was maintained where the excavation reached the walls to ensure these were not undermined. As the concrete floor was being excavated it became apparent that its foundations were more substantial than first thought, allowing an extra 100 mm of depth for the new floor (giving a total depth of 600 mm for the insulated lime concrete). Following excavation the compacted earth was leveled and a layer of geotextile laid on top.

The next stage was to lay a substantial layer (c.500 mm depth) of loose LECA, with an aggregate size of around 10-20 mm (Fig. 8). A second layer of geotextile was placed on top of this. On top of the loose LECA, a 100 mm layer of lime concrete formed of LECA, aggregate size 0-20 mm, bound with NHL5 lime was laid (Figs. 9, 10 & 11). Finally, sandstone flags from a quarry in the North of England (Fig. 12) were laid as a finished surface on a lime mortar bed, and given three coats of wax to protect the surface from spillages.

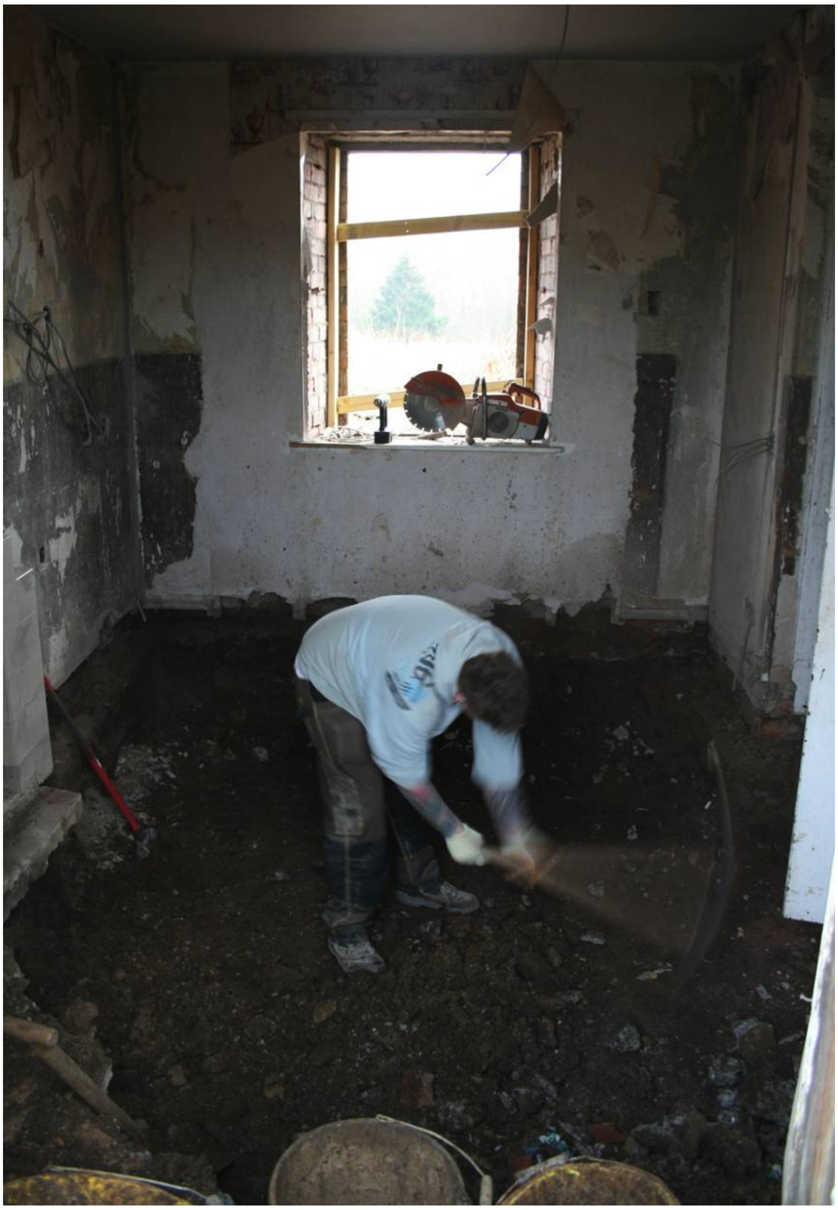

Fig. 7. Excavating the floor in preparation for the insulation layer being put down

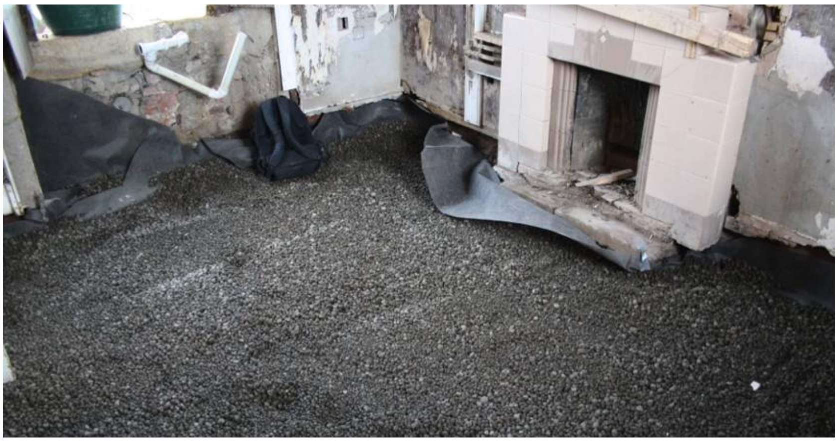

Fig. 8. The loose LECA laid down over a layer of geotextile

Fig. 9. The lime concrete being mixed using a traditional larry

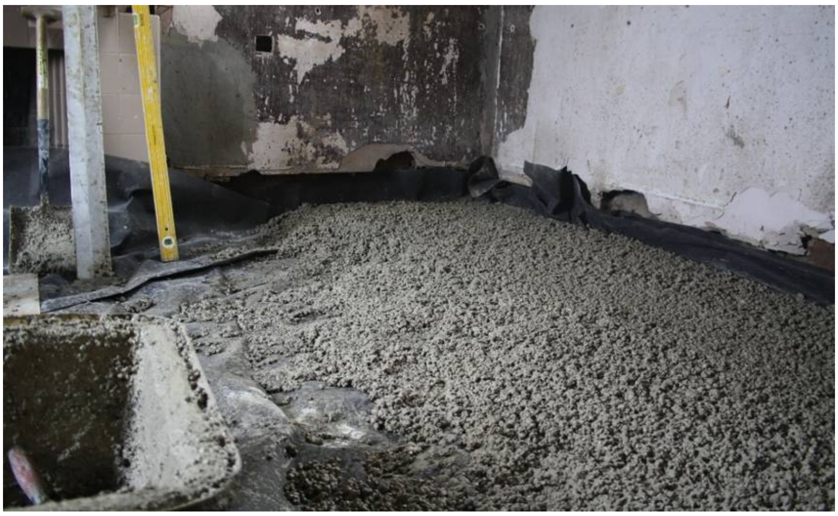

Fig. 10. The lime concrete screed being laid

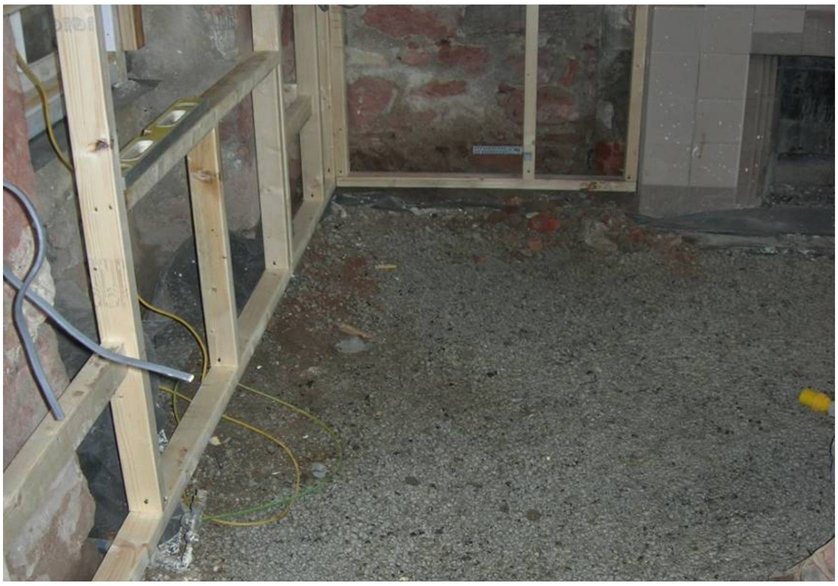

Fig. 11. The lime concrete layer in situ

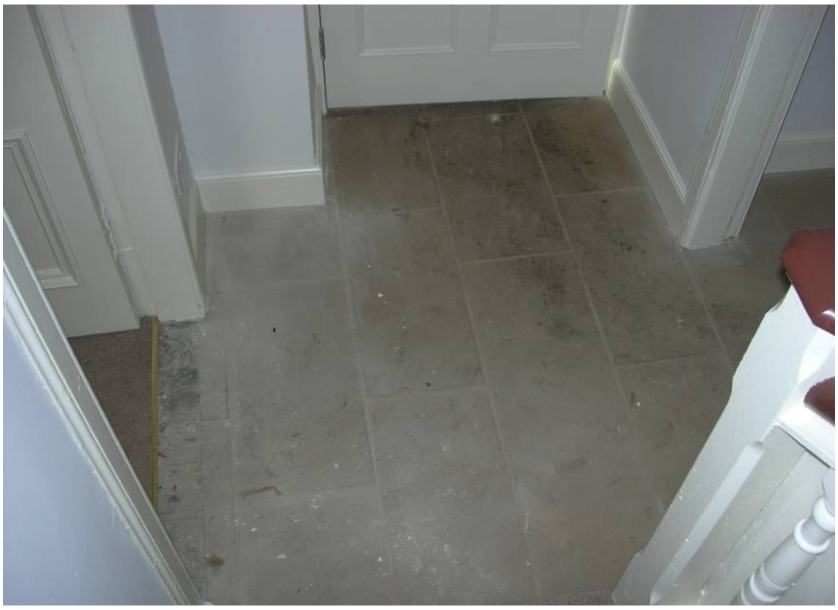

Fig. 12. British sandstone flagstones laid as a finish to the lime concrete floor

7. Improvements to windows

It was decided to upgrade the windows to double glazing. At the outset of the project the windows were in varying states of disrepair. In accordance with the aim of retaining as much original fabric as possible it was therefore decided to repair and upgrade those windows which could be saved, and to have new windows manufactured to the original profile where this was not possible (Fig. 13).

Where windows were repaired this involved new timber being used to replace any sections which were rotten. The original glazing was removed, the checks altered and bevelled glazing beads fitted to take the new double glazed units which were 12.5 mm in thickness. These units were manufactured locally in Glasgow. All batten rods and parting beads were required to be renewed. The assembled windows were then painted and re-hung with new sash cords and weights to allow them to be fully operable and therefore contribute to the passive ventilation of the house when required. During these works all windows were draught stripped.

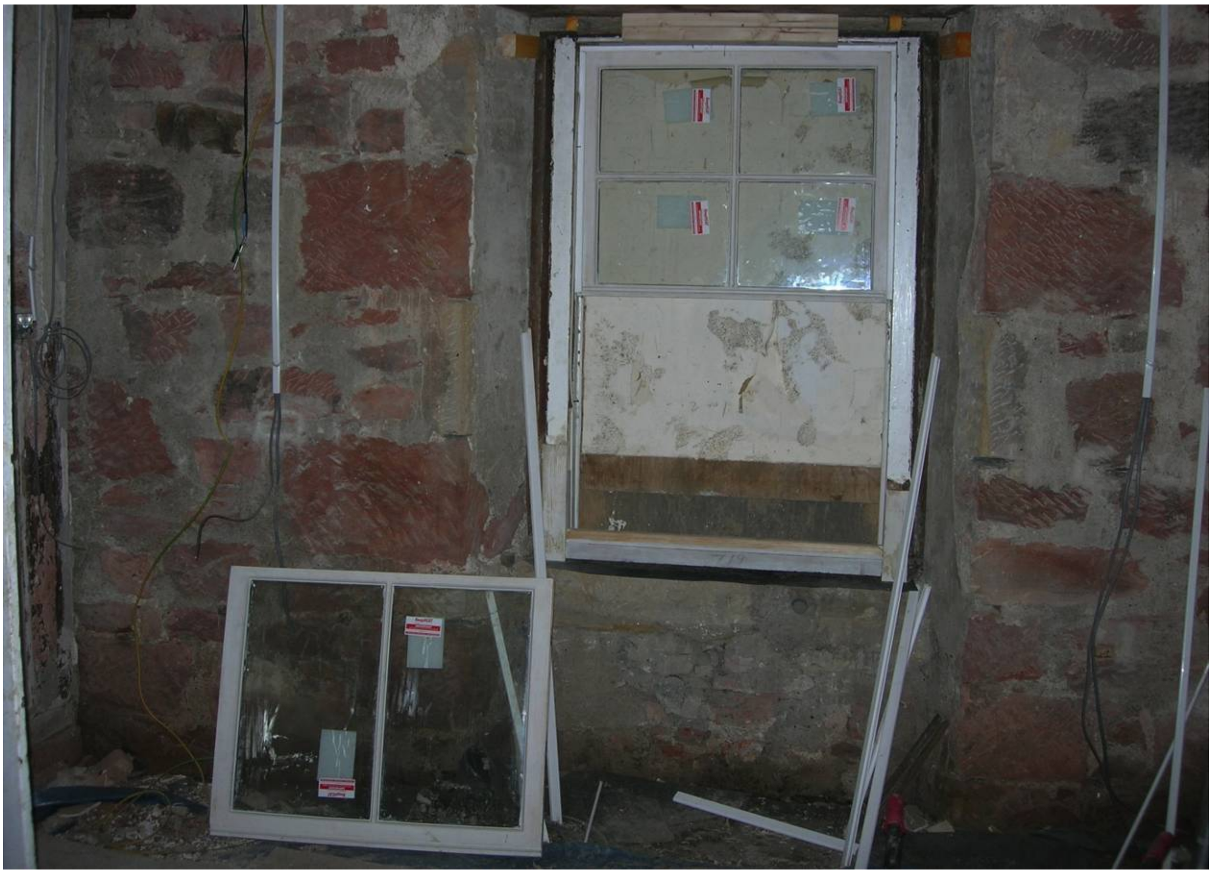

Fig. 13. Original sashes with new double glazed units being installed in repaired cases

In some instances poor maintenance had led to such excessive decay that repair was impractical and new timber windows were manufactured by the joiner who performed the upgrade work (Fig. 14). Replacement was required for two complete window sets in the rear elevation, and one top sash, four bottom sashes and to a case sill in the front elevation. The same new double glazed units were used throughout and all windows brought back to full working order. The pane size and layout of the replacement windows was matched to the originals to ensure visual integrity.

Finally, a small metal roof light above the stairwell had suffered severe corrosion and was replaced by a double glazed alternative which matched, as far as possible, the original.

Fig. 14. New double glazed sash windows awaiting hanging

8. Improvements to the door

The only external door in the property was a modern replacement which was visually inappropriate and poorly insulated. It was decided to replace this with a highly insulated alternative with an appearance more compatible with the building (Fig. 15). The new door was manufactured to incorporate an aerogel insulation blanket, providing a U-value of 0.62 W/m^2K for the door blade. The internal doors were all sound and no works were required to these.

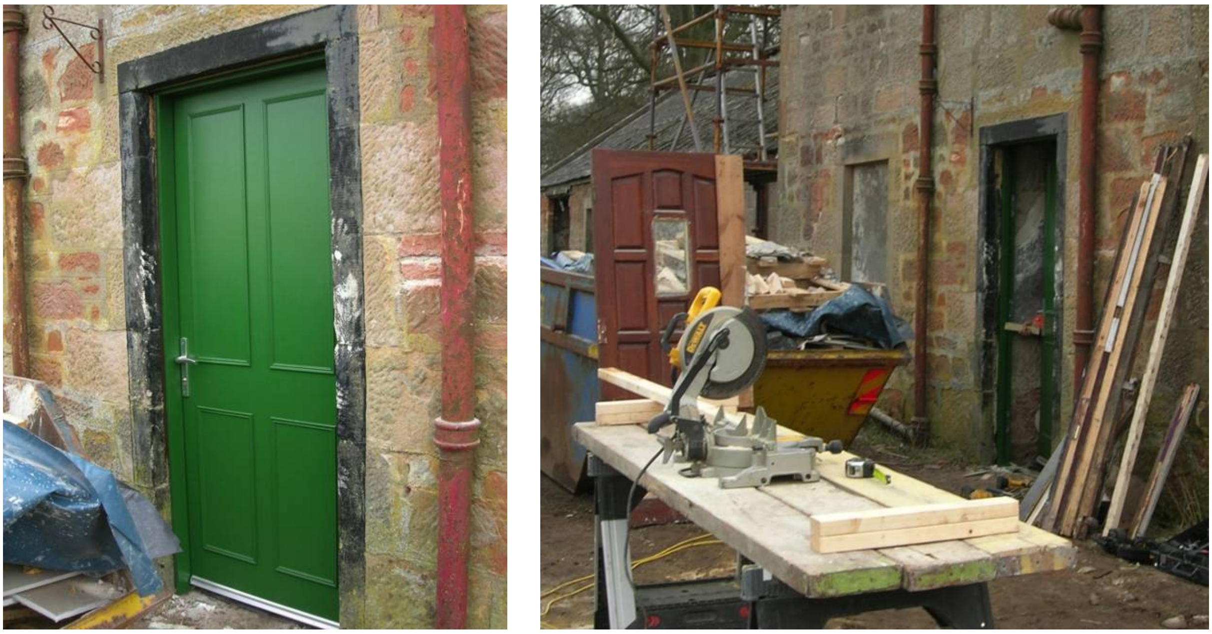

Fig. 15. The new insulated replacement front door, the only external door to the bothy

9. Improvements to the roof space

The loft was insulated with 250 mm thick sheep's wool insulation. Prior to this taking place, some work was required to patch up the lath and plaster ceiling which had suffered some damage and water ingress. A further alteration was to increase the size of the loft hatch to allow a new hot water tank to be installed. The new hatch was insulated in the same way as the rest of the loft and the hot water tank was fitted with a thermal jacket.

10. Heating system

It was decided to install a micro renewable heating system in the form of a pellet-fuelled biomass boiler. This decision was influenced by a number of factors, including the use of biomass on the surrounding estate and the presence of outbuildings to house the boiler system and provide dry storage for the fuel pellets.

The boiler heats four radiators, one in each of the main rooms of the house, and also provides hot water. There is sufficient heat load capacity to heat the outbuildings in future.

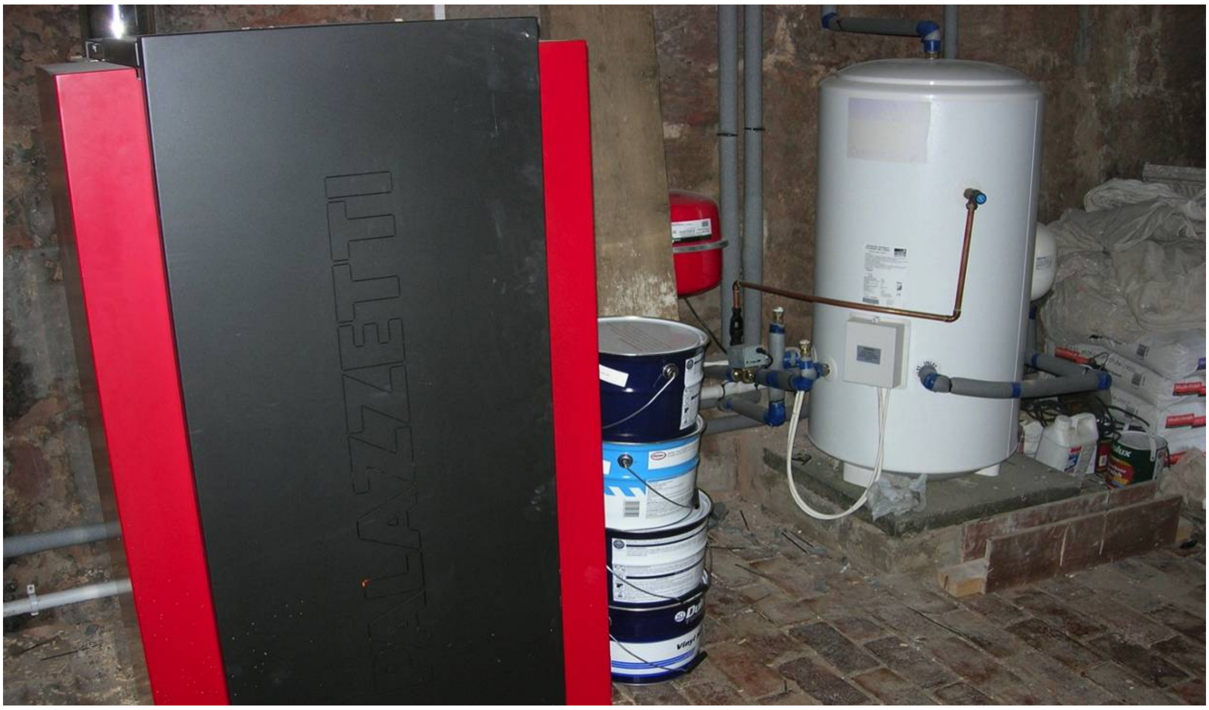

Fig. 16. The pellet fuelled biomass boiler and hot water tank

11. Retention of fixtures

Wherever possible throughout the project original fabric and existing fixtures were retained. This included the retention of existing internal timber doors and door furniture, as well as the re-use of existing skirting boards and facings, which were carefully removed prior to work taking place and then re-instated. Where possible, plaster cornices were also retained, and in areas where these had suffered damage replacement parts were pieced in. Additionally, hardware such as the existing fire places in the ground floor rooms were retained and brought back into use. Externally, this included elements such as rhones and downpipes, all of which were fortunately in good condition.

12. Ventilation considerations

A principal consideration of the project was to ensure natural ventilation in the building. This was achieved through the use of traditional ventilation details, including the fitting of an opening roof light in the stairwell, allowing natural stack ventilation in the centre of the building.

The existing hearth and flue in the main ground floor room were retained and a refurbished late 19th century grate was installed, finished with a plain wooden surround. The grate featured a closable baffle to allow the control of natural ventilation via the flue (Fig. 17). As part of the window refurbishment only basic draught stripping was carried out, in order to ensure an appropriate level of ventilation (to approximate that supplied by trickle vents), necessary in a domestic context.

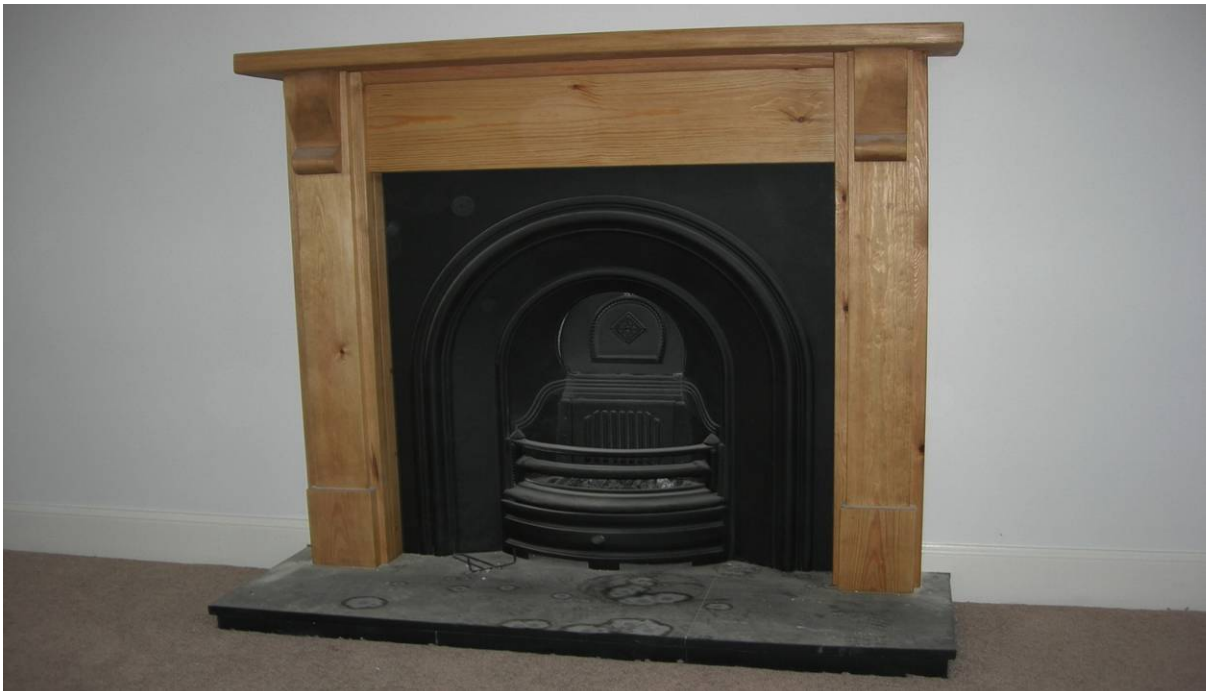

Fig. 17. The hearth and flue in the sitting room, finished with a plain wooden surround

13. Costs

The costs for the energy efficiency upgrade work at the Garden Bothy are summarised below. The worked were carried out in 2009-10):

Enabling Work (masonry repairs)	£3589
Enabling Work (roof repairs)	£3480
Enabling Work (plumbing and electrics)	£5500
Total Enabling Works	**£12,569**
Wall and loft insulation	£11,475
Repair and upgrade of windows	£9540
New insulated door	£1674
Lime concrete floor	£10,000
Skylight	£1400
Total Energy Efficiency Fabric Work	**£34,089**
Biomass heating system	£16,000
Total for all works	**£62,658**

The energy efficiency upgrade work was achieved at a cost in the region of £30,000 with a further £10,000 spent on the enabling work. The total cost of the improvement works came to just over £40,000 (excluding the biomass heating system). The cost would have been reduced had only one or two types of wall insulation been used, and other measures been simplified. It should be noted that prior to the works the property was in a poor condition and was probably uninhabitable.

14. Post-intervention thermal performance

Post-intervention thermal performance measurements are currently on-going and will be published in 2013.

15. Moisture monitoring results

Results for the monitoring of moisture levels within the building fabric are currently on-going and will be published in 2013.

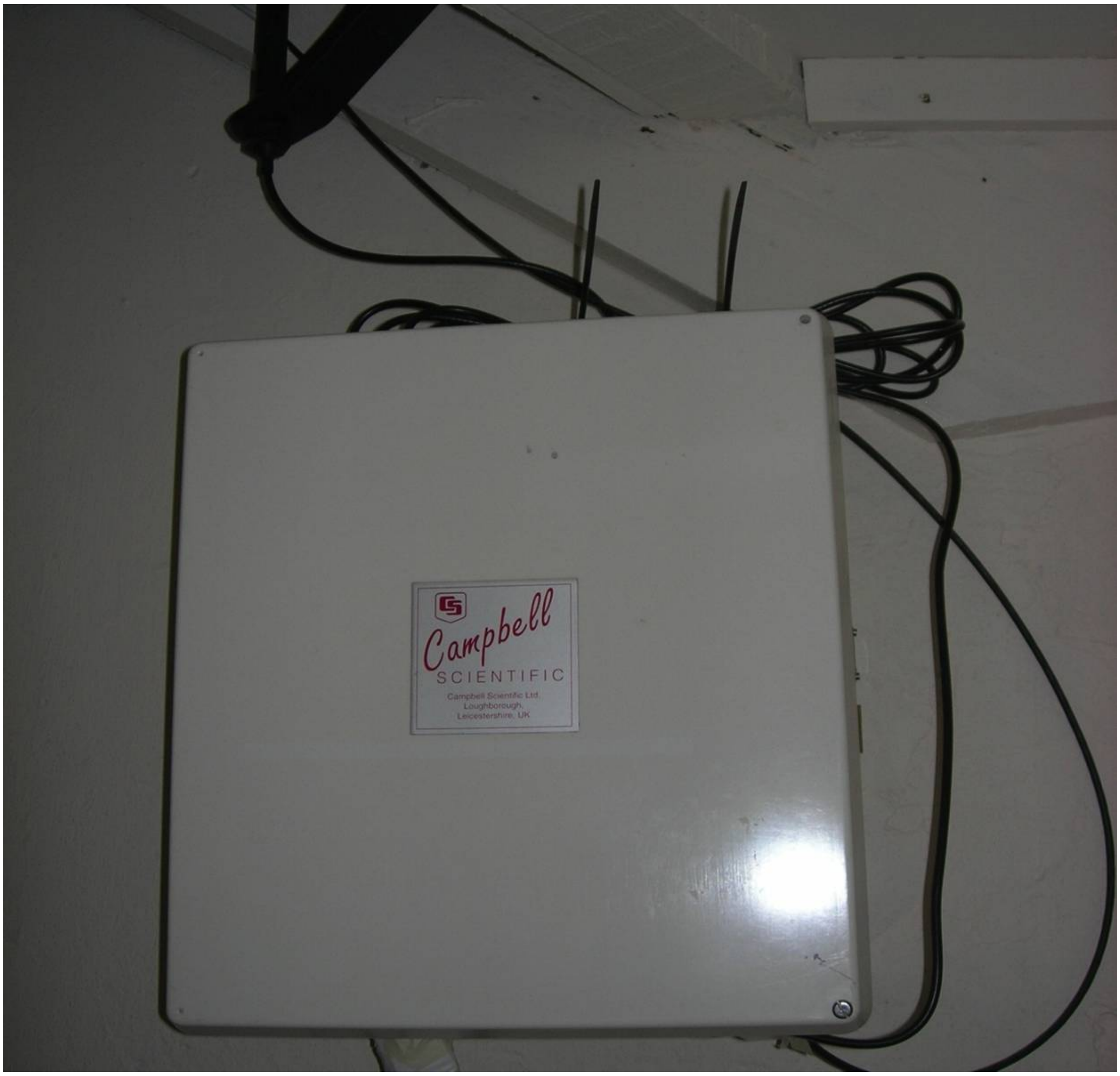

Fig. 18. Remote logging equipment for long term monitoring of hygrothermal performance

16. Conclusion

The work undertaken at the Garden Bothy represents a ‘whole building’ approach to what can be achieved when sensitively upgrading the thermal performance of a traditionally constructed building. Four different materials for insulating walls were trialled, two of which are appropriate where original lath and plaster wall linings remain intact, and two for where the wall lining had been lost. Additionally, a highly insulated lime concrete floor was laid, and the timber windows were upgraded with new double glazed units. The loft was insulated and the front door was upgraded. Together, these measures demonstrate a comprehensive package which shows what can be achieved to improve the thermal performance of a traditionally constructed building. Monitoring of moisture levels and to establish the improvement in U-values is on-going and will be published in 2013.

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