

Kirkton of Coull, Aberdeenshire

Thermal Improvements to a 19th century farmhouse



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This publication is a web publication and is available for free download from the Historic Scotland website:
www.historic-scotland.gov.uk/refurbcasestudies

This publication should be quoted as:
Historic Scotland Refurbishment Case Study 16

ISBN 978-1-84917-178-6

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Thermal improvements to a 19th century farmhouse

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With acknowledgement and thanks to The MacRobert Trust



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1. Introduction

This case study is one in a series of Refurbishment Case Studies published by Historic Scotland where thermal upgrades are described on traditional and historic properties. Although the series often describes energy efficiency improvements to domestic structures, other themes of refurbishment are included in the series, such as emergency repairs to heating plant and equipment, and general fabric repairs. This case study describes the thermal improvements made to the fabric of a mid-19th century granite farmhouse in Aberdeenshire.

While thermal refurbishment of domestic properties is well established, there are many aspects of the refurbishment of traditionally constructed properties where more evidence is needed to inform best practice, from the point of view of both the on-going health of the building and, more importantly, the occupants. This case study will describe interventions to the floors, coombed ceilings and walls of a building that is typical of the rural architecture of north east Scotland. The principles for the intervention differ from the approach taken by conventional insulation contractors, in that there is a desire to retain existing fabric where possible, to augment the performance of original elements, and to maintain the largely vapour open nature of the traditional construction materials.

In selecting the materials and specification for the works, the energy performance alone was not the only consideration; factors of disruption, cost, payback and product life were also relevant. The owners were interested in establishing a basic template for the refurbishment of similar properties on the estate and elsewhere, especially working with a local contractor to deliver the improvement works. The interventions described in this case study follow the interventions set out in the *Historic Scotland Short Guide 1 – Fabric Improvements for Energy Efficiency in Traditional Buildings* and as demonstrated in other Historic Scotland Refurbishment Case Studies.

2. The site

The house is situated in a rural location on a south west slope with an open outlook (Fig. 1). The principal elevation faces south west, allowing solar gain to the rooms situated at the front of the building. The building consists of a ground floor with a hall, two principal rooms, a kitchen and a shower room (Fig. 2). A generous stair leads to two upstairs bedrooms and a bathroom (Fig. 3). The ceilings are coombed and intervention in this area is therefore an important part of the trial. The building dates from the mid-19th century, is unlisted, owned by the MacRobert Trust and is let to a domestic tenant. The walls are constructed of large, regularly coursed, squared granite blocks, bonded with lime; at some stage the external walls were repointed with cement. As granite does not permit the movement of water vapour, the presence of cement pointing is likely to put added pressure onto the joints for the dispersal of any internal moisture in the wall.



Figure 1: *Kirkton of Coull farmhouse, Aberdeenshire*

The pitched slate roof with a skew cope, chimneys and two dormers is typical of many rural buildings in Scotland, especially in the north east region. The interior of the farmhouse had previously been altered extensively; the original lath and plaster had been replaced with modern plasterboard in all but the ground floor bedroom, with modern timber framed double glazed units replacing the original windows throughout. As these replacement windows remain in good condition they were retained and will not be part of this case study.

The property was heated by an LPG gas condensing boiler system of recent date and appropriate efficiency. Notwithstanding this, the tenant had been incurring high utility bills over the last few years and the Trust was keen to upgrade the property in line with their policy of housing stock investment.

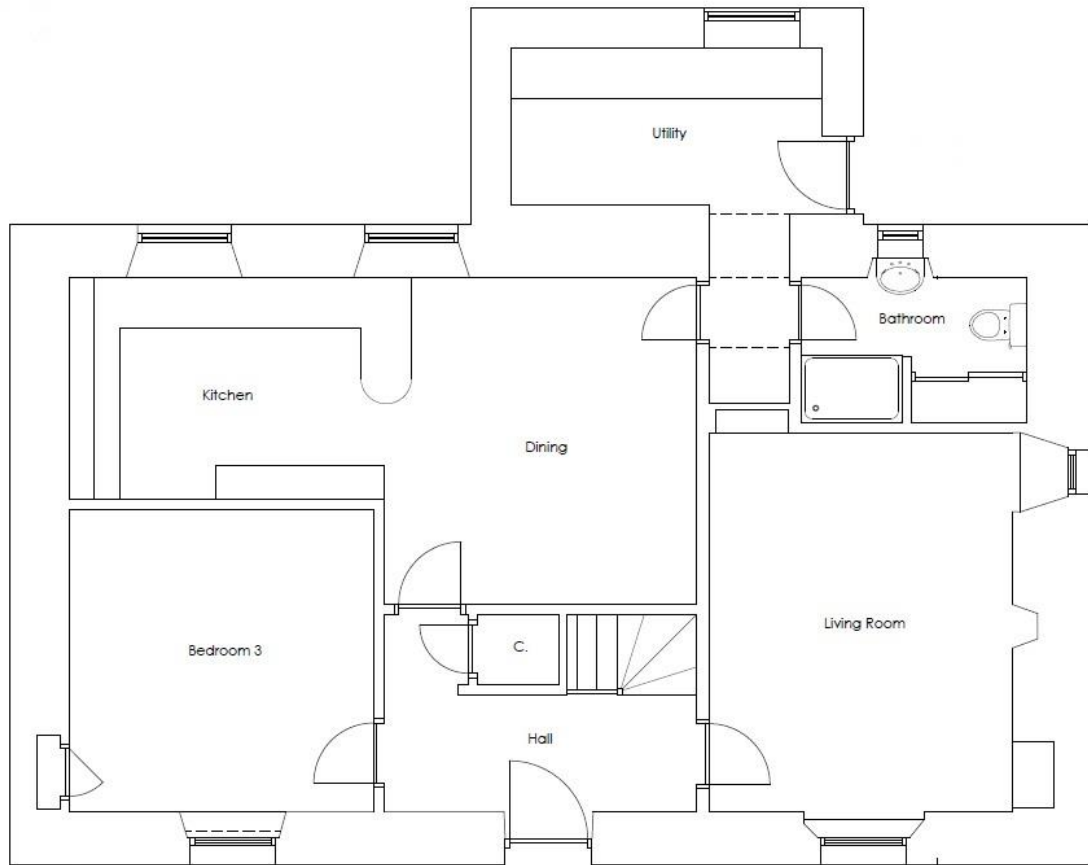


Figure 2: *Ground floor plan*

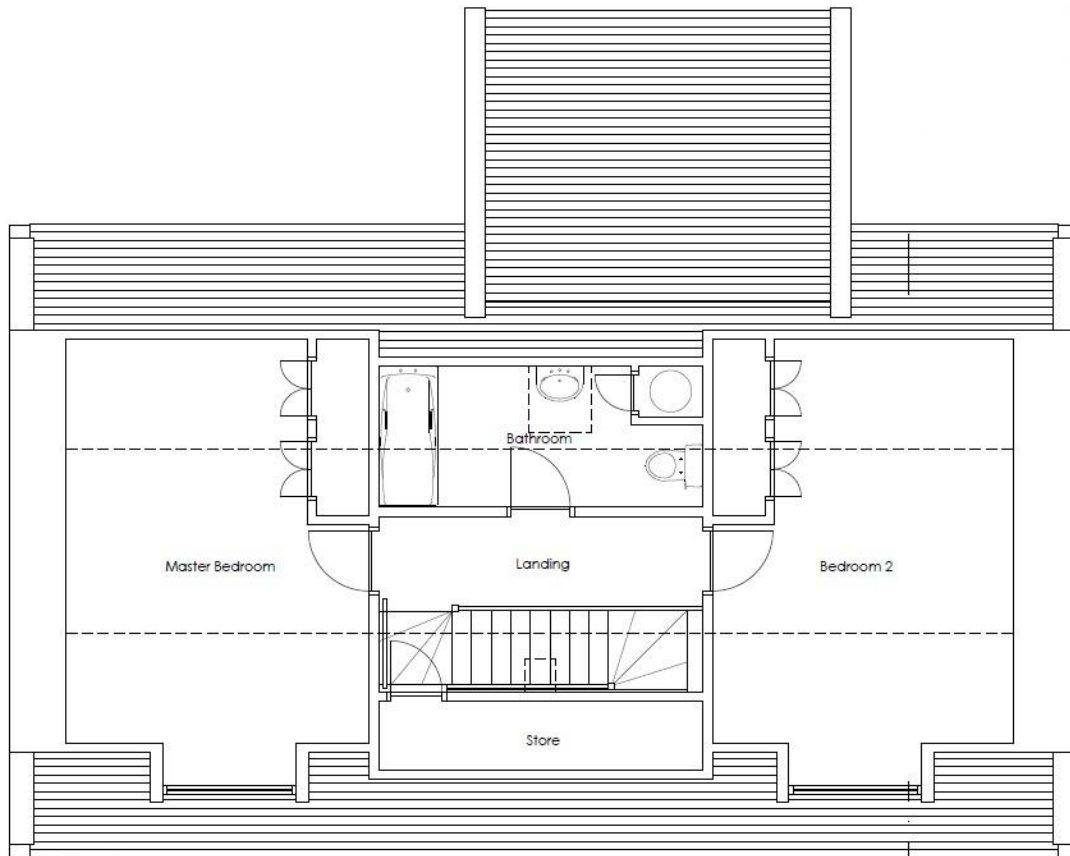


Figure 3: *First floor plan*

3. Existing fuel sources

The house is in a rural location and off the gas grid; electricity and propane gas (LPG) are the main fuel sources. LPG is used for heating and hot water, and electricity is used for lighting and utilities.

4. Energy Performance Certificate

An Energy Performance Certificate (EPC) and a Green Deal Occupancy Assessment were commissioned in order to establish a baseline from which to begin the assessment of the building. The EPC for the property pre-intervention is included as Appendix 1. The EPC methodology used Reduced Data Standard Assessment Procedure (RDSAP) to estimate energy demand and heat loss. Whilst effective for general building modelling, this approach is less well configured for modelling energy use in older and traditional properties. One of the objectives of the pilot was to establish in more detail the effectiveness of the RDSAP modelling and how well it articulated the improvement measures installed. The EPC produced in summer 2013 estimates that the energy costs over a three-year period will be £8,871, resulting in an energy efficiency rating of band F. The typical Scottish household achieves a band D. The areas which scored poorly in the report were

targeted for improvement as part of this case study: namely, the insulation of the roof, walls and floors. The heating system provided one of the best scores in the report, estimating that the current boiler fit is a good one. This suggests, from a modelling point of view, that much of the costs associated with the heating are from poor thermal performance of the building fabric. The EPC report suggests that with improvements to the property, a saving of around £1,848 could be realised over a three year period.

5. Energy consumption prior to works

In addition to the data gathered on the building fabric, energy bills from the previous three years were accessed by the Trust, in order to establish the baseline energy consumption. The LPG gas tank is filled up twice every year, once in spring and once in winter. Fuel costs are high; in the period March 2012 to March 2013 a total of £1559.46 was spent on LPG, and £550.81 on electricity. When benchmarked against figures for the rented sector this is approximately 30% below the average, and gives an energy consumption figure of approx. 229 Kilowatt Hours per square metre per year (kWh/m²/year). This figure is also lower than the figure given in the pre-intervention EPC of 321 kWh/m²/year, supporting the view that the house was under-heated.

6. Monitoring

6.1 Pre-intervention monitoring

A local energy assessor completed pre-intervention monitoring and evaluation in order to establish a baseline performance. This involved the measurement of *in situ* U-values at selected positions on the coombs, walls and floors; conducting air-leakage testing; completing thermal imaging using an infra-red camera, and measuring the relative humidity (RH) at various locations. A local consultant was specifically sought for this work in order to assist in creating capacity in the North East of Scotland in this emerging field.

6.2 Thermal performance

The thermal performance of the unimproved granite cottage was measured prior to the works, and consisted of *in situ* U-value measurements on the gable end walls, ground floor and coomb ceilings using Hukseflux heat flux sensors and other associated equipment. The windows were not tested as double glazed units had been recently installed throughout the cottage. The sensors were positioned in the different rooms of the cottage and the readings taken over a period of two weeks in the autumn of 2013. The heat flux plates were mounted onto the surfaces to be measured (Fig. 4) allowed a baseline pre-intervention U-value to be determined for various building elements. As the site work was completed by the end of March 2014, there remained enough cooler weather in April to achieve two weeks of post

intervention U-value monitoring.



Figure 4: Heatflux plates sited either side of the dormer used to assess heat flow for in situ U-value measurement

6.3 Relative humidity

The relative humidity (RH) in various cavities and voids was also measured during the pre-intervention stage using “i-button” data loggers. Measuring water content in masonry walls is difficult to achieve, but approximate levels, and particularly trends, can be monitored easily using relative humidity as a proxy for wall water content. I-buttons were placed behind the plasterboard linings and in roof voids to monitor changes in the internal environment. High RH values do not imply directly that walls are wet, but in certain locations, high levels may encourage various mechanisms of timber decay. RH monitoring was focused on areas where blown materials were going to be introduced behind existing wall linings; it was important that any changes in the hygrothermal dynamic were recorded and assessed, especially as the granite walls were cement pointed, with a limited ability to disperse water vapour to the outside.

6.4 Thermal imaging

To assist in the identification of areas of high heat loss, a series of thermal images were taken. As the building was heated to a fairly high temperature (20°C), heat

loss pathways showed up clearly. Care was taken to ensure that any solar gain on the fabric was not mistaken for a heat path. Even in the winter, low sun can warm roof elements and other surfaces. Areas that appeared to show high heat loss were the west gable at ground level, the dormers on the first floor, and areas of the roof and wall junction. Also of note was the finding that the roof slopes showed to be much cooler than expected, indicating a better thermal performance than anticipated (Fig. 5). This was confirmed by subsequent investigation, revealing that blown cellulose had previously been installed into the space between the internal lining and the sarking boards.



Figure 5: Thermal image of the front elevation, showing the better than expected performance of the roof. External air temperature 1.4°C

6.5 Air leakage testing

A local company conducted an air permeability test prior to the commencement of the works. This involved the closing of various standard openings in the fabric (hearths, trickle vents etc.), with a large fan being set into the front door opening, following standard practice. The result obtained was $10.92 \text{ m}^3/(\text{hr m}^2)$ at 50 Pascals pressure. This figure is better than might be expected from a building of this type; by contrast, the air permeability of Scotstarvit Tower Cottage (Refurbishment Case Study 7) was $15 \text{ m}^3/(\text{hr m}^2)$. Despite this, it was apparent that the occupant of the cottage was experiencing thermal discomfort. It is likely

therefore that whilst the internal envelope was relatively airtight, spaces and voids behind the linings were open and ventilated. Additionally, since the internal linings are mostly plasterboard, the heat flow through the linings would have been quite high.

6.6 Post-intervention monitoring

Following the work, the same elements were re-measured to assess the effectiveness of the intervention. In addition, the relative humidity behind the insulated area was also monitored to assess any hygrothermal changes. The results for each element are described at the end of each fabric section of this report.

7. Delivering the work

The MacRobert Trust used their retained contractor for the works, as they were keen to maintain continuity and up-skill the local workforce. The work was programmed in two phases; the first in late autumn 2013, and the second in March 2014. The house remained in occupation throughout, which was occasionally limiting to the works, and in hindsight might be approached differently. In many domestic refurbishments of this type a full move out, or 'decant' is preferred. In this case a high degree of client care was required to maintain habitability (Fig. 6).



Figure 6: *Protection of carpets during the works*

8. Fabric improvements to the roof

8.1 Existing conditions and considerations

The roof at Kirkton of Coull is of standard traditional construction, comprising reasonably regularly spaced rafters, mounted from a wall plate on the wall head and enclosed with timber sarking boards. The roof ties, or collars, on the rafters provide the structure for the ceiling of the upstairs rooms. On closer examination it was found that the space between the ties had been previously insulated with a mixture of cellulose fibre and mineral wool, which was quite disturbed in places. The coombs, as described above, were found to have been partially filled with more blown cellulose; this itself was of interest since the filling of such spaces is generally held to be bad practice due to the potential for moisture build up. On both sides of the roof the cellulose material and the sarking were dry, with no sign of decay or condensation. There was no record of any work held by the Trust, but from the packaging material found it is likely to date from the late 1980s.

What was observed, however, was evidence of high humidity levels in the roof space above the first floor ceiling. This was in the form of white mould and evidence of active wood-boring insect damage. It is likely that the raised humidity levels were caused by a reduction in temperature from the legacy insulation work, and a reduction in fortuitous ventilation caused by the blown cellulose in the coombs.

As one of the objectives of the project was the use of wood fibre board to insulate a traditional coombed roof, and that the coverage and fill of the blown cellulose was varied, it was decided to remove the internal plasterboard linings in the first floor rooms and take out the cellulose fibre material. This was done with some ease; and again during removal there were no signs of condensation or any decay. This might well have been due to the vapour open nature of the cellulose material, the plasterboard, and the sarking boards.

8.2 Insulation to the attic space

The legacy insulation material was removed and wood fibre board, 80mm thick, was cut and laid between the ceiling joists. Electrical cables were lifted and laid above the fitted insulation, and care was taken to leave a ventilation gap beneath the sarking (Fig. 7). With insulation installed in this way, the roof space remained a cold roof. For further details of this technique see *Historic Scotland Short Guide 1 – Fabric Improvements for Energy Efficiency in Traditional Buildings*.

The relative humidity readings following the insulation work were recorded above the bathroom and directly above the stairs. Readings were higher than expected, and indicate that the roof space may need additional ventilation. Insulation to roof spaces needs careful planning, as changes to the ambient temperatures can result

in reduced dew points and risk of condensation. This is discussed further in *Refurbishment Case Study 11*.



Figure 7: *Wood fibre board insulation to the attic space, showing vented gap below the sarking*

8.3 Insulation of roof slopes and coomb ceilings

To insulate the roof slopes 80mm wood fibre board was cut to fit between the existing rafters. This was done outside with a table saw, and a snug push-fit was achieved. As this fitting operation was quite neat, and the board was to be further enclosed with new plasterboard, there was no requirement to fit any additional barriers, such as a vapour control layer; this function was provided by the wood fibre board itself. The rafters were of standard dimension for the period (150mm) giving space for a wood fibre board with a ventilation space between the underside of the sarking and the insulation board of 40mm. This insulation layer between the rafters was continued down to the wall heads; these were covered with off cuts of the insulation board (Fig. 8), and thus joining with the blown insulation in the room below.



Figure 8: *Wood fibre board insulation at the junction of the roof and the wallhead.*

8.4 Dormer improvements

Kirkton of Coull has two dormer windows, one in each of the bedrooms on the first floor. Dormer windows, while providing welcome natural light, can lose a lot of heat from the dormer sides and top, even when the glazed elements have good thermal performance. In this case the windows had previously been upgraded to double glazed units, but the framing of the sides that held them was un-insulated. As with the coomb ceilings, the plasterboard around the dormers was removed and wood fibre board sections, 80mm thick, were cut to fit between the structural timbers of the dormer cheeks and the ceiling (Fig. 9). New plasterboard was used to close in the panels; this was taped and lining paper was applied.

The pre-intervention U-value monitoring showed the relative effectiveness of the existing blown cellulose (Table 1). A failure in the post-intervention monitoring meant that no post intervention *in situ* readings were available and a calculated U-value had to be used. However, even noting the existing insulation, there was a reasonable improvement. Had there been no insulation prior to the work there would have been a more significant improvement.



Figure 9: Fitting wood fibre insulation to the dormers

| Location | Pre intervention (W/m ² K) | Post intervention (calculated) (W/m ² K) | % Improvement |
|-------------------|---------------------------------------|---|---------------|
| RH side of window | 0.45 | 0.37 | 16 |
| LH side of window | 0.44 | 0.37 | 16 |

Table 1: Measured pre-intervention and post-intervention (calculated) U-values

9. First floor gable end walls

The gable end walls had been relined with plasterboard on timber studs, with no insulation. This might explain why the upstairs was considered cold, despite having some insulation previously installed on the roof slopes. It was also evident that there was free air movement through the eaves and into the void spaces below the coombs, and this may have contributed to the poor thermal performance. The granite masonry was confirmed as being dry, and it was decided to blow in cellulose fibre behind the existing plasterboard lining. This required several holes,

25mm in diameter, to be made in the plasterboard, approximately 1 metre apart. As the wall face was slightly uneven, exact thicknesses were hard to assess, but 60-70mm of cellulose insulation was probably achieved. To assist in keeping the core of the gable wall dry and to provide a degree of trickle ventilation, the existing chimney flue was cleaned out, the hearth opened out and a vent provided into the room. Humidity monitors were enclosed within this blown insulation to assess any changes due to the added material (Fig. 10) where a slight increase was noted following the works in November 2013. The increase in the relative humidity in the NW gable will require monitoring, as it is much higher than would be desirable; however, these readings may be due to lower temperatures associated with the refurbishment works as well as the more restricted bulk air movement following the insertion of the blown cellulose insulation.

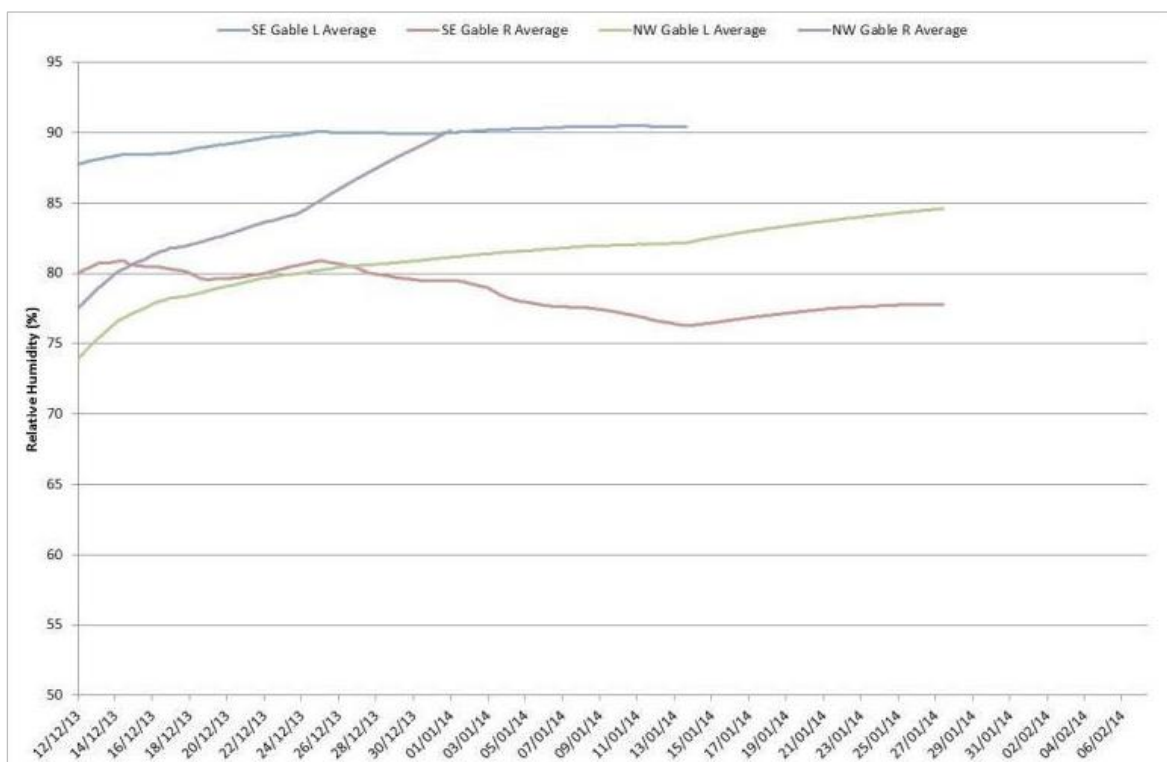


Figure 10: *Relative humidity in the first floor gable ends from December 2013 after the works in November. The increase in relative humidity reflects the reduced air movement.*

10. Ground floor wall insulation

10.1 Measures installed

As with the gable walls on the first floor, blown materials were used for the thermal upgrade of the ground floor walls. Due to considerations about damp at low level, a blown polystyrene bead was used, although the installation techniques were essentially the same. The press cupboard and the area underneath the window cill in the north east bedroom were insulated with a layer of Spacetherm PP board. As

the base of the lining connects with the solum void below, the skirtings were removed to check that there was a break formed by the floorboards. Where this was short, or missing, sheep's wool was used to loosely close off this connection.

It was not possible to blow material into the east gable wall of the lounge, due to the placement of the tenant's furniture; such project specific considerations will always provide a variable in any upgrade process, and site supervision cannot assume that operatives will be able to address different situations; this also supports that a full move out by the occupant is better for such a project. This section of wall will be addressed in phase 2 of the project. The lath and plaster lining in this room had been covered with a modern textured wall paper which restricts the movement of water vapour through the linings; this was therefore removed and replaced with a traditional lining paper. A clay vapour open paint was used to complete the re-decoration, maximising humidity buffering and water vapour dispersal.

10.2 Post-intervention monitoring

Post-intervention monitoring on the ground floor bedroom showed a significant improvement in thermal performance (Table 2). Post-intervention readings for the lounge will have to await completion of the insulation work (expected in early 2015).

| Location | Pre-intervention U-Value (W/m ² K) | Post-intervention U-Value (W/m ² K) | % Improvement |
|----------------|---|--|---------------|
| Lounge wall 1 | 1.3 | Not complete | – |
| Lounge wall 2 | 1.3 | Not complete | – |
| Bedroom wall 1 | 1.5 | 0.22 | 85% |
| Bedroom wall 2 | 1.3 | 0.08 | 94% |

Table 2: Pre and post-intervention U-values

The monitoring of the relative humidity in the filled cavity indicated a very small increase in ambient levels, with readings around the 90% level (Fig. 11). This is likely to be due to the reduction in air leakage from the wall and floor insulation.

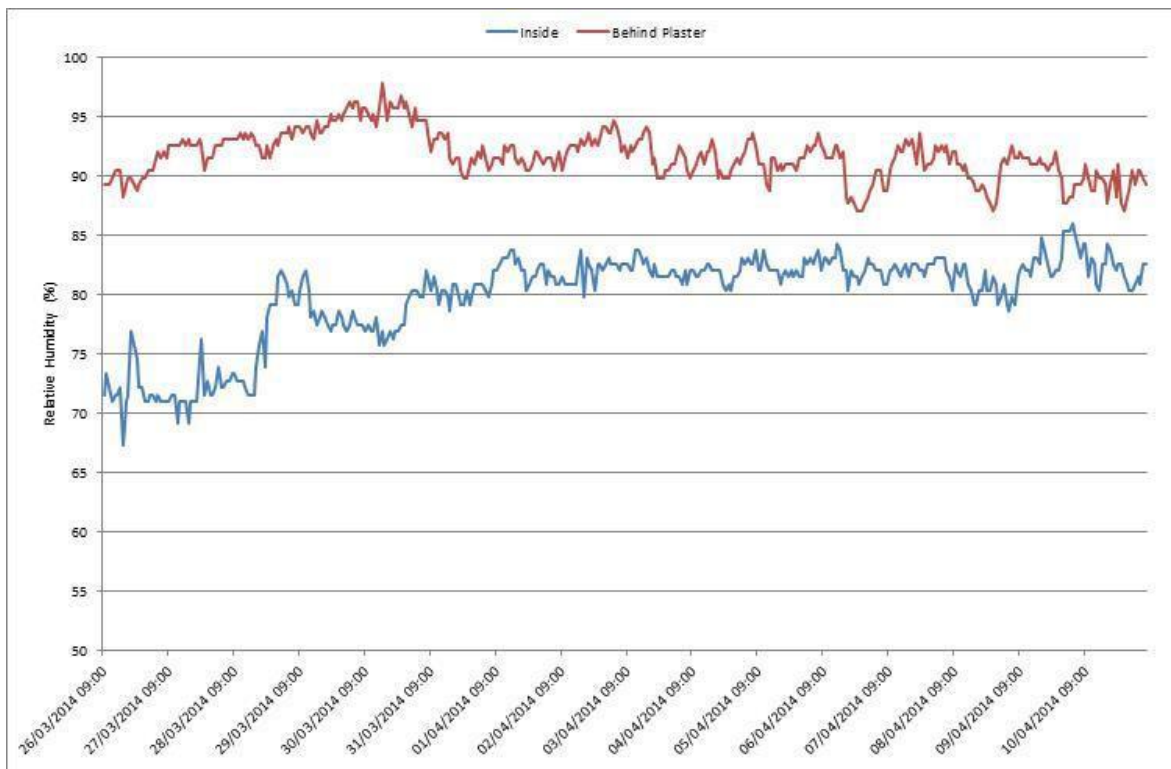


Figure 11: *Relative humidity readings in March and April 2014 from the internal and external face of the plasterboard in the ground floor bedroom after the insulation works to the walls*

Relative humidity was also monitored via loggers within the insulation behind the plasterboard on the ground floor gables. The average results obtained are set out in Table 3.

| Location | Average RH pre intervention | Average RH post intervention | Percentage change |
|-------------------|-----------------------------|------------------------------|-------------------|
| Bedroom (NW wall) | 79.0 | 83.0 | 4% increase |
| Lounge (NE wall) | 88.0 | 92.0 | 4% increase |

Table 3: *Average relative humidity (RH) changes in the ground floor gables*

In addition to assessing relative humidity in the filled wall cavity, monitoring of the air temperature in the downstairs bedroom pre- and post-intervention was carried out. Comparison of pre-intervention (Fig. 12) and post-intervention (Fig. 13) internal and external temperatures showed a reduction in the temperature fluctuation due to the insulation and improved air tightness of the space. The insulation to the timber floor would also have contributed to the reduction in temperature variation recorded in May 2014 (Fig. 13). The temperature ‘spikes’ in Figures 12 and 13 show occasional warm days, where internal and external temperatures converged. This end of the building (the south west gable) is fully open to afternoon sun, and

demonstrates solar gain.

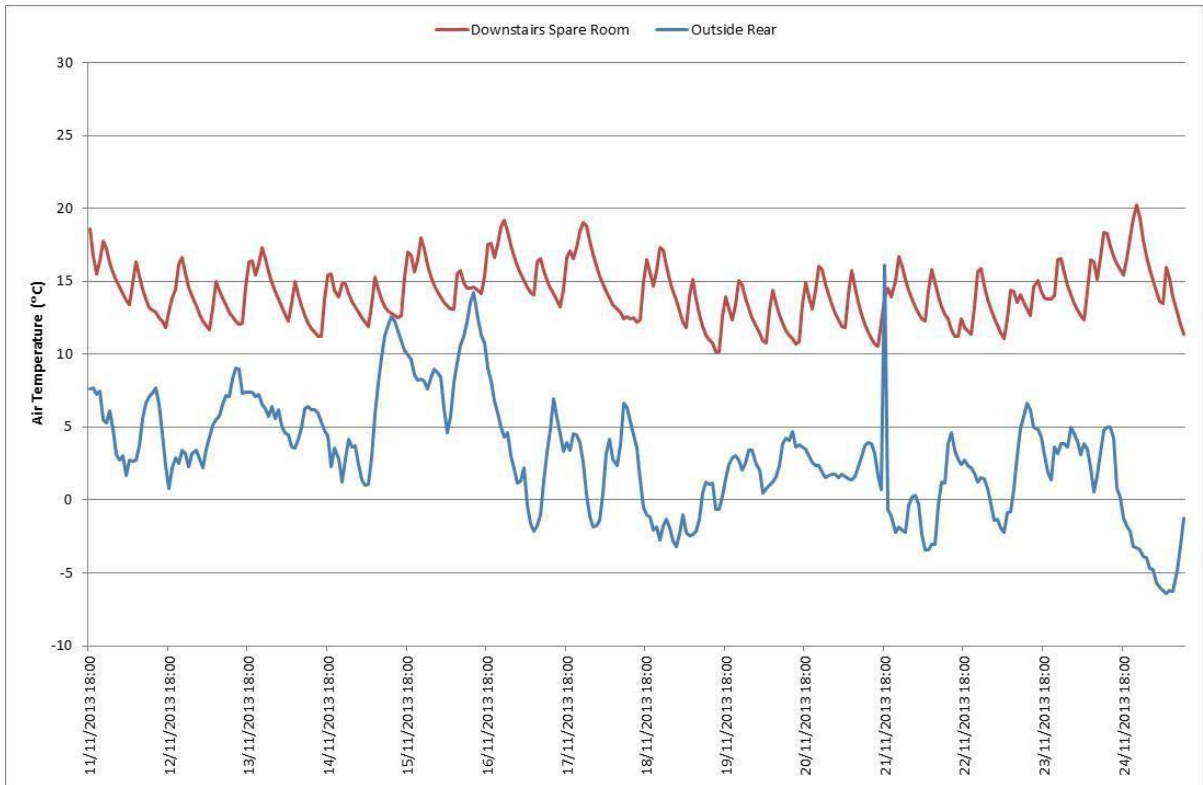


Figure 12: Monitoring before the works, showing internal and external air temperatures in the downstairs bedroom

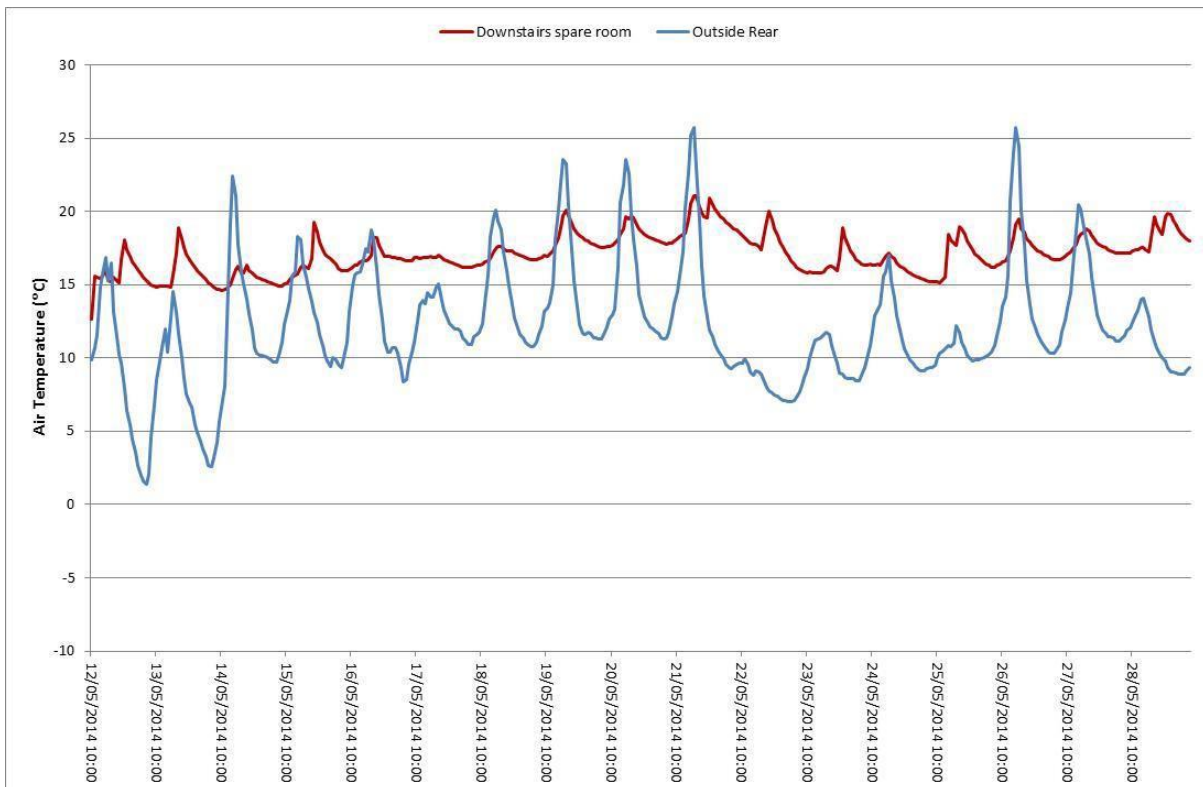


Figure 13: Monitoring after the works, showing the internal and external air temperatures in the same downstairs bedroom

11. Other insulation materials

In order to trial newer types of insulation, an area of the stair cupboard (was lined with a new product; a thin aerogel based insulation board. This material, from a supplier in Scotland, was only 11mm thick, and could be mechanically fastened to the existing linings. The joints required to be taped and filled, but since it was the inside of the stair cupboard, the surface was not further finished (Fig. 14), although lining paper and a paint varnish would be suitable in a larger space. The U-value achieved by this measure was measured in two places as 0.27 and 0.37 W/m²K respectively (Table 4). This type of material may be suitable where it is not desirable to fill the space behind an internal lining. It also allows the retention of the existing lining and if required, it could be subsequently removed.

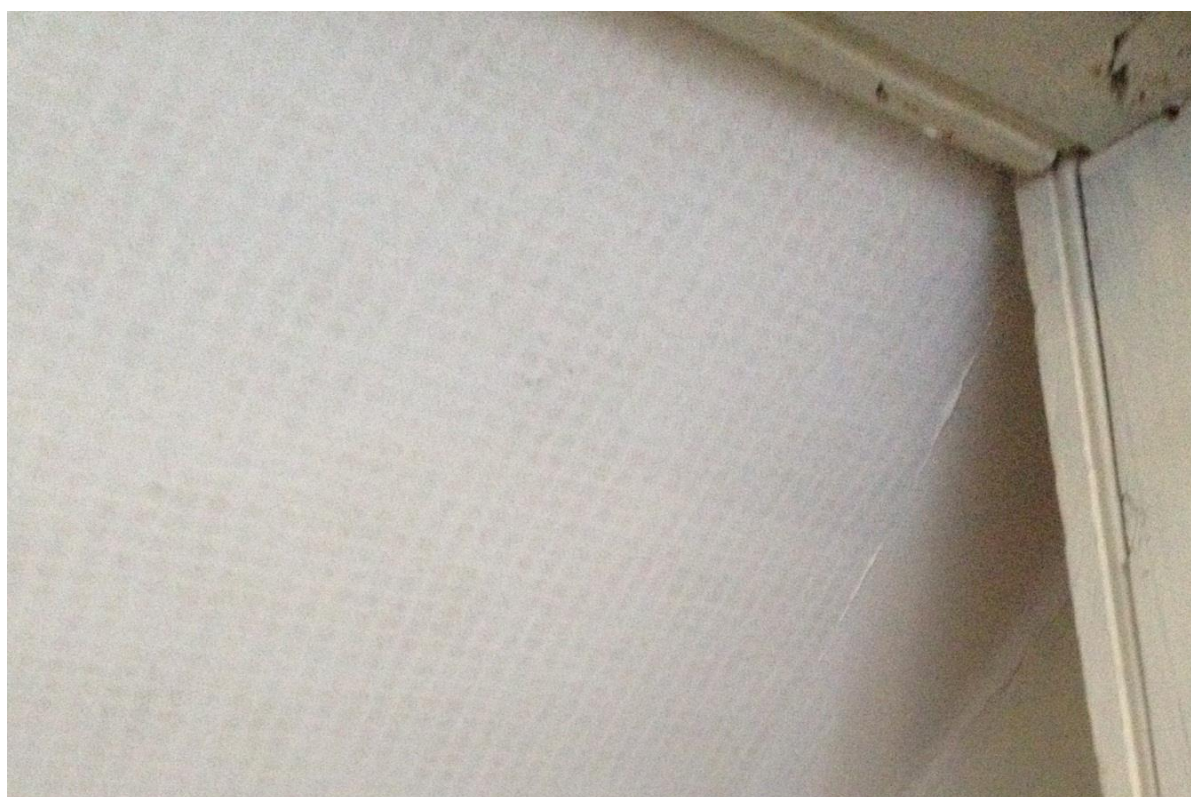


Figure 14: *The trial aerogel board following installation*

| Location | Pre-intervention U-Value (W/m ² K) | Post-intervention U-Value (W/m ² K) | % Improvement |
|-------------------|---|--|---------------|
| Stair cupboard RH | 0.46 | 0.27 | 41% |
| Stair cupboard LH | 0.52 | 0.37 | 29% |

Table 4: *Stair cupboard pre- and post-intervention U-Values*

The effectiveness of this measure was made less apparent as the space behind the lath and plaster had already been filled with blown cellulose as in other parts of the building. Had this not been present, the initial U-values shown would have been

much higher, and the thermal improvement would have been more than the percentage improvement noted in Table 4.

12. Suspended timber floor insulation

The floors in the hall and ground floor bedroom were suspended timber over a standard solum void. In these locations, floor timbers were lifted and wood fibre board insulation, 80mm thick was fitted between the floor joists, much as with the roof timbers. To maximise the thickness of insulation being used, woven tapes were fastened beneath the joists to hold the cut wood fibre boards (Fig. 15). Due to a misunderstanding on site, a compressed fibreboard flooring material was used to provide a new floor; although the re-use of the existing timber flooring (as demonstrated in Refurbishment Case Studies 7 and 20) would have been possible, and preferable. The improvement in U-value from the installation of the wood fibre boards was considerable (Table 5).



Figure 15: Floor opened up, showing the wood fibre board insulation in place

| Location | Pre-intervention U- Value (W/m ² K) | Post-intervention U- Value (W/m ² K) | % Improvement |
|--------------|--|---|---------------|
| Timber floor | 4.00 | 1.00 | 75% |

Table 5: Suspended timber floor pre- and post-intervention U-Values

13. Concrete floor insulation

In some parts of the cottage, the timber floors had been replaced with solid concrete floors. This concrete had probably been poured directly onto the solum material with no insulation. Invariably such floors are cold, which not only provide a heat loss path, but also affect perceptions of thermal comfort. There are several options when considering improvement; these range from breaking out the concrete floor and reinstating an insulated timber one, breaking it out and replacing it with an insulated lime concrete floor, or upgrading the existing concrete floor. The latter can be achieved with a thin aerogel based insulated floor layer, laid on top of the existing concrete. Although this material is expensive, it can be quickly installed with minimal disruption to the occupants of the house. The expected U-value for the floor following this work will be approximately $0.25\text{W/m}^2\text{K}$. This material will be installed during a second phase of works in 2015.

14. Ventilation considerations

The series of upgrades at Kirkton of Coull farmhouse have improved the airtightness of the building and have therefore reduced the natural ventilation of the original design. Maintaining adequate ventilation in traditional buildings is important to ensure the free passage of water vapour through the voids and the building fabric and to maintain occupant health. Increasing the insulation and reducing the air changes in traditional buildings is generally considered to be a positive measure, but it is important to ensure that the building remains adequately ventilated. The hearths and flues of older buildings are ideal for this purpose and should generally be left open, or, if necessary, have the air movement rate modified with a chimney balloon or an adjustable baffle; many late 19th century hearths have a movable hood built in for this purpose. To maintain the use of flues a passive vent system will be installed in the former kitchen flue in summer 2015, ensuring that existing flue ventilation can be provided with little disruption to the existing fabric. The passive vent system uses a combination of passive stack and wind assistance to provide background ventilation without the heat loss typically associated with simpler ventilation options.

15. Post-intervention monitoring summary

15.1 Thermal performance

The monitoring, and feedback from the tenant, showed that a significant improvement had been made to the energy efficiency of the building envelope. In the case of the roof slopes in the cupboard a 41% improvement was achieved (Table 4). The suspended timber floor on the ground floor achieved a 75% improvement (Table 5). The floor improvement is important because occupants' experience of thermal comfort is commonly linked to floor temperature; the better insulated the floor the less we notice the ambient air temperature. Consequently, if floors are well insulated, occupants can be comfortable with a lower internal air temperature.

Restrictions on how the monitoring was done, and the time of year, meant that direct comparisons with each room was not possible (the post-intervention monitoring was done in May), but the results show that that temperatures in the first floor bedroom fluctuated less over the diurnal cycle, indicating that the wood fibre board insulation to the coombs, and the solid wall insulation, had introduced a degree of thermal stability or buffering into what was previously a thermally much more responsive and less well insulated structure. Before intervention, the red and green lines in Figure 16 indicate a substantial variation in temperature, at times up to 10° Celsius.

While the roof slopes themselves were well insulated before the works with the blown cellulose, the adjacent areas of the dormers, parts of the coomb and the masonry of the gable were not insulated at all. This resulted in air leakage and thermal loss from the gables and the adjacent areas. The refurbishment works addressed these areas, giving a much tighter thermal envelope to the upper parts of the building, and a reduction in the fluctuation in the temperatures in the upstairs bedrooms. This can be seen in reduced temperature ranges shown on the blue line in Figure 17.

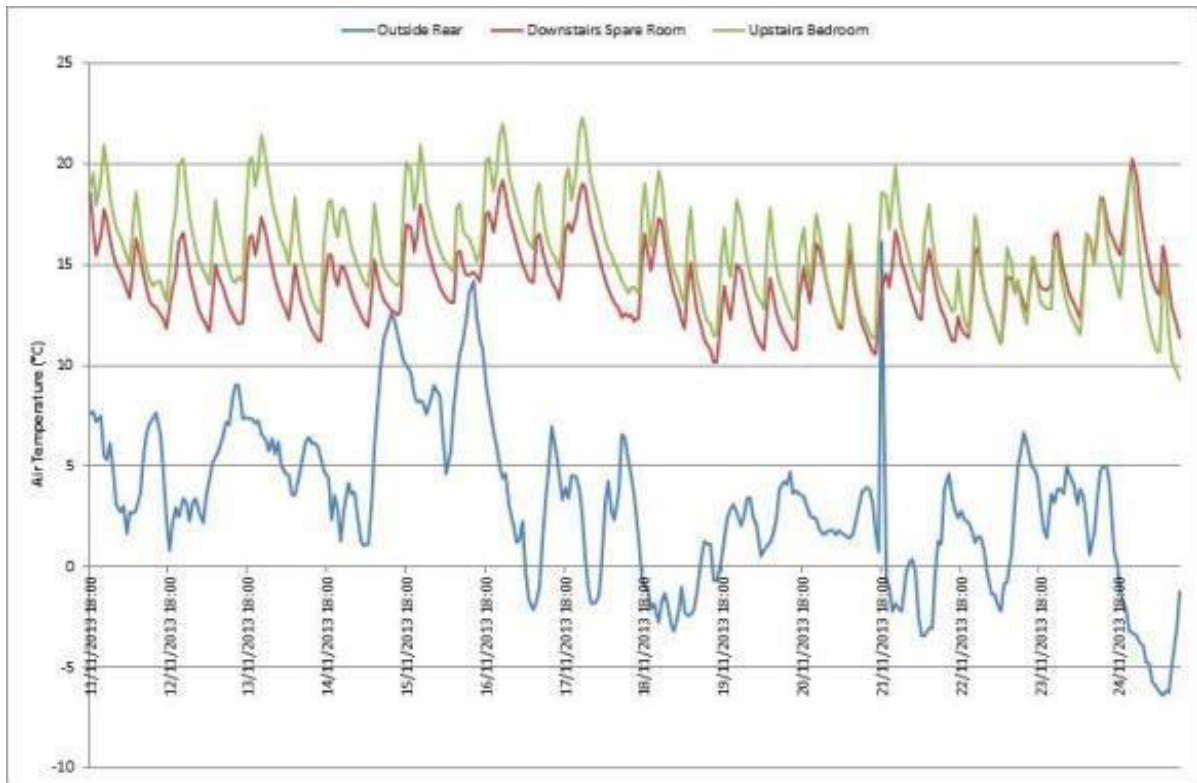


Figure 16: The red and green lines show the temperature fluctuations in the upstairs and downstairs bedrooms before the work, and the blue line shows the outside air temperature

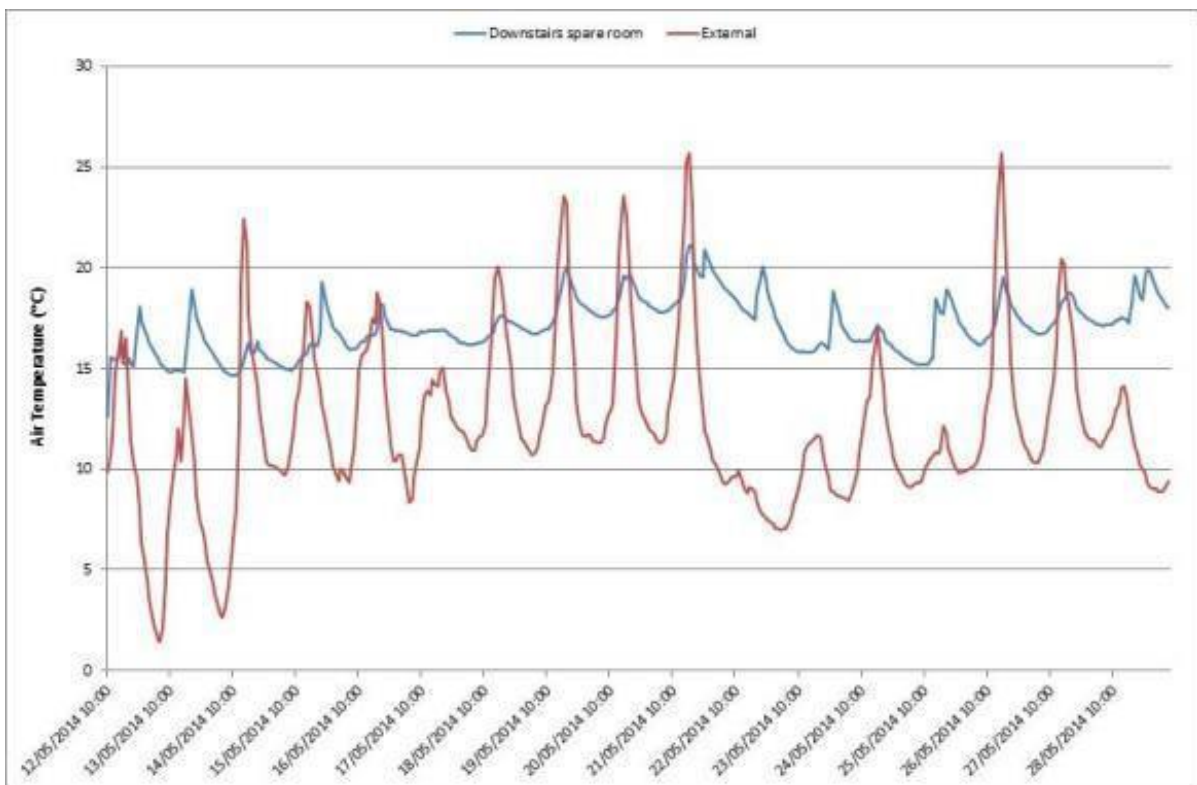


Figure 17: Room temperature fluctuations in the downstairs bedroom after the works. The blue line showing the internal temperature is in a much narrower temperature band.

15.2 Relative humidity

The monitoring of relative humidity provides an indication of the effects of the interventions on the building fabric, and enables an assessment to be made on their long term impacts. Allowing the built fabric to achieve moisture equilibrium across the building structure and linings was an important principle in the refurbishment. Initial monitoring in April 2014 showed a largely stable environment, but with some high readings (Fig. 18).

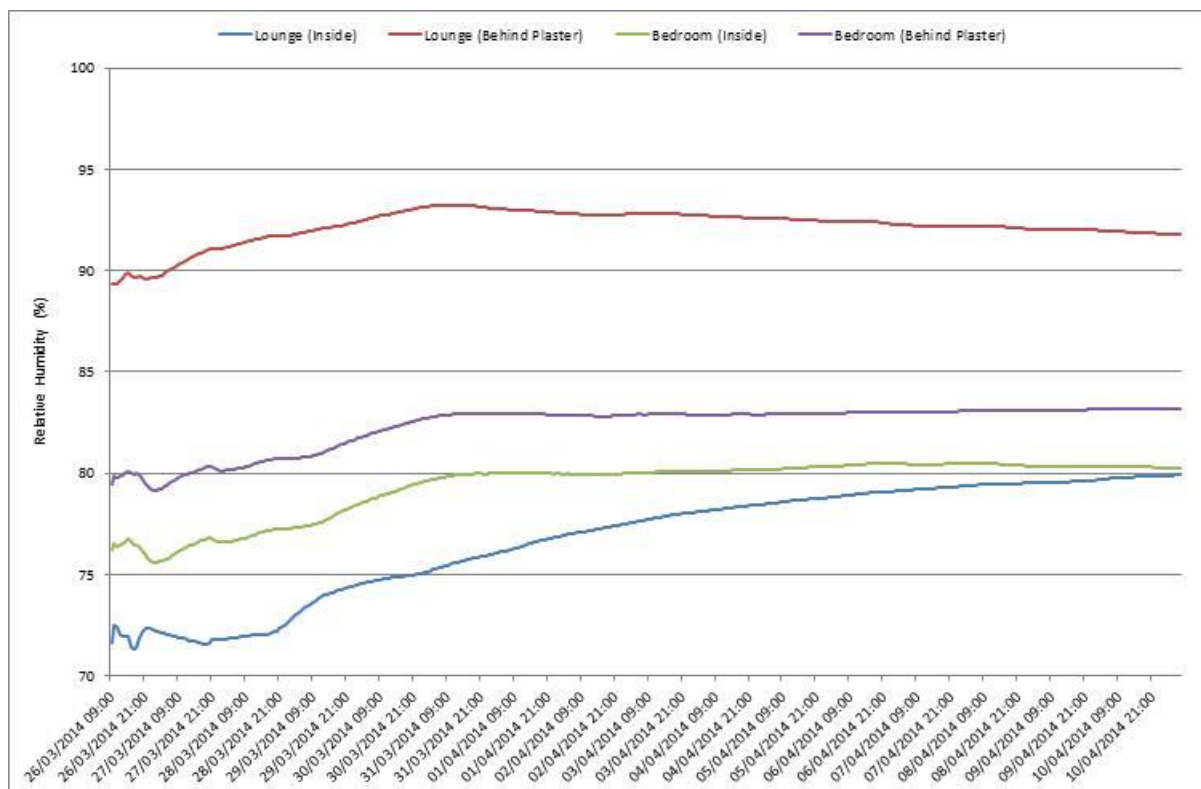


Figure 18: Smoothed relative humidity readings post-interventions

The RH readings for behind the plaster in the lounge are high, but the trend is downwards; and future monitoring will confirm if there remains a risk. The other fabric areas are within accepted limits, as long as the trend remains steady or downwards. Longer term monitoring will reveal such trends. The rising gradient of the blue line in Figure 18 is likely to reflect the increased water content of the air from a rising air temperature. Several techniques adopting similar solid wall insulation techniques have been adopted on other Historic Scotland projects several years ago, and have not given rise to any issues (*Refurbishment Case Study 1*). A further phase of monitoring will be programmed on completion of the final stage of works in summer 2015 to further investigate the effects of the wall insulation.

16. Cost of the works

Much of Historic Scotland's recent technical research work has been focused on the technical aspects of fabric improvements to increase thermal efficiency. As this work has been largely experimental, the likely cost of completing the work in a more routine and standard manner has not been possible. For the works to Kirkton of Coull a Quantity Surveyor was appointed by the Client to compare standard industry rates for similar work (cost per square metre) with the actual costs and time taken to install the range of materials described in this case study. Broadly, there was a good degree of similarity in the two approaches despite the different materials and techniques applied. This will allow the Client to apply standard rates for future refurbishment work and in planning improvements to other properties. Figures were aggregated to give an indication of costs for the project. These are summarised in Table 6 below.

By integrating energy efficiency measures with planned maintenance or other internal works, many work items such as decoration can be combined, reducing the overall cost. It is apparent that energy efficiency upgrade works should be programmed to fit with other work on the fabric and not commissioned in isolation; this can avoid duplicate tasks such as decoration, and reduces disruption for the occupants.

| Measure | Area/ no. | Rate (labour and materials) | Total | VAT (5% for insulation works) | Total cost inc. VAT | Total cost (in. VAT) per m ² / no. |
|---|------------------|--------------------------------------|---------|--|------------------------|--|
| Loft insulation | | | | | | |
| Installing 80mm of wood fibre boards between the joists | 25m ² | £21.45 | £536.25 | £26.81 | £563.06 | £22.54 |
| Coombed upper floor ceilings | | | | | | |
| Stripping of existing plasterboard finish | 35m ² | £6.00 | £210.00 | £10.50 | £220.50 | £6.3 |
| Installing 80mm wood fibre board insulation between rafters | 35m ² | £23.45 | £820.75 | £41.04 | £861.79 | £24.62 |
| Redecoration | 35m ² | £17.00 | £595.00 | £29.75 | £624.75 | £17.85 |
| Dormer cheeks and ceilings | | | | | | |

| | | | | | | |
|--|------------------|---------|-----------------|----------------|-----------------|---------|
| Stripping of existing plasterboard finish | 31m ² | £12.00 | £372.00 | £18.60 | £390.60 | £12.60 |
| 80mm wood fibre board insulation to walls | 45m ² | £23.45 | £1055.25 | £52.76 | £1108.01 | £24.62 |
| Redecoration | 32m ² | £21.25 | £680 | £34 | £714 | £22.31 |
| Upper floor gable walls | | | | | | |
| Blowing 70mm warmcell insulation into cavity | 17m ² | £37.53 | £638.01 | £31.90 | £669.01 | £39.40 |
| Ground floor walls | | | | | | |
| Blown polystyrene bead insulation to ground floor walls | 26m ² | £26.77 | £696.02 | £30.80 | £726.82 | £27.95 |
| Spacetherm PP board to press cupboard and underneath window cill in NE bedroom | 11m ² | £103.24 | £1135.64 | £56.78 | £1192.42 | £108.40 |
| Redecoration of ground floor walls | 26m ² | £20.00 | £520.00 | £26.00 | £546.00 | £21.00 |
| Insulating floors | | | | | | |
| 80mm wood fibre board insulation between floor joists and relaying of timber floor | 19m ² | £92.23 | £1752.37 | £87.62 | £1839.99 | £92 |
| Total | | | £9011.29 | £523.78 | £9456.95 | |

Table 5: Simplified costs for the works

17. Energy consumption post-intervention

Following the completion of the works in March 2013, the billed energy usage was recorded. In 2014, the year after all of the works had been completed, a total of £1179.62 was spent on LPG, approximately 25% lower than the amount spent in 2012 (Fig. 19). This is a considerable reduction in the heating utility bills as a result

of the thermal reduction works. When benchmarked against figures for the rented sector, this is approximately 50% below the average and gives an energy consumption figure of approximately 182 kWh/m²/year. This figure is lower than the EPC figure of 267 kWh/m²/year, supporting the view that the house is still under heated. The recordings in 2013 are also shown below but are not a good representation of a typical year as this period also covered the majority of the works, when workmen were coming and going, doors and windows were being left open frequently and changes were being made to the building fabric.

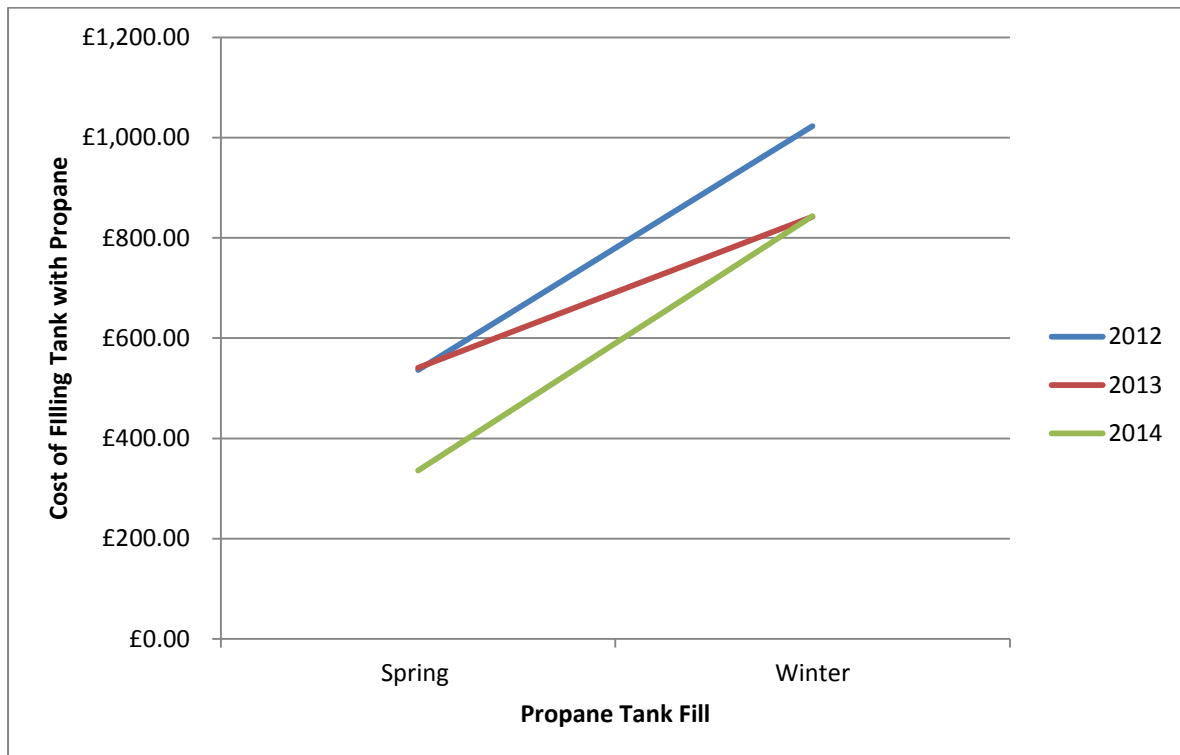


Figure 19: Comparison of heating utility bills over a three year period

18. Energy consumption and EPCs

An important part of the project was to assess how the physical measures installed affected the SAP values of the property. It is the SAP values, used in the compilation of an Energy Performance Certificate (EPC), that apply the measures to give a certain SAP value or 'Rating'. While work to improve the thermal comfort and reduce fuel bills for occupiers is important, the owner was also concerned with the SAP rating. This is important because it may affect the rentability of a property and have implications should any mandatory energy efficiency standards be implemented by Government. It could also limit the potential to take advantage of support packages for domestic customers such as micro-renewable schemes and Feed in Tariffs (FITs) payments, since to receive FITs revenue the property has to be below a certain SAP threshold.

An EPC was produced prior to the works (Appendix 1). Including some legacy

improvements such as double glazing, the building achieved a SAP rating of 31, putting it in EPC performance band F. This is expected for a property of this type, where assumed default values for wall performance generally give a poor performance.

On completion of the work a second EPC was commissioned from the same consultant (draft at Appendix 2), to assess the effect of the interventions. The improvement in performance was modest, and the SAP rating was improved to a score of 40, into EPC Band E. Despite this improvement, it is not what would have been expected given the extent of the works. This is likely to be due to many factors in the way that SAP models buildings. For some measures the software will only accept SAP points to one decimal place, so a series of small improvements may not be included. Coomb ceilings are particularly complex to model accurately; RDSAP normally assesses coomb ceiling (or 'room in the roof') insulation by making an approximation based on floor area. Although other calculation methods are available the cost of most standard surveys will preclude a full calculation (unless the owner is prepared to pay more for the survey). In the case of this project, the way the insulation had been put into the roof did not follow the modelled profiles in Appendix T of the SAP manual, and as SAP recognises insulation in increments of 50mm; the 80mm installed was thus assigned a value for 50mm. This gave a lower SAP score for this measure, and the same applies to the wood fibre installed in the ground floor. This highlights the limitations of the RDSAP and the EPC process for older or traditional structures and suggests that some review might be appropriate.

19. The occupant experience

For this trial it was decided with the Client and the tenant that work should be programmed as a series of packages with the house still occupied. In hindsight one of the lessons learned is that the work could have been delivered more effectively if the house had been vacated. The attrition on floor coverings, decoration and furniture was noticeable, and put a high burden on the tenant in preparing rooms for the works. Despite this, following the insulation work to the roof slopes, an immediate difference was noticed by the tenant over the winter of 2013-2014. Further information on the occupant's experience will be obtained during future stages of the project.

20. Conclusion

The project at Kirkton of Coull farmhouse has demonstrated that basic thermal upgrade work using a limited range of materials and local trades, can deliver substantial energy efficiency benefits to a traditional building. The validation of costs and rates for the work has demonstrated that the use of technically compatible

materials can be delivered with only modest additional cost when compared with conventional approaches using other materials. The trial has also shown that while the measures were installed successfully it would have been better to conduct such works with an empty property. This project demonstrates a need to adjust the assessment methodology to allow the SAP process to recognise and credit when such techniques are used in older buildings. As this building type is common in Scotland, especially in rural areas off the gas grid, the experience gained here will allow confident intervention in many other buildings.

Appendices

Appendix 1 EPC Certificate, pre-intervention

Appendix 2 Draft EPC Certificate, post-intervention

Energy Performance Certificate (EPC)

KIRKTON OF COULL, COULL, ABOYNE, AB34 4TS

Dwelling type: Detached house
Date of assessment: 28 August 2013
Date of certificate: 28 August 2013
Total floor area: 135 m²

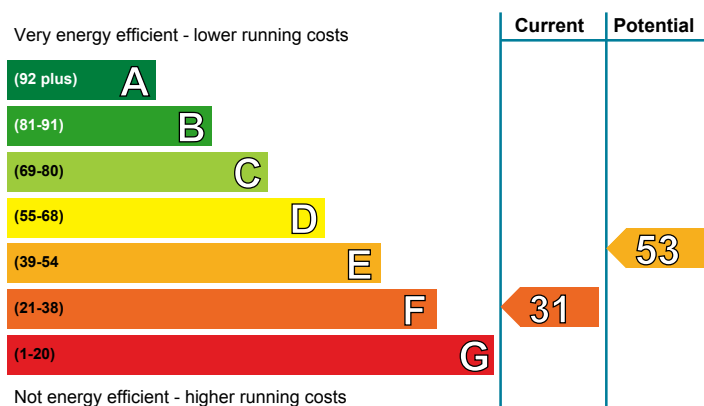
Reference number: 9700-2582-0529-3129-1873
Type of assessment: RdSAP, existing dwelling
Primary Energy Indicator: 321 kWh/m²/year
Main heating and fuel: Boiler and radiators, LPG

You can use this document to:

- Compare current ratings of properties to see which are more energy efficient and environmentally friendly
- Find out how to save energy and money and also reduce CO₂ emissions by improving your home

| | | |
|--|---------------|--|
| Estimated energy costs for your home for 3 years* | £8,871 | See your recommendations report for more information |
| Over 3 years you could save* | £1,848 | |

* based upon the cost of energy for heating, hot water, lighting and ventilation, calculated using standard assumptions

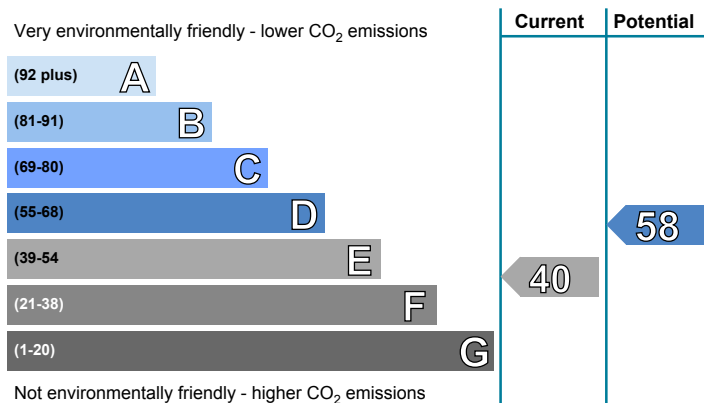


Energy Efficiency Rating

This graph shows the current efficiency of your home, taking into account both energy efficiency and fuel costs. The higher this rating, the lower your fuel bills are likely to be.

Your current rating is **band F (31)**. The average rating for a home in Scotland is **band D (61)**.

The potential rating shows the effect of undertaking all of the improvement measures listed within your recommendations report.



Environmental Impact (CO₂) Rating

This graph shows the effect of your home on the environment in terms of carbon dioxide (CO₂) emissions. The higher the rating, the less impact it has on the environment.

Your current rating is **band E (40)**. The average rating for a home in Scotland is **band D (59)**.

The potential rating shows the effect of undertaking all of the improvement measures listed within your recommendations report.

Top actions you can take to save money and make your home more efficient

| Recommended measures | Indicative cost | Typical savings over 3 years | Available with Green Deal |
|--|------------------|------------------------------|---------------------------|
| 1 Internal or external wall insulation | £4,000 - £14,000 | £1101 | ✓ |
| 2 Floor insulation | £800 - £1,200 | £486 | ✓ |
| 3 Solar water heating | £4,000 - £6,000 | £261 | ✓ |

A full list of recommended improvement measures for your home, together with more information on potential cost and savings and advice to help you carry out improvements can be found in your recommendations report.



The Green Deal may allow you to make your home warmer and cheaper to run at no up-front capital cost. See your recommendations report for more details.

THIS PAGE IS THE ENERGY PERFORMANCE CERTIFICATE WHICH MUST BE AFFIXED TO THE DWELLING AND NOT BE REMOVED UNLESS IT IS REPLACED WITH AN UPDATED CERTIFICATE

Summary of the energy performance related features of this home

This table sets out the results of the survey which lists the current energy-related features of this home. Each element is assessed by the national calculation methodology; 1 star = very poor (least efficient), 2 stars = poor, 3 stars = average, 4 stars = good and 5 stars = very good (most efficient). The assessment does not take into consideration the condition of an element and how well it is working. 'Assumed' means that the insulation could not be inspected and an assumption has been made in the methodology, based on age and type of construction.

| Element | Description | Energy Efficiency | Environmental |
|-----------------------|---|-------------------|---------------|
| Walls | Granite or whinstone, as built, no insulation (assumed) | — | — |
| Roof | Roof room(s), ceiling insulated | — | — |
| Floor | Suspended, no insulation (assumed) | — | — |
| Windows | Fully double glazed | — | — |
| Main heating | Boiler and radiators, LPG | — | — |
| Main heating controls | Programmer, room thermostat and TRVs | — | — |
| Secondary heating | Room heaters, dual fuel (mineral and wood) | — | — |
| Hot water | From main system | — | — |
| Lighting | Low energy lighting in 67% of fixed outlets | — | — |

The energy efficiency rating of your home

Your Energy Efficiency Rating is calculated using the standard UK methodology, RdSAP. This calculates energy used for heating, hot water, lighting and ventilation and then applies fuel costs to that energy use to give an overall rating for your home. The rating is given on a scale of 1 to 100. Other than the cost of fuel for electrical appliances and for cooking, a building with a rating of 100 would cost almost nothing to run.


As we all use our homes in different ways, the energy rating is calculated using standard occupancy assumptions which may be different from the way you use it. The rating also uses national weather information to allow comparison between buildings in different parts of Scotland. However, to make information more relevant to your home, local weather data is used to calculate your energy use, CO₂ emissions, running costs and the savings possible from making improvements.

The impact of your home on the environment

One of the biggest contributors to global warming is carbon dioxide. The energy we use for heating, lighting and power in our homes produces over a quarter of the UK's carbon dioxide emissions. Different fuels produce different amounts of carbon dioxide for every kilowatt hour (kWh) of energy used. The Environmental Impact Rating of your home is calculated by applying these 'carbon factors' for the fuels you use to your overall energy use.

The average Scottish household produces about 6 tonnes of carbon dioxide every year. Based on this assessment, heating and lighting this home currently produces approximately 9.6 tonnes of carbon dioxide every year. Adopting recommendations in this report can reduce emissions and protect the environment. If you were to install all of these recommendations this could reduce emissions by 3.2 tonnes per year. You could reduce emissions even more by switching to renewable energy sources.

Estimated energy costs for this home

| | Current energy costs | Potential energy costs | Potential future savings |
|---------------|----------------------|------------------------|---|
| Heating | £7,797 over 3 years | £6,225 over 3 years |  |
| Hot water | £807 over 3 years | £531 over 3 years | |
| Lighting | £267 over 3 years | £267 over 3 years | |
| Totals | £8,871 | £7,023 | |

These figures show how much the average household would spend in this property for heating, lighting and hot water. This excludes energy use for running appliances such as TVs, computers and cookers, and the benefits of any electricity generated by this home (for example, from photovoltaic panels). The potential savings in energy costs show the effect of undertaking all of the recommended measures listed below.

Recommendations for improvement

The measures below will improve the energy and environmental performance of this dwelling. The performance ratings after improvements listed below are cumulative; that is, they assume the improvements have been installed in the order that they appear in the table. Further information about the recommended measures and other simple actions to take today to save money is available from the Home Energy Scotland hotline which can be contacted on 0800 512 012. Before carrying out work, make sure that the appropriate permissions are obtained, where necessary. This may include permission from a landlord (if you are a tenant) or the need to get a Building Warrant for certain types of work.

| Recommended measures | Indicative cost | Typical saving per year | Rating after improvement | | Green Deal |
|--|------------------|-------------------------|--------------------------|-------------|------------|
| | | | Energy | Environment | |
| 1 Internal or external wall insulation | £4,000 - £14,000 | £367 | F 38 | E 46 | |
| 2 Floor insulation | £800 - £1,200 | £162 | E 41 | E 49 | |
| 3 Solar water heating | £4,000 - £6,000 | £87 | E 43 | E 50 | |
| 4 Solar photovoltaic panels, 2.5 kWp | £9,000 - £14,000 | £208 | E 50 | D 56 | |
| 5 Wind turbine | £1,500 - £4,000 | £83 | E 53 | D 58 | |

Measures which have a green deal tick are likely to be eligible for Green Deal finance plans based on indicative costs. Subsidy also may be available for some measures, such as solid wall insulation. Additional support may also be available for certain households in receipt of means tested benefits. Measures which have an orange tick may need additional finance. To find out how you could use Green Deal finance to improve your property, visit www.greenerscotland.org or contact the Home Energy Scotland hotline on 0800 512 012.

Choosing the right improvement package

For free and impartial advice on choosing suitable measures for your property, contact the Home Energy Scotland hotline on 0800 512 012 or go to www.greenerscotland.org.

About the recommended measures to improve your home's performance rating

This section offers additional information and advice on the recommended improvement measures for your home

1 Internal or external wall insulation

Internal or external wall insulation involves adding a layer of insulation to either the inside or the outside surface of the external walls, which reduces heat loss and lowers fuel bills. As it is more expensive than cavity wall insulation it is only recommended for walls without a cavity, or where for technical reasons a cavity cannot be filled. Internal insulation, known as dry-lining, is where a layer of insulation is fixed to the inside surface of external walls; this type of insulation is best applied when rooms require redecorating. External solid wall insulation is the application of an insulant and a weather-protective finish to the outside of the wall. This may improve the look of the home, particularly where existing brickwork or rendering is poor, and will provide long-lasting weather protection. Further information can be obtained from the National Insulation Association (www.nationalinsulationassociation.org.uk). It should be noted that planning permission might be required and that building regulations apply to this work so it is best to check with your local authority whether a building warrant or planning permission will be required.

2 Floor insulation

Insulation of a floor will significantly reduce heat loss; this will improve levels of comfort, reduce energy use and lower fuel bills. Suspended floors can often be insulated from below but must have adequate ventilation to prevent dampness; seek advice about this if unsure. Further information about floor insulation and details of local contractors can be obtained from the National Insulation Association (www.nationalinsulationassociation.org.uk). Building regulations generally apply to this work so it is best to check this with your local authority building standards department.

3 Solar water heating

A solar water heating panel, usually fixed to the roof, uses the sun to pre-heat the hot water supply. This can significantly reduce the demand on the heating system to provide hot water and hence save fuel and money. Planning permission might be required, building regulations generally apply to this work and a building warrant may be required, so it is best to check these with your local authority. You could be eligible for Renewable Heat Incentive payments which could appreciably increase the savings beyond those shown on your EPC, provided that both the product and the installer are certified by the Microgeneration Certification Scheme (or equivalent). Details of local MCS installers are available at www.microgenerationcertification.org.

4 Solar photovoltaic (PV) panels

A solar PV system is one which converts light directly into electricity via panels placed on the roof with no waste and no emissions. This electricity is used throughout the home in the same way as the electricity purchased from an energy supplier. Planning permission might be required, building regulations generally apply to this work and a building warrant may be required, so it is best to check these with your local authority. The assessment does not include the effect of any Feed-in Tariff which could appreciably increase the savings that are shown on this EPC for solar photovoltaic panels, provided that both the product and the installer are certified by the Microgeneration Certification Scheme (or equivalent). Details of local MCS installers are available at www.microgenerationcertification.org.

5 Wind turbine

A wind turbine provides electricity from wind energy. This electricity is used throughout the home in the same way as the electricity purchased from an energy supplier. Wind turbines are not suitable for all properties. The system's effectiveness depends on local wind speeds and the presence of nearby obstructions, and a site survey should be undertaken by an accredited installer. Planning permission might be required and building regulations generally apply to this work and a building warrant may be required, so it is best to check these with your local authority. The assessment does not include the effect of any Feed-in Tariff which could appreciably increase the savings that are shown on this EPC for a wind turbine, provided that both the product and the installer are certified by the Microgeneration Certification Scheme (or equivalent). Details of local MCS installers are available at www.microgenerationcertification.org.

Low and zero carbon energy sources

Your home's heat demand

For most homes, the vast majority of energy costs come from heating the home. Where applicable to your home, the table below shows the energy that could be saved by insulating the attic and walls, based upon the typical energy use for this building. Numbers shown in brackets are the reduction in energy use possible from each improvement measure.

| Heat demand | Existing dwelling | Impact of loft insulation | Impact of cavity wall insulation | Impact of solid wall insulation |
|------------------------------|-------------------|---------------------------|----------------------------------|---------------------------------|
| Space heating (kWh per year) | 27,244 | (1,368) | N/A | (4,049) |
| Water heating (kWh per year) | 2,918 | | | |

About this document

This Recommendations Report and the accompanying Energy Performance Certificate are valid for a maximum of ten years. These documents cease to be valid where superseded by a more recent assessment of the same building carried out by a member of an Approved Organisation.

The Energy Performance Certificate and this Recommendations Report for this building were produced following an energy assessment undertaken by an assessor accredited by ECMK (www.ecmk.co.uk), an Approved Organisation Appointed by Scottish Ministers. The certificate has been produced under the Energy Performance of Buildings (Scotland) Regulations 2008 from data lodged to the Scottish EPC register. You can verify the validity of this document by visiting www.scottishepcregister.org.uk and entering the report reference number (RRN) printed at the top of this page.

| | |
|-----------------------------|---|
| Assessor's name: | Mr Douglas Mackintosh |
| Assessor membership number: | ECMK201915 |
| Company name/trading name: | Mr Douglas Mackintosh |
| Address: | 45 Diriebught Road Inverness Inverness-shire IV2 3JL |
| Phone number: | 07933 728475 |
| Email address: | dmackint@live.co.uk |
| Related party disclosure: | No related party |

If you have any concerns regarding the content of this report or the service provided by your assessor you should in the first instance raise these matters with your assessor and with the Approved Organisation to which they belong. All Approved Organisations are required to publish their complaints and disciplinary procedures and details can be found online at the web address given above.

Use of this energy performance information

This Certificate and Recommendations Report will be available to view online by any party with access to the report reference number (RRN) and to organisations delivering energy efficiency and carbon reduction initiatives on behalf of the Scottish and UK Governments. If you are the current owner or occupier of this building and do not wish this data to be used by these organisations to contact you in relation to such initiatives, please opt out by visiting www.scottishepcregister.org.uk and your data will be restricted accordingly. Further information on this and on Energy Performance Certificates in general can be found at www.scotland.gov.uk/epc.

Opportunity to benefit from a Green Deal on this property

Under a Green Deal, the cost of the improvements is repaid over time via a credit agreement. Repayments are made through a charge added to the electricity bill for the property.

To see which improvements are recommended for this property, please turn to page 3. You can choose which improvements you want to install and ask for a quote from an authorised Green Deal provider. They will organise installation by an authorised Green Deal installer. If you move home, the responsibility for paying the Green Deal charge under the credit agreement passes to the new electricity bill payer.

For householders in receipt of income-related benefits, additional help may be available.

To find out more, visit www.greenerscotland.org or call 0800 512 012.

**Authorised
home energy
assessment**

**Finance at
no upfront
cost**

**Choose from
authorised
installers**

**May be paid
from savings
in energy bills**

**Repayments
stay with the
electricity bill
payer**

Energy Performance Certificate (EPC)

PREVIEW
NOT FOR ISSUE



KIRKTON OF COULL, COULL, ABOYNE, AB34 4TS

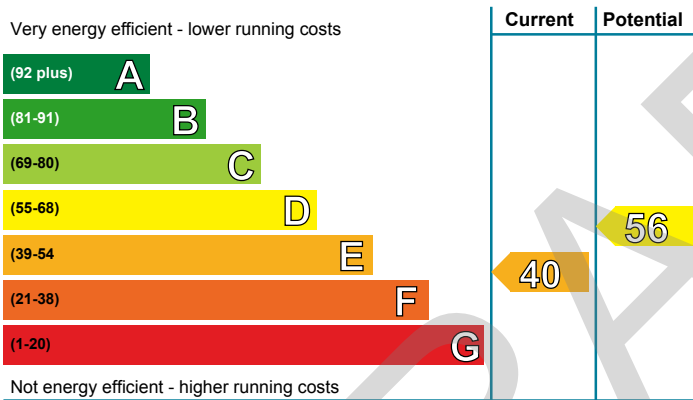
| | | | |
|-----------------------------|--------------------|----------------------------------|------------------------------|
| Dwelling type: | Detached house | Reference number: | 0000-0000-0000-0000-0000 |
| Date of assessment: | 18 August 2014 | Type of assessment: | RdSAP, existing dwelling |
| Date of certificate: | 05 September 2014 | Primary Energy Indicator: | 267 kWh/m ² /year |
| Total floor area: | 135 m ² | Main heating and fuel: | Boiler and radiators, LPG |

You can use this document to:

- Compare current ratings of properties to see which are more energy efficient and environmentally friendly
- Find out how to save energy and money and also reduce CO₂ emissions by improving your home

| | | |
|--|---------------|--|
| Estimated energy costs for your home for 3 years* | £7,620 | See your recommendations report for more information |
| Over 3 years you could save* | £825 | |

* based upon the cost of energy for heating, hot water, lighting and ventilation, calculated using standard assumptions

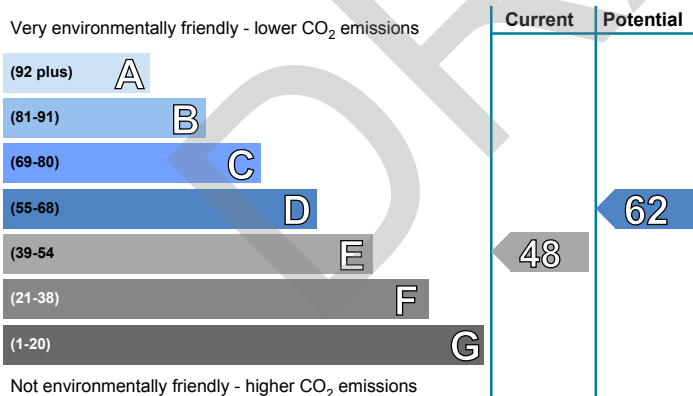


Energy Efficiency Rating

This graph shows the current efficiency of your home, taking into account both energy efficiency and fuel costs. The higher this rating, the lower your fuel bills are likely to be.

Your current rating is **band E (40)**. The average rating for a home in Scotland is **band D (61)**.

The potential rating shows the effect of undertaking all of the improvement measures listed within your recommendations report.



Environmental Impact (CO₂) Rating

This graph shows the effect of your home on the environment in terms of carbon dioxide (CO₂) emissions. The higher the rating, the less impact it has on the environment.

Your current rating is **band E (48)**. The average rating for a home in Scotland is **band D (59)**.

The potential rating shows the effect of undertaking all of the improvement measures listed within your recommendations report.

Top actions you can take to save money and make your home more efficient

| Recommended measures | Indicative cost | Typical savings over 3 years | Available with Green Deal |
|--|------------------|------------------------------|---------------------------|
| 1 Internal or external wall insulation | £4,000 - £14,000 | £282 | ✓ |
| 2 Floor insulation | £800 - £1,200 | £228 | ✓ |
| 3 Low energy lighting | £20 | £48 | |

A full list of recommended improvement measures for your home, together with more information on potential cost and savings and advice to help you carry out improvements can be found in your recommendations report.



The Green Deal may allow you to make your home warmer and cheaper to run at no up-front capital cost. See your recommendations report for more details.

THIS PAGE IS THE ENERGY PERFORMANCE CERTIFICATE WHICH MUST BE AFFIXED TO THE DWELLING AND NOT BE REMOVED UNLESS IT IS REPLACED WITH AN UPDATED CERTIFICATE

Summary of the energy performance related features of this home

This table sets out the results of the survey which lists the current energy-related features of this home. Each element is assessed by the national calculation methodology; 1 star = very poor (least efficient), 2 stars = poor, 3 stars = average, 4 stars = good and 5 stars = very good (most efficient). The assessment does not take into consideration the condition of an element and how well it is working. 'Assumed' means that the insulation could not be inspected and an assumption has been made in the methodology, based on age and type of construction.

| Element | Description | Energy Efficiency | Environmental |
|-----------------------|---|-------------------|---------------|
| Walls | Granite or whinstone, with internal insulation Granite or whinstone, as built, no insulation (assumed) | | |
| Roof | Roof room(s), ceiling insulated | | |
| Floor | Suspended, insulated | — | — |
| Windows | Fully double glazed | | |
| Main heating | Boiler and radiators, LPG | | |
| Main heating controls | Programmer, room thermostat and TRVs | | |
| Secondary heating | Room heaters, dual fuel (mineral and wood) | — | — |
| Hot water | From main system | | |
| Lighting | Low energy lighting in 67% of fixed outlets | | |

The energy efficiency rating of your home

Your Energy Efficiency Rating is calculated using the standard UK methodology, RdSAP. This calculates energy used for heating, hot water, lighting and ventilation and then applies fuel costs to that energy use to give an overall rating for your home. The rating is given on a scale of 1 to 100. Other than the cost of fuel for electrical appliances and for cooking, a building with a rating of 100 would cost almost nothing to run.


As we all use our homes in different ways, the energy rating is calculated using standard occupancy assumptions which may be different from the way you use it. The rating also uses national weather information to allow comparison between buildings in different parts of Scotland. However, to make information more relevant to your home, local weather data is used to calculate your energy use, CO₂ emissions, running costs and the savings possible from making improvements.

The impact of your home on the environment

One of the biggest contributors to global warming is carbon dioxide. The energy we use for heating, lighting and power in our homes produces over a quarter of the UK's carbon dioxide emissions. Different fuels produce different amounts of carbon dioxide for every kilowatt hour (kWh) of energy used. The Environmental Impact Rating of your home is calculated by applying these 'carbon factors' for the fuels you use to your overall energy use.

The average Scottish household produces about 6 tonnes of carbon dioxide every year. Based on this assessment, heating and lighting this home currently produces approximately 8.0 tonnes of carbon dioxide every year. Adopting recommendations in this report can reduce emissions and protect the environment. If you were to install all of these recommendations this could reduce emissions by 2.0 tonnes per year. You could reduce emissions even more by switching to renewable energy sources.

Estimated energy costs for this home

| | Current energy costs | Potential energy costs | Potential future savings |
|---------------|----------------------|------------------------|---|
| Heating | £6,510 over 3 years | £6,039 over 3 years |  |
| Hot water | £834 over 3 years | £549 over 3 years | |
| Lighting | £276 over 3 years | £207 over 3 years | |
| Totals | £7,620 | £6,795 | |

These figures show how much the average household would spend in this property for heating, lighting and hot water. This excludes energy use for running appliances such as TVs, computers and cookers, and the benefits of any electricity generated by this home (for example, from photovoltaic panels). The potential savings in energy costs show the effect of undertaking all of the recommended measures listed below.

Recommendations for improvement

The measures below will improve the energy and environmental performance of this dwelling. The performance ratings after improvements listed below are cumulative; that is, they assume the improvements have been installed in the order that they appear in the table. Further information about the recommended measures and other simple actions to take today to save money is available from the Home Energy Scotland hotline which can be contacted on 0808 808 2282. Before carrying out work, make sure that the appropriate permissions are obtained, where necessary. This may include permission from a landlord (if you are a tenant) or the need to get a Building Warrant for certain types of work.

| Recommended measures | Indicative cost | Typical saving per year | Rating after improvement | | Green Deal |
|---|------------------|-------------------------|--------------------------|-------------|------------|
| | | | Energy | Environment | |
| 1 Internal or external wall insulation | £4,000 - £14,000 | £94 | E 42 | E 49 | |
| 2 Floor insulation | £800 - £1,200 | £76 | E 44 | E 51 | |
| 3 Low energy lighting for all fixed outlets | £20 | £16 | E 44 | E 51 | |
| 4 Solar water heating | £4,000 - £6,000 | £90 | E 46 | E 53 | |
| 5 Solar photovoltaic panels, 2.5 kWp | £9,000 - £14,000 | £214 | E 54 | D 59 | |
| 6 Wind turbine | £1,500 - £4,000 | £86 | D 56 | D 62 | |

Measures which have a green deal tick are likely to be eligible for Green Deal finance plans based on indicative costs. Subsidy also may be available for some measures, such as solid wall insulation. Additional support may also be available for certain households in receipt of means tested benefits. Measures which have an orange tick may need additional finance. To find out how you could use Green Deal finance to improve your property, visit www.greenerscotland.org or contact the Home Energy Scotland hotline on 0808 808 2282.

Choosing the right improvement package

For free and impartial advice on choosing suitable measures for your property, contact the Home Energy Scotland hotline on 0808 808 2282 or go to www.greenerscotland.org.

About the recommended measures to improve your home's performance rating

This section offers additional information and advice on the recommended improvement measures for your home

1 Internal or external wall insulation

Internal or external wall insulation involves adding a layer of insulation to either the inside or the outside surface of the external walls, which reduces heat loss and lowers fuel bills. As it is more expensive than cavity wall insulation it is only recommended for walls without a cavity, or where for technical reasons a cavity cannot be filled. Internal insulation, known as dry-lining, is where a layer of insulation is fixed to the inside surface of external walls; this type of insulation is best applied when rooms require redecorating. External solid wall insulation is the application of an insulant and a weather-protective finish to the outside of the wall. This may improve the look of the home, particularly where existing brickwork or rendering is poor, and will provide long-lasting weather protection. Further information can be obtained from the National Insulation Association (www.nationalinsulationassociation.org.uk). It should be noted that planning permission might be required and that building regulations apply to this work so it is best to check with your local authority whether a building warrant or planning permission will be required.

2 Floor insulation

Insulation of a floor will significantly reduce heat loss; this will improve levels of comfort, reduce energy use and lower fuel bills. Suspended floors can often be insulated from below but must have adequate ventilation to prevent dampness; seek advice about this if unsure. Further information about floor insulation and details of local contractors can be obtained from the National Insulation Association (www.nationalinsulationassociation.org.uk). Building regulations generally apply to this work so it is best to check this with your local authority building standards department.

3 Low energy lighting

Replacement of traditional light bulbs with energy saving recommended ones will reduce lighting costs over the lifetime of the bulb, and they last up to 12 times longer than ordinary light bulbs. Also consider selecting low energy light fittings when redecorating; contact the Lighting Association for your nearest stockist of Domestic Energy Efficient Lighting Scheme fittings.

4 Solar water heating

A solar water heating panel, usually fixed to the roof, uses the sun to pre-heat the hot water supply. This can significantly reduce the demand on the heating system to provide hot water and hence save fuel and money. Planning permission might be required, building regulations generally apply to this work and a building warrant may be required, so it is best to check these with your local authority. You could be eligible for Renewable Heat Incentive payments which could appreciably increase the savings beyond those shown on your EPC, provided that both the product and the installer are certified by the Microgeneration Certification Scheme (or equivalent). Details of local MCS installers are available at www.microgenerationcertification.org.

5 Solar photovoltaic (PV) panels

A solar PV system is one which converts light directly into electricity via panels placed on the roof with no waste and no emissions. This electricity is used throughout the home in the same way as the electricity purchased from an energy supplier. Planning permission might be required, building regulations generally apply to this work and a building warrant may be required, so it is best to check these with your local authority. The assessment does not include the effect of any Feed-in Tariff which could appreciably increase the savings that are shown on this EPC for solar photovoltaic panels, provided that both the product and the installer are certified by the Microgeneration Certification Scheme (or equivalent). Details of local MCS installers are available at www.microgenerationcertification.org.

6 Wind turbine

A wind turbine provides electricity from wind energy. This electricity is used throughout the home in the same way as the electricity purchased from an energy supplier. Wind turbines are not suitable for all properties. The system's effectiveness depends on local wind speeds and the presence of nearby obstructions, and a site survey should be undertaken by an accredited installer. Planning permission might be required and building regulations generally apply to this work and a building warrant may be required, so it is best to check these with your local authority. The assessment does not include the effect of any Feed-in Tariff which could appreciably increase the savings that are shown on this EPC for a wind turbine, provided that both the product and the installer are certified by the Microgeneration Certification Scheme (or equivalent). Details of local MCS installers are available at www.microgenerationcertification.org.

Low and zero carbon energy sources

Your home's heat demand

You could receive Renewable Heat Incentive (RHI) payments and help reduce carbon emissions by replacing your existing heating system with one that generates renewable heat and, where appropriate, having your loft insulated and cavity walls filled. The estimated energy required for space and water heating will form the basis of the payments. For more information go to www.energysavingtrust.org.uk/scotland/rhi.

| Heat demand | Existing dwelling | Impact of loft insulation | Impact of cavity wall insulation | Impact of solid wall insulation |
|------------------------------|-------------------|---------------------------|----------------------------------|---------------------------------|
| Space heating (kWh per year) | 21,966 | (72) | N/A | (993) |
| Water heating (kWh per year) | 2,918 | | | |

About this document

This Recommendations Report and the accompanying Energy Performance Certificate are valid for a maximum of ten years. These documents cease to be valid where superseded by a more recent assessment of the same building carried out by a member of an Approved Organisation.

The Energy Performance Certificate and this Recommendations Report for this building were produced following an energy assessment undertaken by an assessor accredited by ECMK (www.ecmk.co.uk), an Approved Organisation Appointed by Scottish Ministers. The certificate has been produced under the Energy Performance of Buildings (Scotland) Regulations 2008 from data lodged to the Scottish EPC register. You can verify the validity of this document by visiting www.scottishepcregister.org.uk and entering the report reference number (RRN) printed at the top of this page.

| | |
|-----------------------------|--|
| Assessor's name: | Mr Douglas Mackintosh |
| Assessor membership number: | ECMK201915 |
| Company name/trading name: | Green Deal Highland |
| Address: | 50 Park Street Nairn Inverness-shire IV12 4PP |
| Phone number: | 07933728475 |
| Email address: | info@greendealhighland.com |
| Related party disclosure: | No related party |

If you have any concerns regarding the content of this report or the service provided by your assessor you should in the first instance raise these matters with your assessor and with the Approved Organisation to which they belong. All Approved Organisations are required to publish their complaints and disciplinary procedures and details can be found online at the web address given above.

Use of this energy performance information

This Certificate and Recommendations Report will be available to view online by any party with access to the report reference number (RRN) and to organisations delivering energy efficiency and carbon reduction initiatives on behalf of the Scottish and UK Governments. If you are the current owner or occupier of this building and do not wish this data to be used by these organisations to contact you in relation to such initiatives, please opt out by visiting www.scottishepcregister.org.uk and your data will be restricted accordingly. Further information on this and on Energy Performance Certificates in general can be found at www.scotland.gov.uk/epc.

Opportunity to benefit from a Green Deal on this property

Under a Green Deal, the cost of the improvements is repaid over time via a credit agreement. Repayments are made through a charge added to the electricity bill for the property.

To see which improvements are recommended for this property, please turn to page 3. You can choose which improvements you want to install and ask for a quote from an authorised Green Deal provider. They will organise installation by an authorised Green Deal installer. If you move home, the responsibility for paying the Green Deal charge under the credit agreement passes to the new electricity bill payer.

For householders in receipt of income-related benefits, additional help may be available.

To find out more, visit www.greenerscotland.org or call 0808 8 [redacted]

Authorised
home energy
assessment

Finance at
no upfront
cost

Choose from
authorised
installers

May be paid
from savings
in energy bills

Repayments
stay with the
electricity bill
payer

DRAFT

Further reading

Technical Papers

Our Technical Papers series disseminate the results of research carried out or commissioned by Historic Scotland, mostly related to improving energy efficiency in traditional buildings. At the time of publication the series has 20 titles covering topics such as thermal performance of traditional windows, U-values and traditional buildings, keeping warm in a cool house, and slim-profile double-glazing.

All the Technical Papers are free to download and available from the publications page on our website www.historic-scotland.gov.uk/conservation

Refurbishment Case Studies

This series details practical applications concerning the repair and upgrade of traditional structures to improve thermal performance. The Refurbishment Case Studies are projects sponsored by Historic Scotland and the results are part of the evidence base that informs our technical guidance. At the time of publication there are 13 case studies covering measures such as upgrades to windows, walls and roof spaces in a range of traditional building types such as tenements, cottages and public buildings.

All the Refurbishment Case Studies are free to download and available from the publications page on our website www.historic-scotland.gov.uk/conservation

INFORM Guides

Our INFORM Guides series provides an overview of a range of topics relating to traditional skills and materials, building defects and the conservation and repair of traditional buildings. At the time of publication the suite has over 45 titles covering topics such as: ventilation in traditional houses, maintaining sash and case windows, domestic chimneys and flues, damp causes and solutions improving energy efficiency in traditional buildings, and biological growth on masonry.

All the INFORM Guides are free to download and available from the publications page on our website www.historic-scotland.gov.uk/conservation

Short Guides

Our Short Guides are aimed at practitioners and professionals, but may also be of interest to contractors, home owners and students. The series provide advice on a range of topics relation to traditional buildings and skills.

All the Short Guides are free to download and available from the publications page on our website www.historic-scotland.gov.uk/conservation