The Community Council's position on Insulating Homes in a Conservation Zone

Marchmont and Sciennes

Community Council

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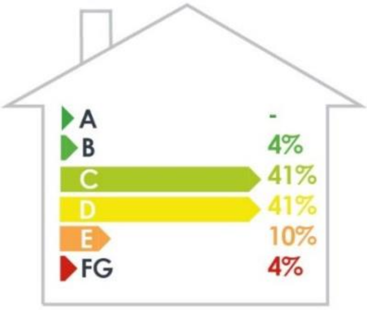
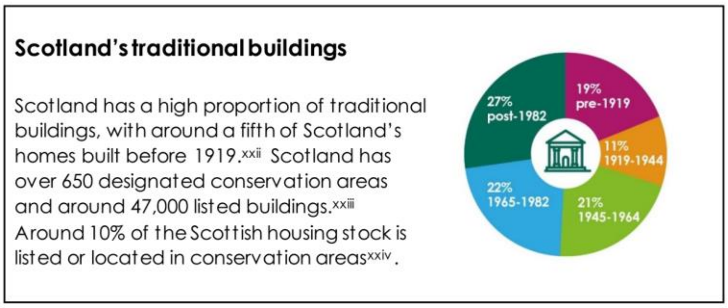
1 Background

The Scottish Government are pressing to reduce to zero, greenhouse gas emissions generated by our houses by 2045. In order to achieve this, they are creating a Heat in Buildings Strategy, built round their draft document[1] published in 2021, which includes the statement from the Minister responsible that "*Transforming our homes and workplaces will be immensely challenging, requiring action from all of us, right across society and the economy*".

To achieve this, they have assessed that we will have to spend in excess of £33 billion in improving the insulation and heating methods of Scotland's buildings. In the first instance, they are targeting improving the insulation standard of all residential properties in Scotland to meet Energy Performance Certificate (EPC) rating C by 2033, and plan to have installed heat pumps in over 1 million homes and around 50,000 non-domestic buildings by 2030.





Over 50% of Scottish homes don't meet the EPC rating C and about 20% of all houses in Scotland were built before 1919 with about half of these in conservation zones. The vast majority of Houses in the Marchmont and Sciennes area were built before 1919 and being in a conservation zone, has restricted householders' ability to improve the insulation of their homes. As a result, most houses in this area have an EPC rating of E or below.

So, will improving the houses in our area to an EPC rating of C reduce our energy usage significantly? Probably not - a study by Cambridge University into houses where roof insulation or cavity wall insulation were added[2] found that a householders energy usage initially fell by about 8% but after 5 years, even this small energy saving was lost. This research suggests that small improvements in thermal efficiency tend to be used to improve householders comfort and not to reduce energy usage. Therefore, if Scotland is to significantly reduce the energy used to heat our houses, it will need to target a high level of insulation.

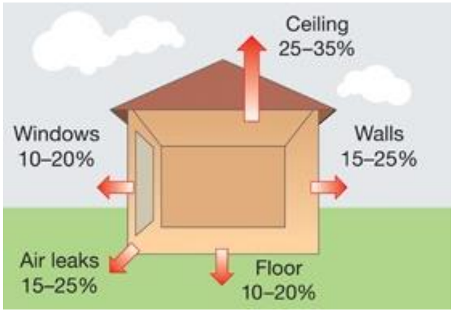
The Oxford research group CREDS[3] have recommended that an EPC rating of B or even A should be the target for Scottish homes. Others suggest that the aim should be to meet the more ambitious EnerPHIT[4] standard, the refit equivalent of the PasivHaus[5] standard.
Meeting these higher standards would require:

- improved thermal insulation (based on the principle: if it has to be done, do it right)
- reduction of thermal bridges – components that provide a path for heat loss
- considerably improved airtightness
- use of high quality windows – to near PasivHaus standards
- ventilation with highly efficient heat recovery would also be highly desirable

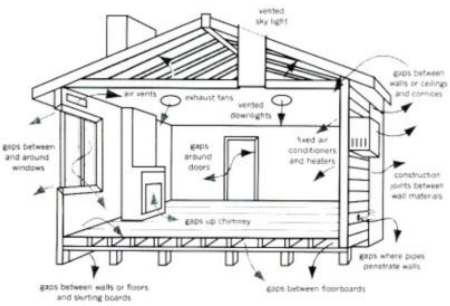
2 The challenge

Most of the houses and tenement flats in the Marchmont and Sciennes area were built before 1919. They are not easy to insulate and are difficult to make draught proof to the high standard now required. Having inspected several buildings in the area, and talked with their owners, it is clear that the cost and disruption required to achieve these high standards, will be a major obstacle in achieving the net zero targets set by the Scottish Government.

The Listed Building and Conservation Areas guidance document[6] issued by the City of Edinburgh Council, was last updated in October 2022. Listed buildings form a special group, often requiring complex and expensive solutions in order to preserve internal features of the building, whereas only the external appearance of houses in conservation zones is protected. However, the number of houses impacted by being in conservation zones far exceeds those impacted by listed building controls. The focus of this analysis will therefore be on the issues associated with adapting houses where the preservation of their appearance is the primary concern.



The percentage heat loss for each component differs between housing types



Air leakage can account for 15-25% of heat loss from a building

When planning to upgrade the insulation of a house, the first stage is to identify the main areas of heat loss and prioritise them for improvement. The disruption and cost of making any improvement is large and so these should be carried out to the highest possible standard to ensure that this will not need to be revisited. Most of the pre 1919 houses and tenement flats in the Marchmont and Sciennes area have roofs that are difficult to insulate and also suffer from a high level of air leakage through windows, doors and open fireplaces. Almost all windows in this area are still single glazed.

The U value is a measure of heat loss, the lower the value the better. The target U value for ceilings and floors should be 0.2 W/m^{2}K or below. Walls are slightly harder to insulate but if possible should be kept below a U value of 0.3 W/m^{2}K. Windows are more difficult though a U value of 1.0 W/m^{2}K or below is achievable without significantly impacting on the external look of the building.

2.1 Windows

All windows in the heritage buildings in our area are fitted with sash and case windows. These use a pair of cast iron counter-weights attached to sashcord that acts through pulleys to offset the weight of the moveable window frame and glass. When these houses were built, glass was not available in large sheets, so the windows were cut up into smaller sections with astragals. Usually, the front windows are divided into 2 or 4 sections and the rear windows into as many as 6 sections.

Figure 1: Details of window structure and external view of window with thin double glazing installed

Sash windows as originally fitted, are draughty and have single glazed panels with a U value of 5.4 W/m^{2}K. Fitting draught proofing to these windows produces a problem of condensation on their inside face. The council's guidance used to prohibit the use of double glazing, and as a consequence secondary glazing panels have been installed by some householders. This reduces the U value of the combined window and secondary glazing to about 2.5 W/m^{2}K.

The current guidance still emphasises the use of drapes and shutters to reduce heat loss, but does now permit the use of vacuum insulated glass, thin double glazing, secondary glazing and narrow profile glazing.

Thin double-glazing units suitable for fitting into existing window frames have been available for over ten years. The only modification required is for the cast iron counter-weights to be replaced with heavier lead ones. Currently, The Original Glass Company[7] manufacture double glazing panels with coatings on the inner pane to reduce radiation heat loss and are filled with Krypton gas to increase their insulation property. Properties of their Thin Sealed Units are given in Table 1.

Table 1: Thicknesses and performance data for Thin Sealed Units

	Glass	Cavity	Overall	U value
Heritage 3/4/3	3 mm	4 mm	10mm	1.9 W/m^{2}K
Heritage 4/4/4	4 mm	4 mm	12 mm	1.8 W/m^{2}K
Heritage 4/6/4	4 mm	6 mm	14 mm	1.4 W/m^{2}K
Heritage 4/8/4	4 mm	8 mm	16 mm	1.1 W/m^{2}K

Double glazing units with 20mm air gap are able to provide a U value of 1.2 W/m^{2}K and state of the art triple glazed units are currently specified as having a U value of 0.8 W/m^{2}K. The thin double-glazing units detailed in Table 1 perform well if the cavity can be kept at 8mm and even the thinnest glazing unit still makes a massive difference to the performance of an otherwise standard window. When higher performance windows are required, the original sliding sash design will need to be abandoned as it will not be possible to provide sufficiently heavy counter weights. The box containing the weights provides a path for heat loss and should be replaced at the same time.

2.2 Doors

Traditional doors are difficult to draught proof to a high standard and letterboxes add to this problem. The door panels which make up approximately a third of the door area, are less than 15mm thick giving an overall U value rating of 2.5 W/m^2K. Replacing the door with one incorporating insulation while retaining the outer appearance is one option and allows the draught proofing elements to be designed in and fitted with the new door. Where there is an inner door available, an alternative approach is to replace it with a high-quality insulated door with double or triple glazed units and integrated draught proofing.

Figure 2: Original front door and well insulated inner door

Fan lights above the door are fixed so can easily be replaced with double or triple glazed panels as appropriate. If decorative glass panels need to be retained, a double-glazing panel can be installed behind or in front of these depending on location and design.

2.3 Roofs

Roofs in the Marchmont and Sciennes area are predominantly flat with a pitched front aspect to give the impression that the houses and tenement flats have gabled roofs.

Figure 3: View from Google maps of roofs in the Marchmont area

Dormer windows are set into the pitched front to provide light to the top floor rooms and a cupola on the roof provides light to the stair well in the middle of the house or tenement flat block.

This combination of roof types presents a challenge when adding insulation. The flat roof section can be "hot decked insulated" where the insulation is placed directly on top of the wooden boards that make up the roof surface. This is then overlayed with a waterproof membrane. A typical construction using 100mm thick sheets of PIR insulation will only achieve a U value of 0.35 W/m^{2}K, requiring additional insulation measures. Rockwool's HARDROCK insulation when 210mm thick can achieve a better thermal performance of 0.18 W/m^{2}K.

Pitched roofs can be insulated internally by removing the ceiling and placing 150mm of PIR board between joists. The ceiling is then reconstituted with 35mm of PIR backed with plasterboard in order to minimise thermal bridging by the joist timbers. A vapour barrier is required that seals the space above the ceiling and the underlay beneath the roof tiles must be replaced with a breathable membrane. This will provide an acceptable U value of around 0.2 W/m^{2}K.

Figure 4: Cupola above a stair well with additional double glazing unit seen from below and above

Cupolas are great for letting the light in but appalling at keeping heat in, due to poor sealing of the traditional design and the single glazed glass. Some people have installed double glazing units into the cupola frame. An approach that seals off the draughts and increases the insulation is to include an additional high quality glazing unit horizontally under the cupola. Because the U value of glazing units are derated when not vertical, triple glazing as a minimum should be used in this location, with pentuple glazing being offered by Velux to meet the PassivHaus standard.

2.4 Floors

Where ground floors are constructed of floorboards on wooden joists, the standard insulation procedure of lifting the boards, inserting batts of insulating material and reflooring is the best solution. Replacing the flooring also allows under floor heating to be installed at the same time.

Some firms offer a service using specialist machines that will run under the floorboards and spray a layer of foam underneath. This avoids the complication of removing and replacing the floorboards but prevents access to the services while improving the insulation. It is also thought by some to introduce an unnecessary fire risk since the insulation is not contained within fire resistant material.

2.5 Walls

The most difficult area to improve in these older buildings is the walls. Traditional stone buildings need to be able to absorb and release moisture to prevent decay of the building fabric. Whichever insulation option is used, it mustn't interfere with this process. Also, most of the rooms in our houses and tenement flats have elaborate cornice plaster work at the junction of floor and ceiling and complex skirting boards that need to be left in place.

Figure 5: Injecting polystyrene insulation behind wall lining + Hemp board insulation between timber framing

Most external walls in this area are built of stone between 600mm and 900mm thick, with battens supporting an inner lath and plaster wall lining. External insulation is not possible and so any improvement to this stone wall construction will require the interior of the house to be modified in one of three main ways:

- Injecting insulation behind the lath and plaster wall lining
- Insulation applied on top of existing wall lining
- Insulation fitted to new framework separated from wall after removal of wall lining

Filling the gap between the wall lining and stone wall reduces ventilation in this area and so it is important that the walls being treated are generally dry and that the insulation material chosen permits water vapour to pass through, while still preventing draughts. There is some concern regarding moisture control and the recommendation is that the final wall finish should allow moisture to escape. Performance is determined by the depth of the gap and the material used.

Applying insulation on top of the existing wall lining brings the wall forward and must be tapered towards cornice and skirting board. In order to limit the thickness while maximising the performance, aerogel insulation material faced with either plasterboard or magnesium oxide board are used. This can be as thin as 12mm overall, though 40mm is normally required to achieve a reasonable standard. Alternatively the aerogel can be attached to the wall with a steel mesh over the top onto which plaster is applied.

By removing the lath and plaster work and building a frame filled in with hemp board or similar, the insulation properties can be better controlled and an air gap kept for moisture control. The thickness of the insulation will still be limited if the intention is to leave the cornice plasterwork in place.

Table 2: Results for different wall insulation methods - Historic Scotland Refurbishment Case Study 4

Insulation	Thickness applied	U-value prior to improvement	Improved U value
Wood fibreboard	80 mm	1.1 W/m²K	0.19 W/m²K
Hemp board	100 mm	1.1 W/m²K	0.22 W/m²K
Aerogel board	50 mm	1.1 W/m²K	0.23 W/m²K
Blown cellulose	100 mm	1.1 W/m²K	0.29 W/m²K
Injected polystyrene bead	50 mm (approx)	1.1 W/m²K	0.32 W/m²K
Aerogel board	40 mm	1.1 W/m²K	0.37 W/m²K

A detailed study of the insulation performance of a six flat tenement block in Glasgow was carried out by Historic Scotland and the results published as a Refurbishment Case Study[8]. The thermal performance results are given in Table 2 with illustration of two methods in Figure 5. The study also found that all methods showed no significant increase in moisture levels in the outer stone wall.

The blown polystyrene bead solution performs well and is the least intrusive. If fire risk or moisture control is a concern then retrofitting of fibreboard into a frame should be considered, though this requires more depth. Using aerogel board is too expensive for general usage but is a workable solution for the area behind the shutters and inside Edinburgh Presses where space is restricted and the application is directly onto a lime plaster or cement finish.

2.6 Air tightness and forced ventilation

For a high thermal efficiency, it is important to restrict air leakage as far as possible. However, to control humidity and maintain a degree of comfort, air change is required. If a forced ventilation unit with heat exchanger is installed, this would take air out of the bathroom and kitchen and deliver fresh air to the living spaces without a significant loss of heat. These units can be small enough to be placed in small spaces with external air inlet and outlet through the wall or through the roof.

2.7 Heat pumps and solar panels

Because many of our houses have a large flat roof, this is the ideal place to install solar panels and air sourced heat pumps.

Figure 6: Water heating solar panel installed in roof valley

3 Conclusion

It has been shown that insulating just to meet an EPC rating of C is unlikely to substantially reduce the energy usage of the houses and tenement flats in this area. Any time an insulation upgrade is being considered it should therefore be carried out to meet the higher standards that we can expect to be required in the future.

The Council's planning guidance on Listed Buildings and Conservation Zones[5] provides a set of restrictions that will be applied when planning applications or listed building consent is being sought. For buildings in conservation zones, these restrictions only apply to the outward appearance of the building. The Council's document has recently been updated to include double glazing and the introduction of solar panels and air source heat pumps. The guidance needs to be reviewed in light of modern good practice, extended to allow greater window modification and should encourage the placing of solar panels and heat pumps out of site on the flat roofs.

A set of good practice examples of insulation improvements is also needed. These can be developed by consulting with builders and other practitioners. This should include standard methods to update windows, walls and roofs in order to achieve significantly improved insulation at an economic price, while maintaining the heritage of the building. Planning would then be able to quickly approve proposals using these good practice approaches, allowing the rate of insulation improvements in the houses and tenement flats in conservation zones to be accelerated.

4 References

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