Post-intervention monitoring of 11 Annat Road, Gannochy Trust Estate

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November 2018

Introduction

This report summarises the results of monitoring & in situ U-value measurements carried out at 11 Annat Road on the Gannochy Trust Estate, Perth, following refurbishment. 11 Annat Road is a single storey detached house with a storage loft accessible using a retractable ladder. Icynene, a spray foam insulation, was injected into the cavity behind the lath & plaster on the internal walls. Woodfibre insulation boards were fitted between the rafters in the loft space.

The objective of the monitoring is to evaluate the moisture conditions at the interface between the internal cavity wall insulation and the masonry, since this is the location that is potentially at risk from interstitial condensation or high moisture contents due to lower interface temperatures caused by the improved insulation. Similarly, in the loft space the monitoring was carried out to assess any risk to the woodfibre insulation.

Monitoring ended in May 2018.

In situ U-value measurements were also carried out to assess the thermal improvements.

Measurement of interface conditions

A modified Gemini Tinytag temperature and humidity probe (TGP 4505) is inserted through the lath and plaster and insulation until it reaches the masonry (Figure 1).

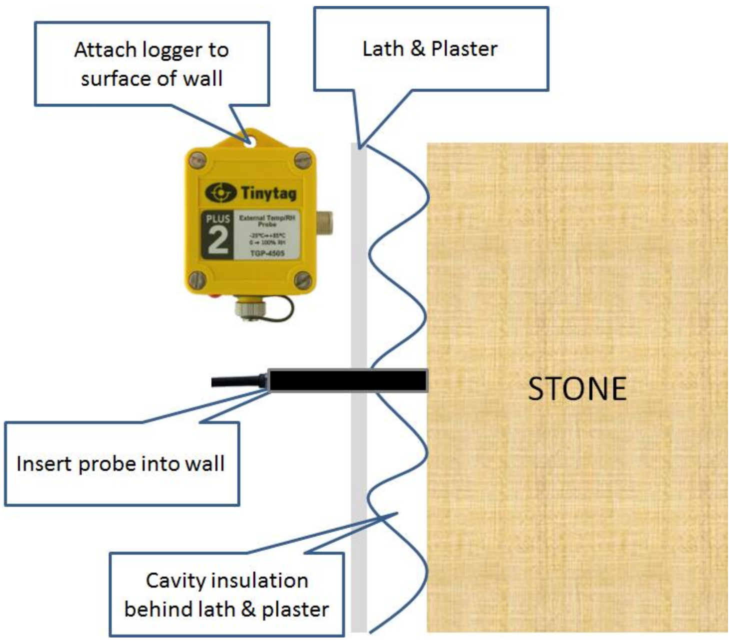

Figure 1: Schematic diagram showing location of Tinytag probe in wall.

The end of the probe is covered with a vapour permeable Gortex membrane, to prevent direct condensation on the sensor, then a plastic sleeve is pushed onto the probe so that only the end of the probe in contact with the masonry is open (Figure 2).

Figure 2: Schematic of modification of probe.

A probe was inserted into the N-W facing gable wall under the gable window in the living room whilst work was still in progress on the house on 2 February 2015. A second probe was inserted in the S-E gable wall above the picture rail in the main bedroom on 12 March 2015 (Figure 3). Tinytag loggers for measuring room conditions and the external temperature/RH sensor were also installed on 12 March.

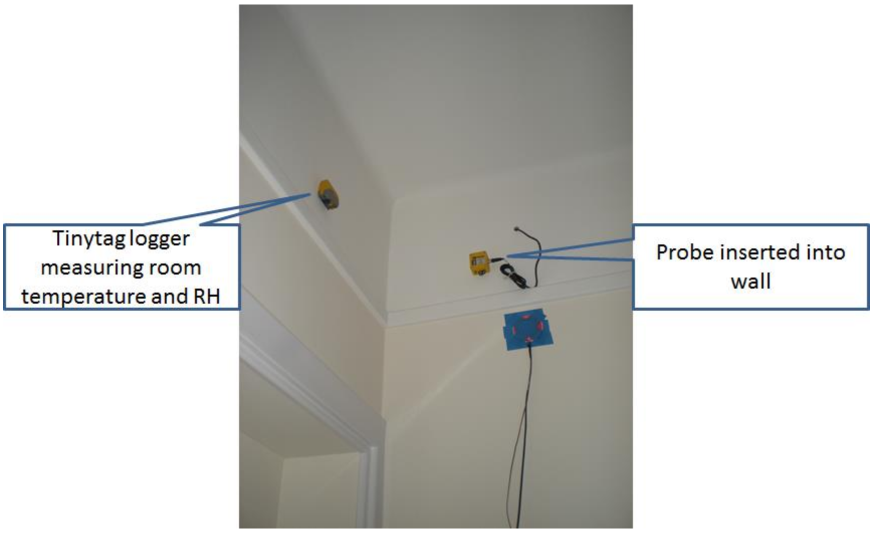

Figure 3: To right of photograph probe inserted into wall above picture rail. To left Tinytag logger for measuring room conditions.

A probe was also positioned above a slab of the woodfibre insulation in the loft (Figure 4) on 2 February 2015.

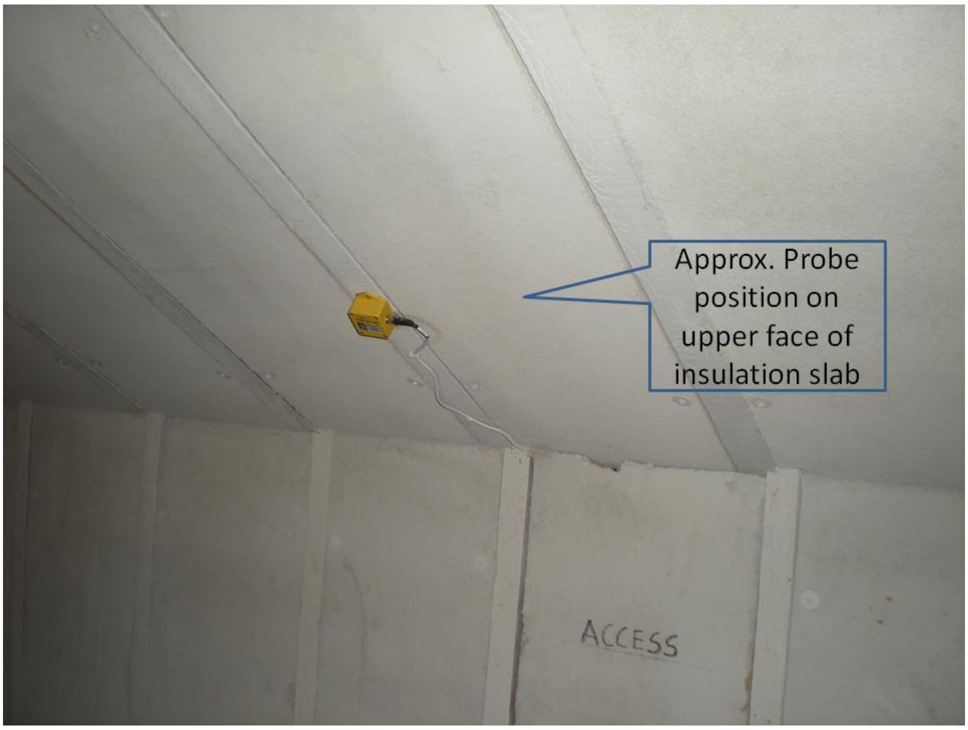

Figure 4: Location of temperature/RH probe above insulation slab in attic.

An external temperature and humidity sensor was mounted within a radiation shield attached to a drainpipe on the S-E gable wall.

External surface temperatures were also measured on the N-W facing gable wall of the living room and the S-E facing gable wall of the bedroom to assess the influence of differences in incident solar radiation on the moisture performance of the walls.

Data were measured at 15- or 20-minute intervals.

Results

The temperature and relative humidity data were processed to produce daily averages.

Living Room

Figures 5 & 6 compare the interface conditions measured by the wall probe inserted in N-W gable with the room and external conditions.

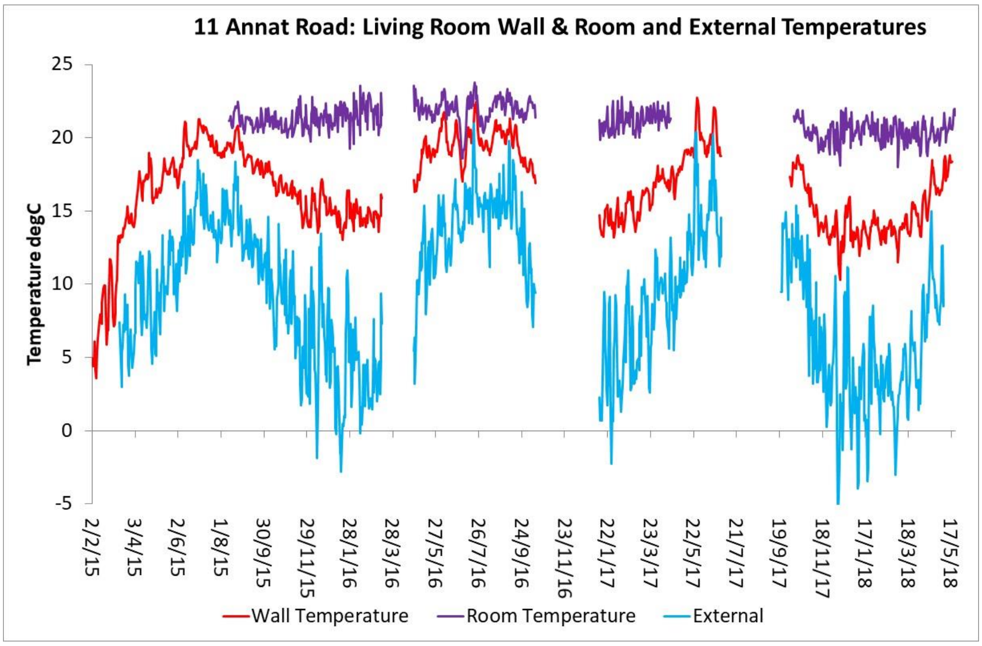

Figure 5: Living room, wall probe and external temperatures.

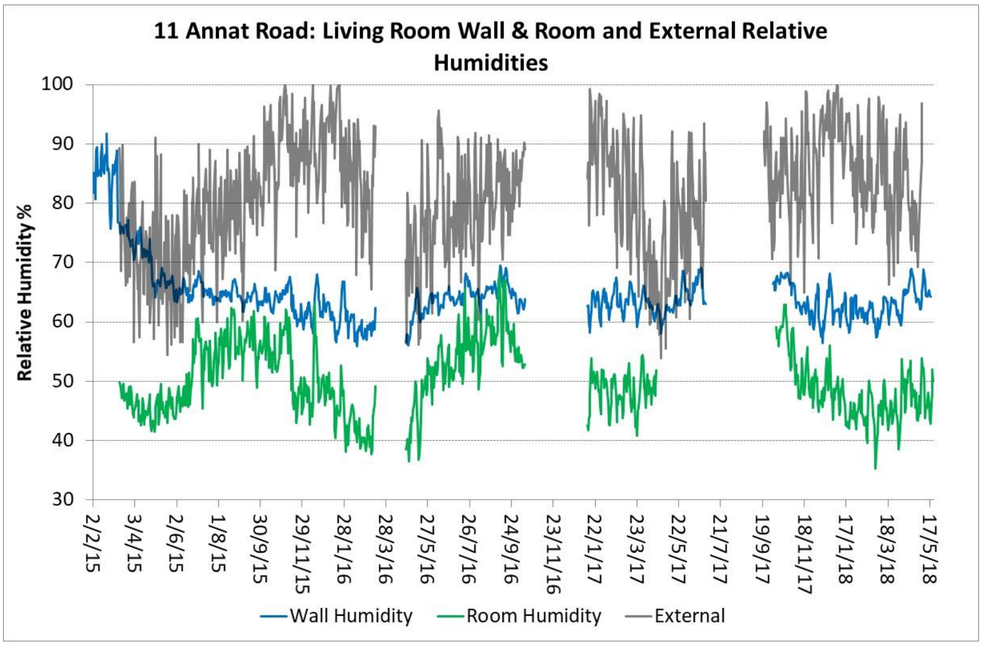

Figure 6: Living room, wall probe and external Relative Humidities.

Figure 6 indicates that after installation there is a period of high humidities, probably due to drying out of the Icynene insulation and unheated room conditions. However, after the heating system had become operational and tenants had moved in the humidities fall to safe levels below 70%RH. The critical level for interstitial RH is generally taken as 80%, above which there is potential for timber decay for long periods of exposure.

During the heating season, the difference between the room and wall probe temperatures confirms that the insulation installed behind the plaster is effective (Figure 5).

Bedroom

Figures 7 & 8 compare the interface conditions measured by the wall probe inserted in S-E gable with the room and external conditions.

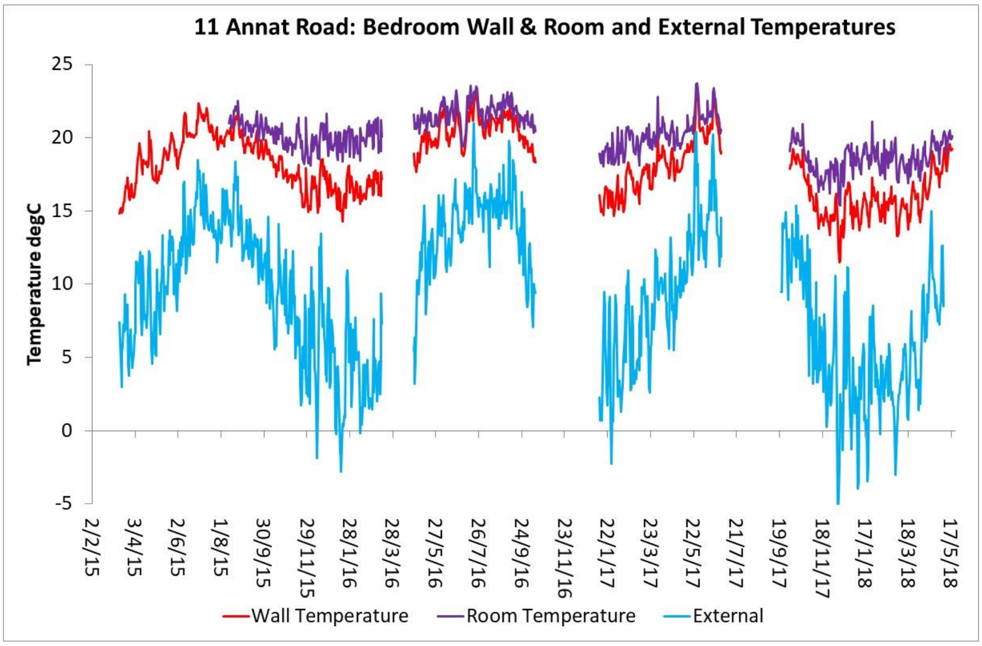

Figure 7: Bedroom, wall probe and external temperatures.

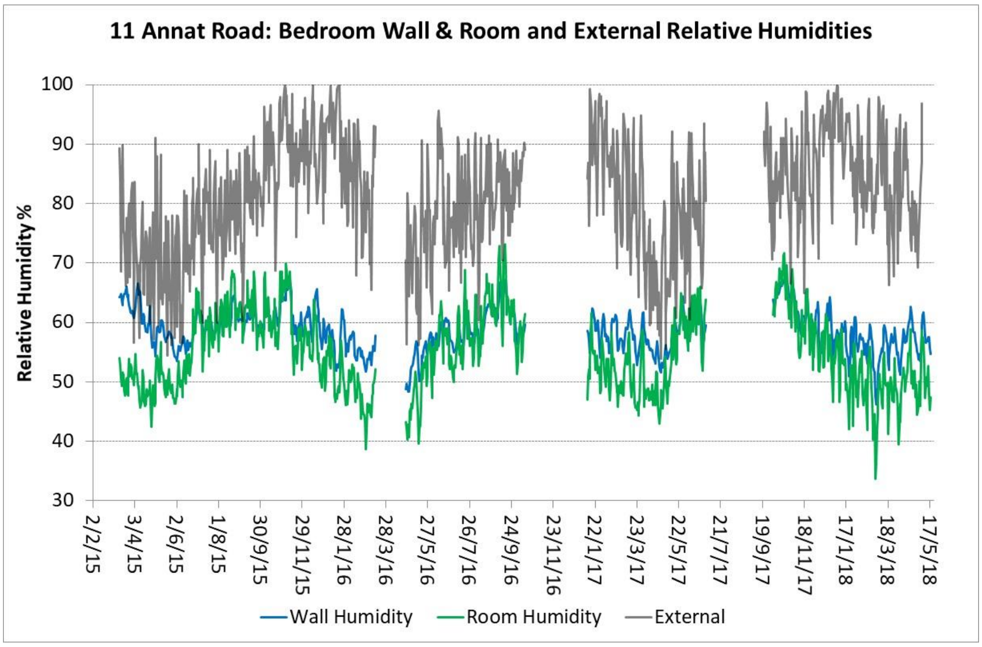

Figure 8: Bedroom, wall probe and external Relative Humidities.

In the ground floor bedroom, where monitoring only began with heating operational, the humidity levels in the wall are safe (Figure 8). The difference between the room and wall probe temperatures during the heating season confirms that the insulation installed behind the plaster is effective (Figure 7).

External surface temperatures were also measured on both gable walls (Figure 9).

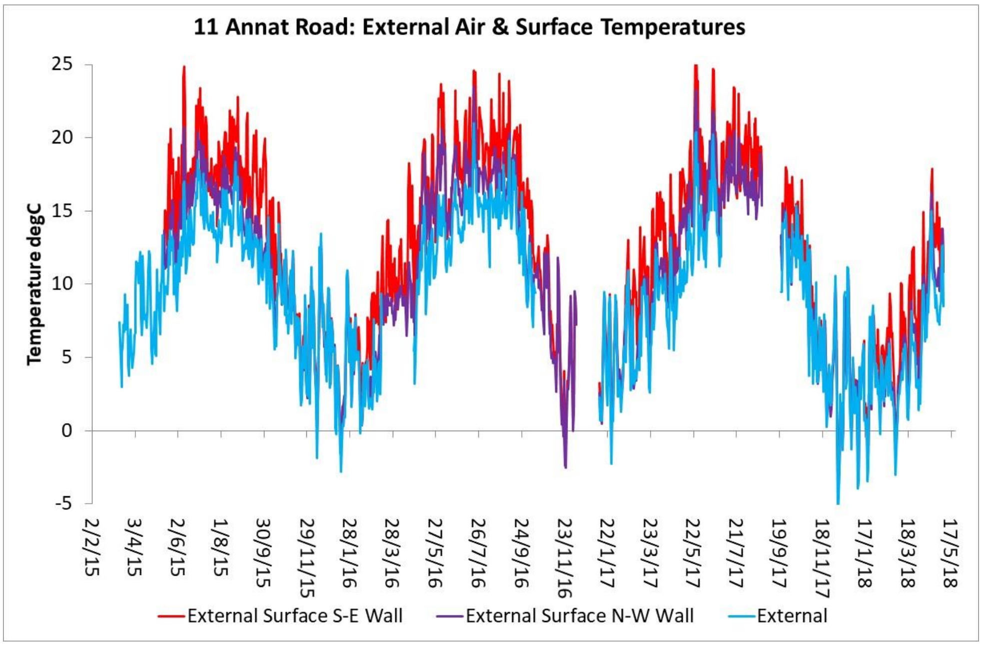

Figure 9: External surface temperatures measured on the S-E and N-W gable walls and the external air temperature.

Figure 9 indicates that the S-E gable (bedroom) benefits more from solar gains in the spring and summer periods than the N-W elevation. During winter there is little difference between the surface and external air temperatures. The increased external surface temperature on the bedroom wall may help lower the humidity at the interface between the stone and the insulation compared with the N-W gable of the living room, despite the bedroom conditions being more humid than the living room.

Loft

Figures 10 & 11 compare the interface conditions measured by the probe placed on cold face of the woodfibre insulation with the loft room and external conditions.

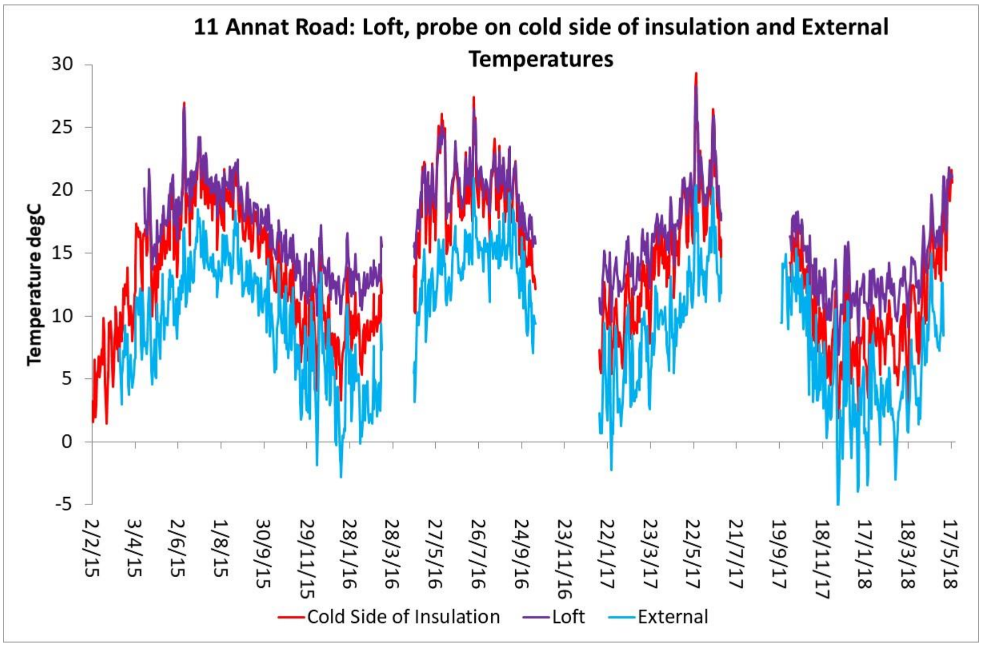

Figure 10: Loft, probe on cold face of insulation and external temperatures.

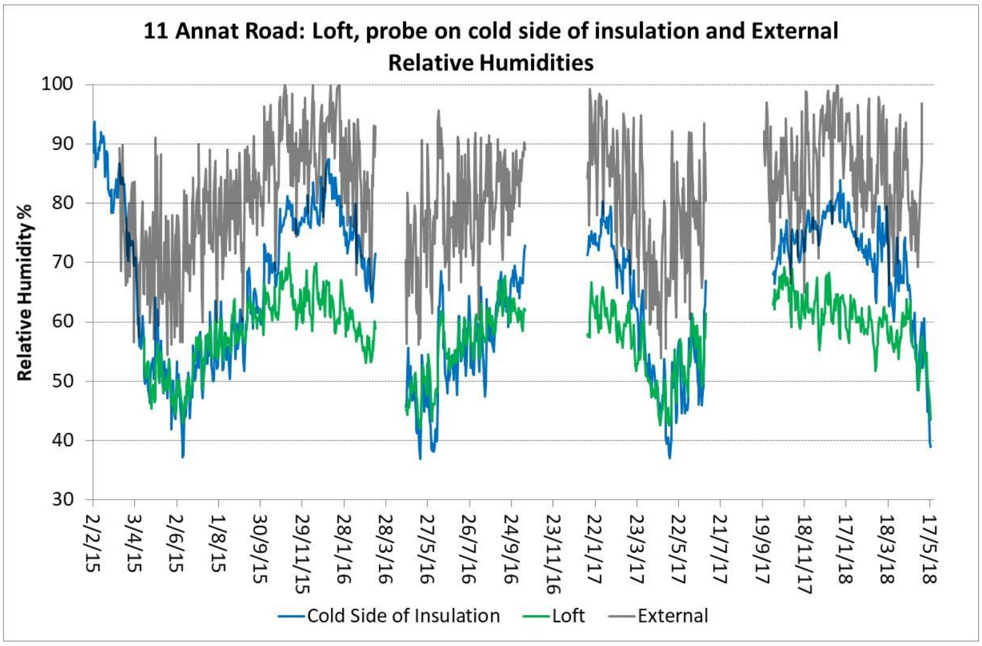

Figure 11: Loft, probe on cold face of insulation and external Relative Humidities.

The probe temperatures and RHs tend to follow the loft conditions in spring and summer, but probe temperatures fall and humidities rise in autumn and winter. Relative humidities on the cold side of the insulation tend to peak and exceed 80% during winter for short periods. Calculating the moisture content of the air in the loft, above the insulation and the exterior (Figure 12) indicates that air moisture content above the insulation is lower than the exterior during spring and summer, however it tends to be higher than the external moisture content during autumn and winter and is closer to the loft air moisture content. These results suggest that the woodfibre tends to buffer moisture: accumulating moisture in the autumn and winter and releasing it during spring and summer.

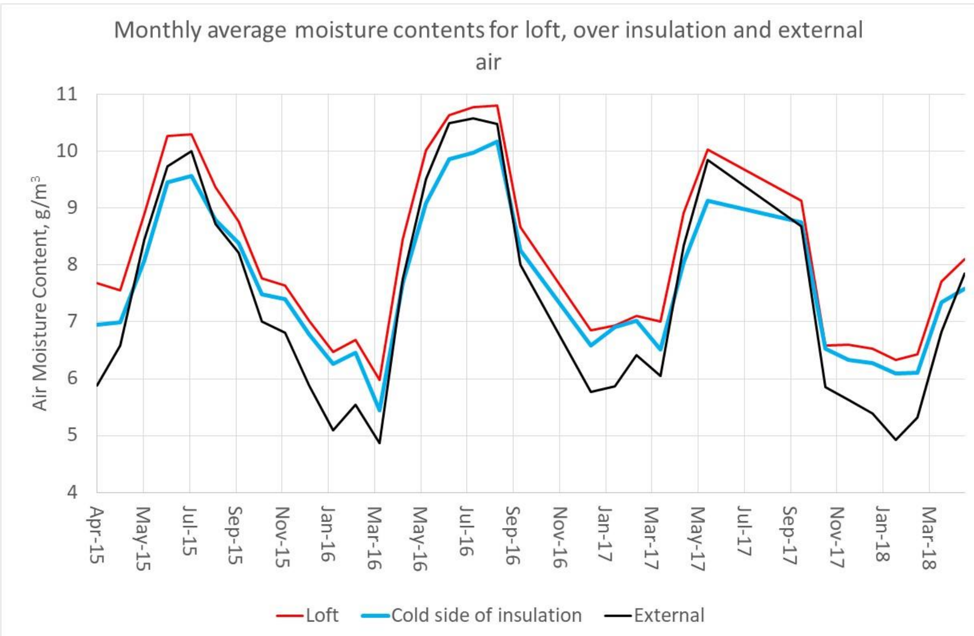

Figure 12: Monthly average air moisture contents in loft, cold side of insulation and exterior.

Figure 13 compares the air temperatures of ground floor rooms, the loft and the external environment.

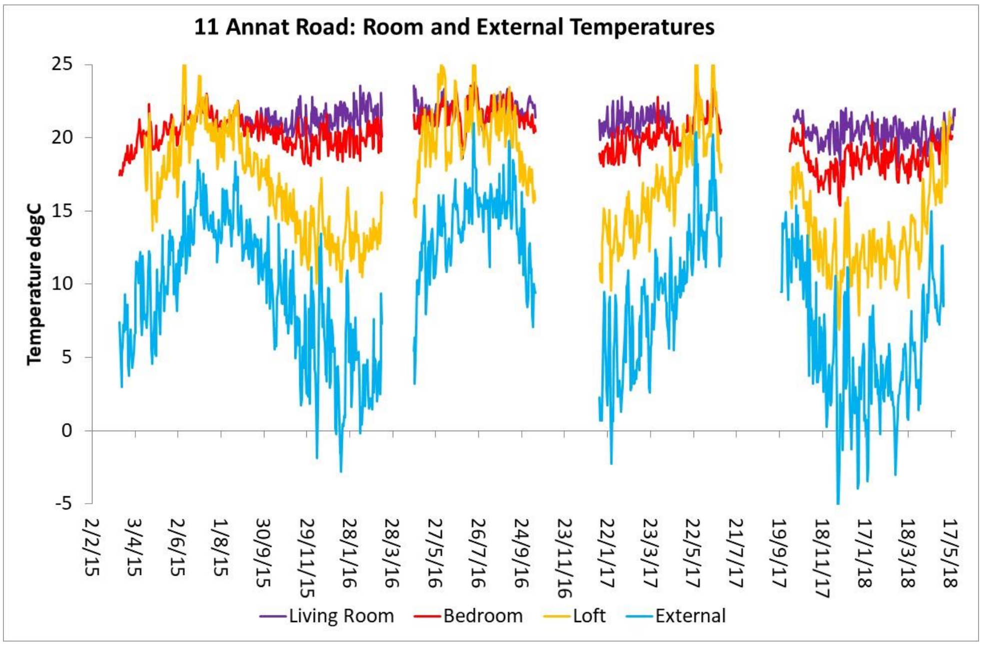

Figure 12: Comparison of loft, living room, bedroom and external temperatures

Figure 13 indicates that whilst the attic space is always warmer than outside, during the heating season it is significantly colder than the ground floor rooms. Heat is therefore lost from the ground floor to the loft space; however, the roof insulation will reduce the heat loss compared to the previous situation with no insulation. It could be argued that insulation at the ceiling level of the ground floor would be a better option than the roof insulation; however, the warmer and drier attic conditions are more suitable for storage.

In situ U-value measurements

Pre-intervention

U-values were measured on the rear elevation of a similar untreated property between 16 April & 12 May 2014. The results were as follows:

	U-value (W/m^{2}K)
Kitchen wall under window (tiled section above sink)	**1.2**
Kitchen wall above window	**1.0**
Kitchen wall above door	**1.0**
Bathroom wall adjacent to WC (tiled section)	**1.7**
Bathroom wall adjacent to WC (painted/plastered section)	**0.9**
Bathroom wall above window	**0.8**

The average U-value was 1.1 W/m^{2}K, however the range was 0.8-1.7 W/m^{2}K. Note that the measurement locations were not ideal, but access to more suitable rooms was not available.

Post-intervention measurements in 11 Annat Road

Measurements were made on the gable wall in the monitored bedroom (Figure 14), and in the loft as shown below between studs and rafters (Figures 15 & 16).

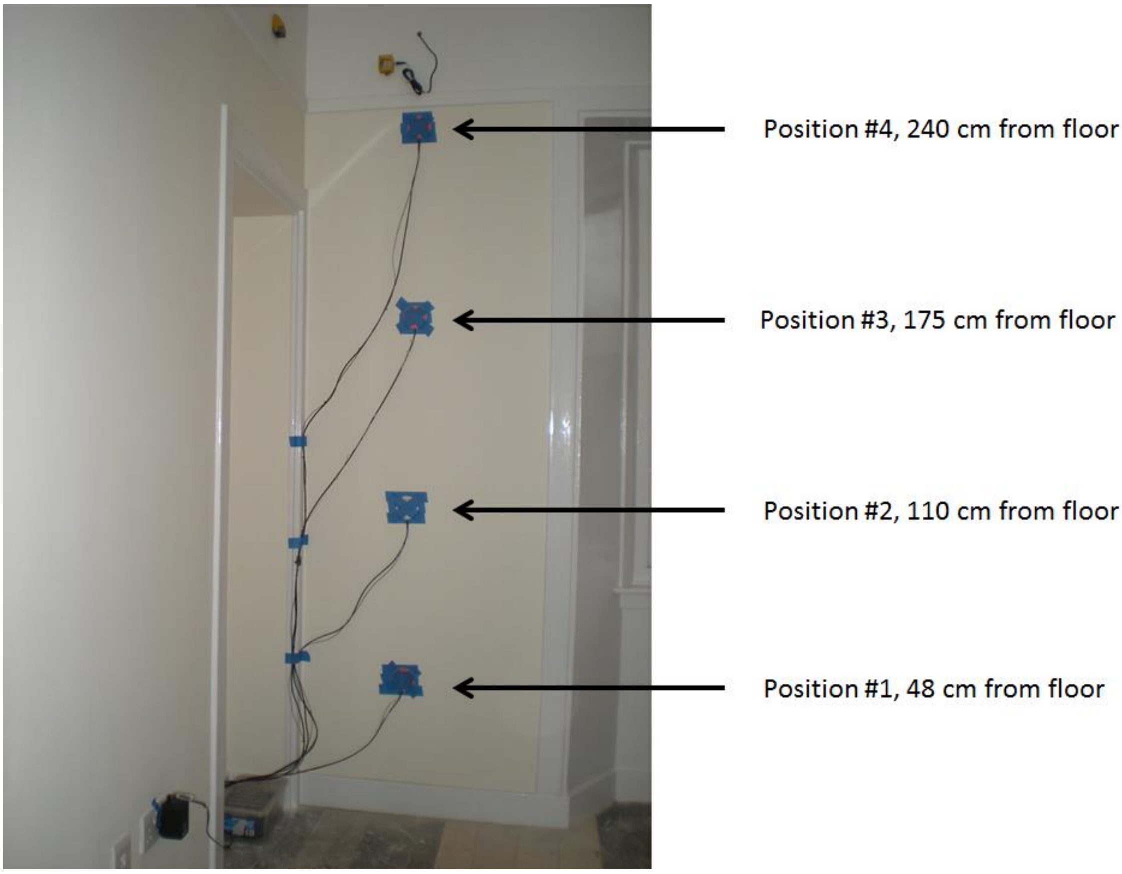

Figure 3: Position of sensors on gable wall of bedroom - locations on the gable wall of the ground floor bedroom were chosen to enable a profile to be measured up the wall.

Figure 15: Loft Coombe

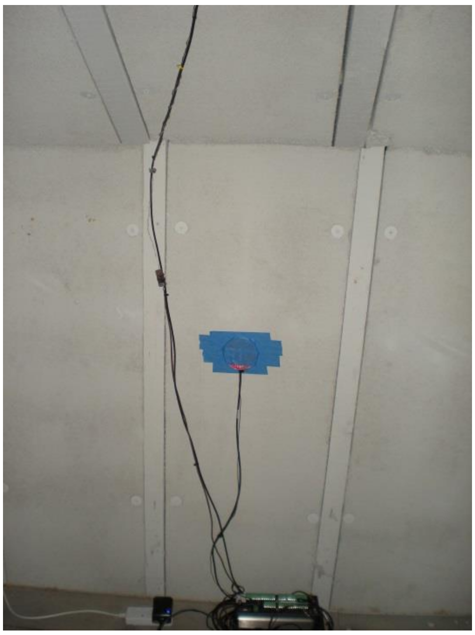

Figure 16: Loft Wall

The in situ U-values measurements were carried out between 12 March & 16 April 2015.

The results are as follows:

	U-value (W/m^{2}K)
Position#1	0.43
Position#2	0.35
Position#3	0.39
Position#4	0.48
Average	0.41

Whilst there is a variation in the U-values in the profile with a standard deviation of 0.05 W/m^{2}K (i.e. about ±13% about the average value of 0.41 W/m^{2}K, the U-values represent a significant improvement compared to the uninsulated property.

The loft U-values are as follows:

	U-value (W/m^{2}K)
Loft Coombe	0.13
Loft Wall	0.15

These values include the effect of the roof as the calculation of the U-values is referred to the external temperature.

Using the temperature measured by the probe placed on top of the insulation in the coombe to estimate the U-values effectively of the insulation only gave the following results:

	U-value (W/m^{2}K)
Loft Coombe (insulation only)	0.42
Loft Wall (insulation only)	0.50

These results are consistent with installing 75mm of insulation with a thermal conductivity of around 0.035-0.04 W/mK.

Conclusions

Satisfactory U-values have been achieved by injecting Icynene foam behind lath & plaster in the ground floor walls with an average value of 0.41 W/m^{2}K compared to 1.1 W/m^{2}K for uninsulated walls in a similar property.

Low U-values have been achieved using woodfibre insulation in the loft.

Monitoring of humidity within the walls indicate safe levels of humidity throughout the monitoring period after an initial period of high humidity following the injection of Icynene, which is applied wet.

Some periods of high humidity greater than 80%RH occur on the cold side of the loft woodfibre insulation mounted between the rafters, however calculations of air moisture contents indicate that the woodfibre may be acting as a moisture buffer. It is recommended that the moisture content of the woodfibre is measured seasonally and its condition assessed by visual inspection.

The roof insulation will reduce the heat loss compared to the previous situation with no insulation. Insulation at the ceiling level of the ground floor would be a better option to reduce overall heat loss from the dwelling; however, the warmer and drier attic conditions resulting from the woodfibre between rafters are more suitable for storage.