



Solid Wall Insulation in Scotland

Exploring barriers, solutions and new approaches

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EXECUTIVE SUMMARY

In April 2012, Changeworks, supported by Historic Scotland, held a major conference in Edinburgh to address the main issues, barriers and solutions for insulating Scottish solid masonry walls. This report, funded by the Scottish Government, provides the main findings from the conference and an overview of the current state of affairs in Scotland with regard to solid wall insulation (SWI).

With almost a quarter of Scottish housing having solid stone walls and the majority of them uninsulated, SWI presents a major opportunity to help alleviate fuel poverty and tackle climate change. The forthcoming Green Deal and Energy Company Obligation (ECO) aim to increase the number of SWI installations across the UK dramatically. However, this improvement measure is often not as straightforward as it seems. As the Changeworks conference highlighted, there remain differing views and unresolved issues about the best approaches to take in insulating solid walls, many of which the conference explored.

The main findings from this report are as follows:

- Solid walls perform thermally better than current energy modelling assumes (i.e. they have lower U-values when measured *in situ*). This means that the potential financial and CO₂ savings from SWI are often less than predicted – the implications of this could be considerable.
- There are numerous techniques and systems for insulating solid walls and this can be confusing to those considering installing SWI. Techniques cover internal (e.g. insulating plasterboard, injecting behind lath and plaster, insulating lining) and external (render or cladding), and there is a wide choice of materials.
- Although external wall insulation (EWI) is more expensive than internal wall insulation (IWI), it is generally considered the technically easier solution as it creates fewer cold bridges and fewer potential problems with moisture build-up within the walls. However, EWI is not applicable in many properties, for example, where the façade has to be retained or where the property forms part of a bigger building (e.g. a tenement flat).
- IWI can lead to moisture build-up in external walls (interstitial condensation), as exterior walls stop receiving heating and become more likely to attract and retain moisture. This can lead to health problems for the occupants (e.g. from mould growth) and structural issues for the building. The risk of moisture build-up, and associated consequences, varies greatly and depends on multiple factors: exposure to driving rain, temperature, build and thickness of wall, condition of wall, and materials used (insulation and vapour barriers). Appropriate methods to minimise the risk of moisture build-up differ between individual properties but solutions may include the use of breathable materials or avoiding over-insulating walls.

- Costs for SWI vary greatly, but are generally high and this is a significant barrier to wider uptake. Whilst the Green Deal and ECO intend to address this barrier, there are concerns about lack of consumer uptake. Other barriers households face in installing SWI are the lack of impartial advice available, permissions needed from multiple tenants and owners in multi-tenure blocks, disruption during installation (possibly including a need to move out temporarily) and other changes required to property (e.g. reduction in room size, reduced light ingress).
- The large range of options and the difficulty in finding impartial advice could lead to market paralysis, i.e. lack of uptake of SWI for fear of damaging properties. This risk is exacerbated where conflicting advice exists, with recommendations or notes of caution varying between advice sources.
- The moisture modelling method adopted by many SWI manufacturers may not be appropriate when applied to solid masonry walls, as it was developed for use on timber-framed buildings. Implications of this require further research.
- The Green Deal and ECO focus is targeting a dramatic increase in SWI installations, and insulation installers are concerned that there are not enough installers to meet this potential demand, and that there is a lack of specialist skills (needed for many properties where specialist solutions are required) and training. The Solid Wall Insulation Guarantee Agency (SWIGA) is in development, to help provide confidence in the market.
- Many of the technical issues raised in this report, particularly concerning the U-values of solid walls and effects of IWI on interstitial condensation, need to be addressed more fully before householders and landlords can have sufficient confidence of the appropriate solutions, savings and impacts of SWI.

1. INTRODUCTION

Current and previous UK energy efficiency policies have tended to focus on insulating lofts and cavity walls, but the potential for these relatively straightforward and cost-effective insulation measures is diminishing. Increasing attention is therefore being placed on the measures suitable to reduce energy consumption in hard-to-heat properties, and in particular, solid wall insulation (SWI). SWI will be a key measure targeted by the forthcoming Green Deal and Energy Company Obligation (ECO), and can have an important role in meeting climate change and fuel poverty targets. With almost a quarter of Scottish domestic properties having solid walls, the potential for SWI is great. However, significant confusion still exists on the best approach for insulating solid stone walls, the potential impacts of insulation on the walls themselves and the financial cost and savings.

Changeworks held a conference in April 2012, supported by Historic Scotland, to bring together 200 industry experts, academics and practitioners to discuss these issues. This report, funded by the Scottish Government, provides a summary of findings and lessons emerging from the conference, illustrating the current state of affairs concerning SWI. This is aimed at a wide audience and is intended to be a non-technical summary.

This report focuses on solid masonry walls, not hard-to-fill cavities or concrete walls. In reality, however, many of the solutions will be the same.

2. CONTEXT

2.1 Solid walls: the challenge

24% of domestic properties in Scotland have solid walls¹. These are geographically widespread and account for a wide range of properties, from tenement flats common in urban areas to stone cottages in more rural locations. Solid-walled properties in Scotland were mainly built between c.1550 to c.1920, and tend to be c.600mm thick and comprise lime- or clay-bonded stone². Although the façade of solid walls can differ (e.g. rubble, ashlar), the stone type and properties of these walls tend to be similar. The characteristics of solid walls are often quite different from modern constructions; they are less airtight and permeable, allowing air and moisture movement through the structure.

Currently, only 2% of homes with solid walls in the UK have SWI (and this figure is almost double that of 2008)³. The Scottish Household Condition Survey (2010)⁴ estimates this figure to be around 11% for non-cavity wall properties in Scotland (of which solid masonry walls form the majority), although it may be lower in reality. This means there are approximately 500,000 properties with uninsulated solid walls in Scotland⁵.

2.2 Drivers and motivations

SWI has a large role to play in reducing energy consumption in a large proportion of dwellings across Scotland. This will assist in meeting the Climate Change (Scotland) Act⁶, the Scottish Government's targets to reduce total energy consumption by 12% by 2020 and eradicate fuel poverty as far as is reasonably possible by 2016. In addition, social landlords have responsibilities to ensure housing meets minimum energy efficiency requirements (Scottish Housing Quality Standard), and are likely to increasingly explore SWI as most or all of their properties have been installed with loft and cavity wall insulation where applicable. Private landlords will also have to meet minimum energy efficiency standards from 2018, and from 2016 they will not be able to refuse 'reasonable' requests from their tenants for energy efficiency improvements where financial support is available⁷.

¹ Scottish House Condition Survey 2010 - <http://www.scotland.gov.uk/Publications/2011/11/23172215/0>

² Historic Scotland presentation (Curtis, R.)
<http://www.changeworks.org.uk/uploads/2%20How%20a%20solid%20wall%20masonry%20wall%20wor ks%20Roger%20Curtis.pdf>

³ <http://www.decc.gov.uk/assets/decc/11/stats/energy/energy-efficiency/4537-statistical-release-estimates-of-home-insulation-.pdf>

⁴ <http://www.scotland.gov.uk/Resource/Doc/363471/0123368.pdf>

⁵ The total number of properties is 2.36 million

⁶ This places a legally binding target of 80% reduction in greenhouse gases by 2050, from 1990 levels, and an interim reduction of 42% by 2020

⁷ Energy Act 2011: Private Rented Sector <http://www.decc.gov.uk/assets/decc/11/policy-legislation/energy%20act%202011/3219-energy-act-2011-private-rented-sector.pdf>

2.3 Green Deal and Energy Company Obligation (ECO)

The Green Deal is the UK Government's flagship energy efficiency policy to drive improvements in UK homes and will be introduced in autumn 2012. Through the Green Deal households will avoid paying upfront costs for installing energy efficiency measures, instead taking out a loan with repayments made through their electricity bills. The 'Golden Rule' of the policy states that these repayments cannot exceed fuel bill savings arising from the energy efficiency measure, meaning householders will be better off with the policy. As part of this policy, the Energy Company Obligation (ECO) will provide funding from energy suppliers in situations where measures are unlikely to meet the Golden Rule including low-income households and hard-to-treat housing. Under the carbon reduction target of ECO, SWI and hard-to-treat cavity wall insulation will be the key measures.

The Department of Energy and Climate Change (DECC) estimate that the Green Deal will lead to 1.8 – 2.2 million SWI installations across the UK by 2020⁸. If realised, this could mean approximately 18,000 – 23,000 SWI installations in Scotland every year between 2013 and 2020⁹. Within this, it is assumed that ECO will install SWI into 380,000 households by the end of March 2015 and 1.5 million by 2022¹⁰, meaning approximately 12,000 installations of SWI in Scotland each year between 2013 and 2015¹¹. Furthermore, the UK government is anticipating that many of these installations will be in the social housing sector and that all social housing with solid walls will have SWI installed by 2018¹². These are ambitious predictions, and represent dramatic increases from the current rate of installation.

⁸ Assumes the maximum feasible installations in 3.3 million DECC's Impact Assessment of the Green Deal <http://www.decc.gov.uk/assets/decc/legislation/energybill/1002-energy-bill-2011-ia-green-deal.pdf>

⁹ Assuming the installation rate in Scotland is equal to that of the total UK and the installation rate is split evenly over 8 years between 2013 and 2020

¹⁰ Green Deal consultation: <http://www.decc.gov.uk/assets/decc/11/consultation/green-deal/3607-green-deal-energy-company-ob-cons.pdf>

¹¹ Assuming uptake in Scotland is the same

¹² Consumer Focus (2011) Scaling the solid wall <http://www.consumerfocus.org.uk/publications/scaling-the-solid-wall>

3. IMPORTANCE OF SWI

SWI can make a significant impact on household energy consumption. For example, in an 'average' property, it is estimated to create savings of £445-475¹³ per year, which is 36-39% of the average domestic fuel bill in Scotland¹⁴. If realised¹⁵, these savings, combined with the advantages in thermal comfort, mean SWI can play a large role in tackling fuel poverty. It will also save on average 1.8 – 1.9 tonnes of CO₂ per property per year, helping to tackle climate change. Whilst the importance of SWI within this context is not disputed, this section addresses how SWI may not make the energy savings widely assumed due to solid walls being more thermally efficient than assumed and modelled, and how it must be viewed in a whole context of energy efficiency measures.

3.1 Thermal performance of SWI

Whilst solid walls are widely assumed to be less energy efficient than other types of walls, research presented at the conference by Dr Caroline Rye suggested otherwise¹⁶. This research project measured the U-values of 59 solid walls of mainly traditional construction (U-values are a measure of heat transfer – the lower the U-value, the lower the heat transfer and therefore the better the thermal insulation properties). This allowed the comparison of U-values used in modelling software (assumed values) and those measured in actual case studies (*in situ* U-values). In 73% of cases it was found that the U-value was over-estimated in the calculating software, indicating that solid walls lose less heat than is assumed. Similarly, another study measuring the *in situ* U-values of 67 walls (mainly uninsulated traditional solid stone walls) found that U-values produced by software tend to be higher than those found in reality¹⁷.

The difference in U-values is likely to be due to the uncertainties regarding the characteristics of solid walls such as the proportion of water content, thermal conductivity of different materials in the wall, proportion of different types of material in the wall¹⁸. Such characteristics can vary greatly between different stone walls and is difficult to measure (for example, stone walls may be made of many different materials so to estimate the proportion is difficult).

¹³ Based on 3 bed semi-detached house <http://www.energysavingtrust.org.uk/scotland/In-your-home/Roofs-floors-walls-and-windows/Solid-wall-insulation>

¹⁴ Average annual energy bill in Scotland in 2011 is £1,232 (£489 electricity and £743 is gas). Figures from DECC Quarterly Energy Prices March 2012 -

<http://www.decc.gov.uk/assets/decc/11/stats/publications/qep/4777-qep-mar12.pdf>

¹⁵ There is increasing evidence that predicted savings do not match reality. Factors such as inaccurate U-values, generic software predictions and the rebound effect all affect this. Many references for this are available, including Historic Scotland Technical Papers 8 and 16, available at

<http://conservation.historic-scotland.gov.uk/home/publications.htm>

¹⁶ Rye, C. (2011) The SPAB Research Report 1: U Value Report, accessed:

<http://www.spab.org.uk/downloads/The%20SPAB%20Research%20Report%201.%20U-value%20Report.%20Revised%20October%202011.pdf>

¹⁷ Historic Scotland Technical Paper 10: U-values and traditional buildings, Dr Paul Baker. Accessed at: http://www.historic-scotland.gov.uk/historic_scotland_technical_paper_16.pdf

¹⁸ SPAB presentation (Rye, C.) <http://www.changeworks.org.uk/uploads/3%20Solid%20wall%20U-values%20and%20interstitial%20condensation%20Caroline%20Rye.pdf>

Whilst this research may suggest that solid walls lose less heat than currently assumed, meaning insulation would create a lower energy saving than currently assumed; this does not negate the need to insulate solid walls. Rather, it suggests that the significance of SWI should not be over-estimated and that a wider understanding of the thermal performance of solid walls is needed. Solid walls may not perform as poorly as historic modelling would suggest but they still fall considerably short of new-build standards and in many cases require attention to make buildings more comfortable and affordable to run.

Such findings indicate that more *in situ* U-value testing of typical Scottish solid walls is required in order to inform energy modelling software and calculations. However, since calculating the U-values of all properties is obviously not possible, it perhaps also suggests that an approach to tackling solid walls needs to be taken that relies less on the exact U-values achieved from insulation.

3.2 Taking a holistic approach

SWI can make a significant difference to reducing energy consumption within a property. However, one lesson emerging from a number of speakers was the importance of not over-estimating the importance of solid wall insulation and of tackling energy use in a property holistically, looking at the whole rather than focusing too much on any one element. Different types of properties have different structures and therefore priorities differ. For instance, in a tenement flat, a high proportion of external wall surface comprises windows (often single glazed), and these have very poor U-values and lose considerable amounts of heat. In this situation, therefore, addressing heat loss through the windows may be equally or more important than installing SWI. Furthermore, given that the walls may retain more heat than previously assumed, this may further reiterate the importance of addressing heat loss through windows.

Some argue that addressing air tightness may be as or more important than insulating walls, since air leakage can be responsible for 40-50% of heat loss in a building¹⁹. Whilst the relatively basic energy modelling software RdSAP (used to produce Energy Performance Certificates and for forthcoming Green Deal Assessments) tends to focus on insulation of walls as a priority, other energy models, such as PhPP, which tends to prioritise roof insulation and air tightness²⁰.

¹⁹ Contact Chris Morgan (Locate Architects) for information on his presentation chris@locatearchitects.co.uk

²⁰ *Ibid* and <http://www.locatearchitects.co.uk/sustdunblane.htm>

4. SWI OPTIONS

4.1 Types of solid wall insulation

SWI is either applied to the exterior of the property (external wall insulation or EWI) or to the interior of the property (internal wall insulation or IWI). Hybrid versions, containing insulation for both interior and exterior, exist but these are less commonly applied at present – although many SWI installations in sensitive settings (e.g. conservation areas) have adopted IWI on front walls and EWI on rear walls where appearance is generally less important. For context, in 2008, there were about 25,000 - 35,000 SWI installations in the UK of which 60% were EWI²¹. The techniques for both types of insulation are outlined below.

a) External wall insulation (EWI)

EWI generally involves thick layers of insulation fixed onto exterior walls (usually with mechanical fixings). This is covered either with a render or cladding finish. Render is usually a thick sand and cement mix applied over a wire mesh, or a thinner, lighter cement over a strong fibre mesh²²; the finish is available in many colours and textures. Render can also contain insulating material; an increasing number of insulated render products are becoming available and may be more affordable. Otherwise, cladding is fixed to the exterior of the insulation; this can be a variety of products such as wood or brick slips. Render is generally less expensive than cladding, however the U-values tend to be higher meaning the insulation properties are not as good.



Before and after photos of a property with EWI. Source: Wetherby Building Systems Ltd

b) Internal wall insulation (IWI)

There are a number of options for IWI, with new approaches constantly being developed:

²¹ Solid Wall Insulation Supply Chain Review (2009) – Purple market research for the Energy Saving Trust http://s3.amazonaws.com/zanran_storage/www.eeph.org.uk/ContentPages/45617343.pdf

²² <http://www.energysavingtrust.org.uk/scotland/In-your-home/Roofs-floors-walls-and-windows/Solid-wall-insulation/Choosing-external-wall-insulation>

1. **Insulation boards** –plasterboards backed with insulation are fixed onto the internal walls, usually using adhesive. The boards are of varying depths, usually 60-100mm²³.
2. **Insulation fitted behind a stud wall** – a metal or wooden framework is attached to the wall and filled with insulation (such as mineral wool). Generic types may be around 120mm thick²⁴, although more slimline products are available that can be particularly useful where space and/or discretion are issues.
3. **Injected blown bead (or foam)** – injected behind lath and plaster. This is a relatively new technique for insulating solid walls but has a number of advantages: cheaper, no reduction in room size, less disruption to householder and interior, and uses less embodied energy²⁵. However, it has a lower U-value and is only applicable where lath and plaster exists.
4. **Flexible thermal lining (often known as ‘insulating wallpaper’)** – this is a relatively thin and flexible material which is fixed onto the wall like wallpaper. This is cheaper and easier to fix than more standard options but has a lower insulating quality.
5. **Internal render** – render can be directly applied onto the inside wall, although this is a relatively rare technique (see the case study in section 9.4). Other materials such as cellulose fibre may also be directly applied onto stone walls (although this goes against the views of some who feel an air gap should be left between the wall and the insulating layer).



Metal frame fitted onto wall with insulating plasterboard. Source: Historic Scotland presentation



Sempatamp (flexible thermal lining) being applied to walls and ceiling. Source: Mould Growth Consultants

4.2 Comparison of external and internal wall insulation

EWI is generally seen as the ‘safest’ option where it is applicable, as there are fewer potential problems associated with moisture and condensation. When IWI is installed, the exterior walls will remain cold as the insulation will block internal heating from

²³ <http://www.energysavingtrust.org.uk/scotland/In-your-home/Roofs-floors-walls-and-windows/Solid-wall-insulation/Choosing-internal-wall-insulation>

²⁴ *Ibid.*

²⁵ Contact Chris Morgan (Locate Architects) for information on his presentation chris@locatearchitects.co.uk

reaching them: this increases the potential for moisture build-up (from the exterior, i.e. rainfall) and retention and makes it harder for the wall to dry out, which could have damaging effects on the building structure and occupants' health (see section 5 for more detail). Dampness could in turn increase a wall's capacity to lose heat. However, the risks of such problems can be reduced by appropriate design.

On the other hand, the fact that walls where IWI has been applied are not heated means that heating will have a faster response rate, and should require less heating input to achieve the same air temperatures. Conversely, walls with EWI will heat up more slowly but will also retain heat for longer, as they will retain their thermal mass properties.

Other advantages of EWI include improvements in property appearance (where the original appearance is poor), weather-tightness and structural integrity²⁶. Unlike IWI, it can be applied without significant disruption to the occupants or the interior of the property (although it may disrupt items on outside of walls).

A main downfall of EWI is that it can only be applied to certain properties. Crucially, it cannot be installed onto any properties where the appearance of the exterior walls needs to be retained e.g. listed buildings, conservation areas etc. Many occupants of traditional stone buildings like their appearance and do not want to cover it up. EWI is generally also unsuitable in multi-occupancy buildings unless carried out on all properties in the building to create a uniform appearance and wall depth. In addition, it cannot be applied to properties with insufficient loads to take the weight of the insulation (this applies to many traditional buildings), or properties located in an exposed climate²⁷. There may also be issues in remote areas with transporting heavy construction materials and finding the right skills for installation.²⁸

EWI tends to be more expensive than IWI as there are substantial costs related with scaffolding (these can be reduced if it is carried out at same time as other work). In addition, items on the exterior wall (satellite dishes, guttering, etc.) will have to be moved or replaced, and EWI will reduce the amount of light coming in through windows as the window reveal is reduced.

The main advantages of IWI are that it is generally (but not always) less expensive, it can be applied on a room-by-room basis or just in certain rooms, and can be easier to install²⁹. It can improve the décor of the interiors, and is therefore best carried out when renovations occur. As mentioned above, a disadvantage of IWI is that heat does not reach the walls meaning that walls are then unheated, potentially leading to moisture build-up and increasing heat loss. It is also impossible to avoid cold bridging

²⁶ BCA Insulation presentation (Shaw, W.)

<http://www.changeworks.org.uk/uploads/8%20The%20installer's%20perspective%20Wilson%20Shaw.pdf>

²⁷ *Ibid.*

²⁸ *Ibid.*

²⁹ Building Life Consultancy presentation (Little, J.)

<http://www.changeworks.org.uk/uploads/4%20Moisture%20transfer%20in%20solid%20walls%20Joseph%20Little.pdf>

with IWI, as there will always be points on the wall (e.g. at floor junctions) where insulation is not present (see section 5.1).

One disadvantage of most types of IWI is that it reduces the size of rooms in which it is applied and causes considerable disruption to the householder as it is messy and furniture, fittings, skirting boards, plug sockets, etc. have to be moved. Slim-line products have been developed that are much thinner and therefore reduce this impact, but they are more expensive.

There may also be walls or wall areas in which it cannot be easily installed, for example, in kitchens and bathrooms where cabinets need to be removed from walls – if cabinets are not removed, this risks cold bridging and condensation. There may also be issues of accessing new services (e.g. electric wires) through insulation. In addition, it may not always be suited to listed buildings, and is disruptive to householders during the installation.

	External wall insulation	Internal wall insulation
Pros	<ul style="list-style-type: none"> • Lower risk of moisture build-up and condensation • Walls retain heat so lose heat less slowly • Enhance structural integrity of building • Less disruption to occupants/ no need for decanting • Can enhance exterior appearance 	<ul style="list-style-type: none"> • Can be cheaper, particularly if done on DIY basis • Can be applied room-by-room or just to certain rooms • Heating has faster response • Can improve interior décor of property • Fewer restrictions on where in what types of properties it can be applied (e.g. can be applied more easily in high-rise blocks, conservation areas)
Cons	<ul style="list-style-type: none"> • More expensive • Not applicable in many properties: buildings where it is desirable to retain original appearance, multi-occupancy properties • Restrictions on when work can be carried out (e.g. due to weather) • Require neighbour's agreement if joined properties. Can be particularly difficult in blocks of flats. 	<ul style="list-style-type: none"> • Potential problems with moisture build-up and condensation • Leads to cold bridging • Issues with accessing services • Loss of room size (unless injection method or slimline products used) • Complex cornicing or fittings can be an issue with fixings internally

Table 1: Summary of the advantages and disadvantages of EWI and IWI.

4.3 Materials for solid wall insulation

For many of the insulation techniques outlined above there are also a variety of insulation materials. The qualities important when selecting a material include: heat conductivity and penetration, costs, fire resistance, availability, acoustics and impact on the environment.

The most common insulation materials are mineral based (e.g. rockwool, glasswool) or plastic based (e.g. foams, polyisocyanurate (PIR), phenolic). Material specifications will include U-values (thermal performance) as well as a range of other specifications linked to the qualities above.



Hemp internal wall insulation. Source: Ecological Buildings Systems.

Some experts believe that using natural materials for SWI has strong advantages³⁰.

In particular, natural materials are vapour permeable, meaning they allow moisture to transfer through them. As old buildings with solid walls also share this characteristic, natural materials are more likely to be suitable as they allow the walls to continue to be vapour permeable, preventing or reducing moisture problems (see section 5). However, the vulnerability of a wall to moisture build-up will depend on a number of factors including the type of insulation used e.g. climatic factors, thickness of walls and so on (section 5.2). Therefore, the issue of breathability may not be such a problem in other types of construction.

Other benefits of natural materials are their environmental credentials: they tend to have lower embodied energy (i.e. the amount of energy used to create the materials), are recyclable, when sourced have a low environmental impact and can break down toxins in properties. When it is growing, hemp absorbs CO₂ from the atmosphere, which means using hemp insulation has a positive impact on tackling climate change.



Wood derived external wall insulation. Source: Ecological Buildings Systems

Types of natural materials include wood derivatives, cellulose, hemp, sheep wool, jute, mineral-based such as calciumsilicate. The latter type of insulation is the most expensive type of natural material but it can transfer a lot of moisture and is very resistant to mould. Whilst they have the lowest insulating quality of the above materials, they can be well suited to situations where condensation is an issue³¹.

Whilst natural materials are supported by many experts, they are more expensive than other

³⁰ Ecological Building Solutions presentation (Crosson, N.)

<http://www.changeworks.org.uk/uploads/6%20Natural%20materials%20Niall%20Crosson.pdf>

³¹ *Ibid.*

products. Mineral wools are by far the cheapest insulation materials and are widely available.

It is also important to recognise that more specialist products may be difficult to obtain in remote areas, limiting the options available to them. This could particularly affect many areas within the Highlands and Islands.

5. MOISTURE AND CONDENSATION

5.1 Risks of moisture and condensation due to SWI

Installing IWI may increase the risk of condensation and damp in walls, if not done using materials and methods appropriate to the property in question. Walls receive moisture both from inside the property (via everyday living) and externally (via precipitation). If walls are insulated internally, and especially when a Vapour Control Layer (VCL) (or vapour barrier) is used, this means that the wall will not dry off to the inside – only to the outside. In wet climates, this means the wall rarely or never dries out, especially in winter.

IWI traps heat inside the building, meaning that external walls receive less heat and can become cold, especially during the winter months. This means that any moisture trapped in them is less likely to evaporate, so moisture is likely to be retained except in the summer months, when heat from the sun may evaporate moisture. In the winter this moisture may freeze, causing associated issues. The vulnerability to walls and potential severity of this moisture-trapping problem depends on a number of factors specific to the individual property (section 5.2).

Furthermore, as the external walls remain cold, the margin between the wall temperature and dew point (the temperature needed to turn moisture vapour into liquid) is reduced. This means water vapour trapped in the wall, if it reaches dew point, will turn into liquid increasing the level of moisture in the walls. Moisture present deep in the wall (in comparison to moisture on or near the surfaces of walls) is known as *interstitial condensation* and can be a particularly difficult problem to eradicate. Research carried out for The Society for the Protection of Ancient Buildings (SPAB) has shown this situation to occur on a number of buildings, and suggests that application of IWI generally increases the risk of interstitial condensation³².

Thermal bridging

Another problem with IWI is thermal bridging (otherwise known as cold bridging) which occurs when insulation within a property is not continuous. When walls are insulated internally, the floor joists which fit into the walls remain uninsulated and therefore cold.

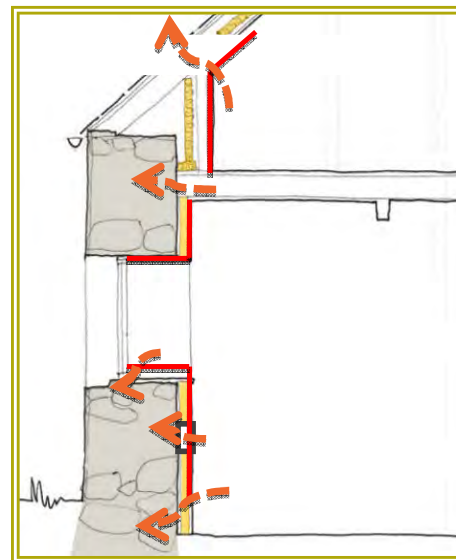


Figure 1: thermal bridging diagram Source: Locate Architects and Sustainable Uist

³² Rye, C. and Hubbard, D. (2011) The SPAB Building Performance Survey 2011 Interim Report <http://www.spab.org.uk/downloads/The%20SPAB%20Research%20Report%202011%20The%20SPAB%20Building%20Performance%20Survey%202011%20Interim%20Report%20October%202011.pdf>
Diagrams of interstitial condensation in case studies can be found: <http://www.archimetrics.co.uk/index.php/interstitial-gradients>

This cold component attracts heat from inside the property, leading to heat loss at a greater rate. Potentially this cold area also attracts moisture which can lead to rotting of joist ends and structural problems. Thermal bridging is also likely in bathrooms and kitchens if wall-mounted units are not removed, leaving the area behind uninsulated or where areas around cornicing are left uninsulated. Figure 1 shows the heat loss where there are gaps in the internal insulation applied. This type of thermal bridging can usually be avoided with EWI.

Problems with condensation

Condensation within a property can cause damp and mould growth which can have severe impacts on the occupants' health including respiratory illnesses. This can be exacerbated if the property is under-heated, for example, in a fuel-poor household. Secondly, moisture can have significant impacts on the building structure leading to loss of binder, thus reducing structural stability of the building. If joist ends are exposed to moisture (through thermal bridging), this increases vulnerability to structural problems. High moisture content in the walls can also increase the heat loss of the walls, meaning it does not achieve the predicted U-values.

Moisture and condensation problems may not be detected for a long time, by which stage there may be limited options. If they are very wet, walls will take a long time to dry out³³. Interstitial condensation can be particularly damaging, difficult to detect, and without appropriate design, difficult to eradicate. In comparison, exterior surface moisture will dry out during warm and sunny periods.

5.2 Factors affecting vulnerability to damp and condensation

Whether solid walls are vulnerable to moisture depends on a number of factors³⁴:

- **Exposure to driving rain** – the level of driving rain will determine the amount of external moisture the building is subject to. Figure 2 shows that Scotland has a higher exposure than areas in southeast England, and that western Scotland is particularly exposed. Since precipitation in Scotland is predicted to increase as a result of climate change, this issue will be further exacerbated in the future. In addition, the location and orientation of the building will affect this, for example, whether it is in a rural or urban location, in an exposed spot or sheltered.



Figure 2: Exposure zones in UK. Ref: BRE Report BR 262

³³ Building Life Consultancy presentation (Little, J.)
<http://www.changeworks.org.uk/uploads/4%20Moisture%20transfer%20in%20solid%20walls%20Joseph%20Little.pdf>

³⁴ *Ibid.*

- **Ability of wall to absorb moisture** – different types of wall, based on building materials, will absorb different amounts of moisture (known as the ‘A-value’).
- **Thickness of walls** - thinner walls will be penetrated by driving rain more quickly and will be affected more by moisture.
- **Moisture from inside the property** – this will depend on the number and behaviour of occupants, for example, the extent to which clothes are dried indoors.
- **Type of insulation** – the extent to which the insulation is permeable will affect the amount of moisture entering and leaving the wall. Hygroscopic materials (i.e. those which can absorb moisture) will present less of a problem. However, the suitability of insulation materials depends on the other factors listed here.

In his presentation, Joseph Little argued that the characteristics of the wall and the climate tend to be the most important factors in determining the risk of moisture problems³⁵. Therefore, choosing the type, thickness and material of the insulation should depend on the characteristics specific to that building.

Calculating moisture

Measuring the moisture content of solid walls is difficult and modelling software can be inaccurate. For example, some models use standard climatic information that is accurate only for London or assume (often incorrectly) that the greatest moisture load is from inside the house³⁶. Moisture moves through walls in more complex ways than is often assumed and understanding this, and the effect of insulation, is therefore argued by some to be more important than pursuing ever-higher U-values³⁷.

5.3 Reducing the risk of condensation and damp

It is important to keep walls dry but perspectives differ on the best approach to manage and reduce the risk of condensation in walls. Some approaches are:

1. **The use of breathable insulation materials** – allowing the wall to remain breathable³⁸ is believed by many traditional building experts to be better for solid stone walls, unlike modern buildings where moisture is prevented from entering the walls.
2. **The installation of a vapour barrier or VCL** – some experts will specify a vapour barrier behind insulation to ensure that moisture does not enter the wall. This is a contrasting approach from the above approach, and while it ensures moisture does not transfer through walls some believe that vapour barriers may prevent the ability of the wall to dry out (especially if moisture is

³⁵ *Ibid.*

³⁶ *Ibid.*

³⁷ SPAB presentation (Rye, C.) <http://www.changeworks.org.uk/uploads/3%20Solid%20wall%20U-values%20and%20interstitial%20condensation%20Caroline%20Rye.pdf>

³⁸ Ecological Building Solutions presentation (Crosson, N.) <http://www.changeworks.org.uk/uploads/6%20Natural%20materials%20Niall%20Crosson.pdf>

entering the wall from outside, as above). If a vapour barrier is used, it is essential that it is perfectly sealed – otherwise moisture may enter the wall and have difficulty escaping. Moisture can also become trapped during construction/installation of insulation if workmanship is poor. Adaptive vapour membranes are now available which, whilst vapour resistant, adapt to let moisture evaporate from behind the membrane³⁹. This is applicable only in certain circumstances and can be cost prohibitive.

3. **To use internal wall insulation cautiously** – some experts advise against the use of IWI due to the potential impact on moisture. However the suitability of IWI differs between situations (as outlined in 5.3). Joseph Little argued in his presentation that there will always be some condensation with IWI; whilst a carefully designed system will manage this moisture, a less well-specified design will lead to moisture problems. Therefore assessing the risk of such problems carefully and not over-insulating will reduce the problem connected with moisture and condensation.

Whilst the problems associated with moisture retention in walls due to SWI can be severe, it is important not to let inaccurate assumptions about risk prevent SWI being installed. Instead, what is needed (in situations where there is a reasonable risk of moisture build-up) is an assessment of the correct approach to take. Part of this approach is including safety margins in calculations⁴⁰, which might mean installing less insulation. More research specific to a Scottish climate and its impact on moisture in walls is needed. This will provide a better understanding of the risk associated with different approaches and in different locations.

³⁹ *Ibid.*
⁴⁰ *Ibid.*

6. Financial costs, savings and funding sources

6.1 Typical costs and factors affecting variation

Whilst a typical cost for SWI was stated at the SWI conference of £65/m²⁽⁴¹⁾, in reality, costs can vary from £15- £125 per m²⁽⁴²⁾ or even more. The Energy Saving Trust estimates that a typical installation cost of IWI will cost £5,500 - £8,500 whilst EWI would cost £9,400 - £13,000⁴³. However, the costs vary enormously depending on a number of factors. Therefore, estimating costs for SWI is much more complex than for other energy efficiency measures such as loft insulation.

Insulation material costs

Firstly, costs vary enormously between types of insulation and types of material used. The cost of materials can often vary by around 20%. For EWI, materials only account for 30-40% of the total install costs; this proportion is higher with IWI⁴⁴. Specialist products, such as the slimline or natural products will tend to be more expensive.

Table 2 provides installation costs for some types of insulation (per m²) from Historic Scotland pilot projects. These should provide an indication only and may not be fully representative of the typical costs a householder would pay. For example, blown bonded bead insulation is a specialist measure and may not be readily available in many areas, and therefore, more expensive in remote areas.

Type of insulation	Cost
Bead insulation blown behind lath & plaster (+ joinery + redecoration)	£14 / m ²
Aerogel blanket fastened to existing wall lining with steel mesh; plaster skim coat to finish (+ redecoration)	£60 / m ²
100mm Sylvactis wood fibre insulation board; plasterboard finish (+ redecoration)	£60 / m ²

Table 2: Installation costs of different insulation materials for pilot projects, supplied by Historic Scotland (excludes VAT)

⁴¹ EWI Ltd. presentation (Ogg, R.)

<http://www.changeworks.org.uk/uploads/10%20Costs%20and%20funding%20mechanisms%20Russell%20Ogg.pdf>

⁴² Changeworks presentation (Heath, N.)

<http://www.changeworks.org.uk/uploads/1%20Overview%20&%20Key%20Issues%20Nicholas%20Heath.pdf>

⁴³ <http://www.energysavingtrust.org.uk/scotland/In-your-home/Roofs-floors-walls-and-windows/Solid-wall-insulation>

⁴⁴ EWI Ltd. presentation (Ogg, R.)

<http://www.changeworks.org.uk/uploads/10%20Costs%20and%20funding%20mechanisms%20Russell%20Ogg.pdf>

Costs for different types of insulation, from a recent Sustainable Uist project report are shown in table 3. These represent costs for the full retrofit of walls and in a remote location. Note that the thermal performance of these products will vary.

Type of insulation	Cost
EWI – 63mm thick insulation	£158 / m ²
IWI – High performance Kingspan insulated plasterboard and framing (Includes removal of existing external wall linings, new skirtings and facings, decorations)	£150 / m ²
IWI – As above but 100mm mineral wool bats and plain plasterboard	£95 / m ²
IWI – As above but 100mm natural fibre insulation and non backed plasterboard	£118 / m ²
IWI – render on inner stone wall with lime render and 50mm Calsitherm block. (Includes removal of existing wall linings, clay-based emulsion paints, plumbing and electric)	£158 / m ²
IWI – Kingspan insulated plasterboard over new timber framing (Includes removal of and fitting of new skirtings and facings, decoration, plumbing and electric)	£120 / m ²

Table 3: Installation costs of different insulation materials based on averages over 3 house types (excludes VAT) ⁴⁵

Size of properties

Secondly, the size of property will determine the amount of insulation required and scale of the work. Table 4 shows some indicative figures, taken from DECC⁴⁶, for the costs of installations in different types of property which vary in size.

Property types	IWI	EWI
Detached house	£7,180	£12,494
Semi-detached / end of terrace	£5,407	£10,097
Mid-terrace house (multiple installations)	£2,997	£5,908
Flat (multiple installations)	£2,988	£5,899

Table 4: Installations costs for different property types

Additional costs

There are many other additional costs that will affect the cost of installation. For EWI, this may include the requirement for scaffolding, moving items such as sky dishes or

⁴⁵ Sustainable Uist, Uist HtT Housing Project 2011-12 final report

<http://www.sustainableuist.org/news/uist-htt-housing-report-published/>

⁴⁶ DECC Green Deal consultation: <http://www.decc.gov.uk/assets/decc/11/consultation/green-deal/3607-green-deal-energy-company-ob-cons.pdf>

hanging baskets, and re-siting downpipes and drainage. Additional costs for IWI may include the costs of de-canting tenants (moving out during installation), re-decoration and moving items such as sockets. 'Making good' costs can be particularly high for IWI - up to 50%⁴⁷. Planning permissions may add additional costs to either EWI or IWI. Finally, it is important to note that both IWI and EWI works can reveal underlying problems with the walls which have to be fixed before insulation work complete, adding additional costs⁴⁸. Installer costs can also vary depending on location. Therefore up-to-date and sufficiently in-depth survey data is crucial in terms of estimating costs⁴⁹.

Economies of scale

Lastly, costs will vary depending on whether it is a single installation, or a multiple installation, and the size of multiple installations (for example, if SWI installed by a Housing Association into several properties). This is illustrated in table 5 (although the costs are not very recent, they illustrate this point).

	Total costs	Average total cost
EWI – single property	£10,600 – 14,600	£12,600 (midpoint)
EWI – multiple properties under 100	£7,600 – 13,500	£10,000
EWI – multiple properties 100+	£6,300 – 10,000	£8,500
IWI – single property	£5,500 - 8,500	£7,000 (midpoint)
IWI – multiple properties	£3,900 – 8,500	£4,700
Flexible thermal lining (insulated wallpaper)	£2,500 - 3,900	£3,700

Table 5: SWI installation costs from 2008/9 (including material, installation & additional costs, excluding VAT)⁵⁰

DECC proposes that through mass installations as a result of the Green Deal, a market transformation of SWI will take place, reducing costs⁵¹. Whilst economies of scale will undoubtedly reduce the costs of some aspects of SWI, a recent report suggests that many of the high costs of SWI are fixed such as logistics, planning permission, scaffolding, unexpected works and making good⁵². This means costs may not reduce as much as predicted.

⁴⁷ Consumer Focus (2011) Scaling the solid wall <http://www.consumerfocus.org.uk/publications/scaling-the-solid-wall>

⁴⁸ *Ibid.*

⁴⁹ EWI Ltd. presentation (Ogg, R.) <http://www.changeworks.org.uk/uploads/10%20Costs%20and%20funding%20mechanisms%20Russell%20Ogg.pdf>

⁵⁰ Solid Wall Insulation Supply Chain Review (2009) – Purple market research for the Energy Saving Trust http://s3.amazonaws.com/zanran_storage/www.eeph.org.uk/ContentPages/45617343.pdf

⁵¹ DECC (2011) Green Deal and Energy Company Obligation: Consultation Document <http://www.decc.gov.uk/assets/decc/11/consultation/green-deal/3607-green-deal-energy-company-ob-cons.pdf>

⁵² Consumer Focus (2011) Scaling the solid wall <http://www.consumerfocus.org.uk/publications/scaling-the-solid-wall>

6.2 Typical savings from SWI

The Energy Saving Trust estimates that fuel bill savings attributable to SWI are on average £445/year for IWI and £475/year for EWI⁵³. These are average figures and are based on a gas-heated, semi-detached, three bedroom house. Savings will be higher in properties off-gas (as overall energy bills are higher in such properties). They will vary enormously between sizes of properties and behaviour of occupants (i.e. what temperature the property is heated to and for how long).

Changeworks' recent energy modelling has shown that IWI would create savings of approximately £130/year in a typical tenement flat in Edinburgh (gas central heating) and £577/year in a detached stone cottage (with coal and electric heating)⁵⁴. These are indicative figures only but show that savings vary greatly depending on size of property and fuel type.

6.3 Current and future funding

CERT and CESP

Current funding streams for SWI include CERT (Carbon Reduction Emissions Target) and CESP (Community Energy Saving Programme), both of which are due to finish at the end of 2012. CERT provides typically 10 – 20% of costs and is available UK-wide, although some focus is on the 'priority group'. CESP can cover up to 100% of costs but is only available in certain low-income areas of the UK⁵⁵.

Green Deal and ECO

The Green Deal and ECO are the UK Government flagship energy efficiency policies due to be introduced in autumn 2012. The Green Deal will enable households to pay back the initial costs of a measure through payments on their energy bills, negating a need to pay upfront costs for measures. Only measures meeting the 'Golden Rule', that energy bill savings exceed repayments, will be eligible. Within the Green Deal, households will be visited by a Green Deal Assessor who advises about potential prices and is provided with prices. Savings from measures cannot be guaranteed and will be dependent on behaviour of occupants. Household occupants which are judged to be low energy users will have to acknowledge in writing that they may not make the estimated energy savings as their baseline energy usage is lower.

The Energy Company Obligation (ECO) is a complementary policy to the Green Deal and will provide funding for some measures that do not meet the Golden Rule.

⁵³ <http://www.energysavingtrust.org.uk/scotland/In-your-home/Roofs-floors-walls-and-windows/Solid-wall-insulation>

⁵⁴ Historic Scotland Technical Paper 16 - http://www.historic-scotland.gov.uk/historic_scotland_technical_paper_16.pdf

⁵⁵ EWI Ltd. presentation (Ogg, R.) <http://www.changeworks.org.uk/uploads/10%20Costs%20and%20funding%20mechanisms%20Russell%20Ogg.pdf>

Funding for ECO measures is split into three strands: affordable warmth (loft and cavity wall in low income households), carbon reduction target and carbon saving communities. Under the carbon reduction target, SWI and non-standard cavity wall insulation will be the main measures funded. Other energy efficiency measures will only be funded (or part-funded) if installed alongside one of these measures. Furthermore, SWI must improve at least 50% of the exterior walls of the property and other measures must be installed within 6 months. Funding for SWI is also eligible under the carbon saving communities strand, which focuses on low income areas.

The UK Government expects that much of the carbon reduction target will be taken up by social housing providers who can install SWI on a large scale, reducing costs. In many cases, it is expected that households will be offered a combination of ECO subsidy and Green Deal finance to fund SWI.

Much detail is still to be announced about the Green Deal and ECO (at the time of writing the UK Government had recently published their response to the consultation). Importantly, announcements are still to be made on which materials and methods it will cover. For instance, it is not clear if it will cover relatively new techniques such as blown bonded beads.

Recent research by Changeworks⁵⁶ for Historic Scotland modelled SWI onto two property types: a tenement flat in Edinburgh and a rural stone cottage. This revealed that at an interest rate of 5% only the blown bead insulation met the golden rule; other types of internal wall insulation did not.

⁵⁶ Historic Scotland Technical Paper 16, Green Deal Financial Modelling (2012)
http://www.historic-scotland.gov.uk/historic_scotland_technical_paper_16.pdf

7. HOUSEHOLDERS' PERSPECTIVES

Installing SWI is dependent on demand and acceptability from householders, so making sure SWI is appealing to householders is a very important issue. Issues which may be of most concern to householders are:

- **Installation costs** – as outlined in previous chapters, the installation cost is large and remains a significant barrier to installation.
- **Disruption** – this is a major concern for households, in particular in relation to IWI. This may involve the need to decant (i.e. households to move out of the property for the installation period) or to move into certain rooms of the house (depending on the size of property and process). These issues will be affected by time of installation. A presentation from Castle Rock Edinvar Housing Association suggested that most tenants prefer not to move out of the property. Other issues may include the dust produced when removing liners.
- **Permanent changes to property** - the majority of techniques will involve some changes to the interior or exterior of the property. Changes to the interior may be of most concern e.g. changes in size of room if IWI installed, re-decoration required. Conversely, this may be a positive aspect of installing insulation if property requires re-decoration as may provide incentive to do so.
- **Lack of clear and impartial advice** – concerns were raised by conference delegates that there was insufficient advice on the best approaches for SWI and this could prevent households proceeding with installation.

Recent research into the experiences of eleven households in southwest England who have recently received SWI in their homes provided very positive responses (although it should be noted that the households received the insulation for free)⁵⁷. They noticed multiple benefits, including improved thermal comfort, and did not perceive disruption to be a major problem.

Similar findings were found in an interview with one Castle Rock Edinvar Housing Association tenant as part of this conference (the interview was recorded and is available on the Changeworks website)⁵⁸. The tenant was positive about the difference it had made to their thermal comfort and cited other benefits such as better sound proofing. The disruption was not too much of an issue as the tenant had been able to remain in the flat during the installation. However, the overall installation period was long and the installation required a lot of finishing.

⁵⁷ Centre for Sustainable Energy (2011) Evaluation of solid-wall insulation in fuel poor households in the private sector. Interim report for eaga Charitable Trust. <http://www.cse.org.uk/downloads/file/solid-wall-insulation-in-fuel-poor-households-in-the-private-sector.pdf>

⁵⁸ <http://www.changeworks.org.uk/projects/solid-wall-conference-downloads/642/>

A concern raised by many conference delegates was the potential lack of uptake for SWI through the Green Deal. A recent research report⁵⁹ found that social housing projects required significant time and costs to engage households with SWI installations. The delivery challenge was found to be even greater in private housing where uptake of SWI was low and a high dropout rate occurred where initially interested owners leave pilot programmes. Furthermore, householders and social or private landlords interested in installing SWI will face potential problems in multi-tenure blocks where permission from all tenants and owners must be sought.

⁵⁹ Consumer Focus (2011) Scaling the solid wall <http://www.consumerfocus.org.uk/publications/scaling-the-solid-wall>

8. INSTALLERS' NEEDS, QUALITY ASSURANCE AND SWIGA

8.1 Sufficient skills and installers for SWI

The conference raised a number of issues in terms of the lack of skills, knowledge and sufficient number of qualified installers to install SWI, especially given the ambitious number of installations predicted under the Green Deal. In particular, whilst EWI has a 30-year market, the IWI market is at an earlier stage, though fast emerging⁶⁰. Particular skills may be missing such as those to apply traditional wet finishes⁶¹. This issue is of particular concern in rural and remote areas where the range of installers is lower and specialists may be harder to find. Concerns were also raised at the conference about the constraints of RdSAP (energy modelling software used to generate Energy Performance Certificates), lack of construction knowledge in the training for DEAs (Domestic Energy Assessors) and the skills required in professionals aside from installers such as plumbers, electricians and planners. A recent research report has also highlighted that in many cases there is also a limited supply chain⁶². Such concerns indicate that there are many issues that need to be resolved before a radical increase of SWI can take place, particularly in terms of ensuring a high quality.

8.2 Quality assurance and SWIGA

When cavity wall insulation is installed by registered installers, the Cavity Insulation Guarantee Agency (CIGA) provides an independent 25 year guarantee protecting the householder from defects in materials or workmanship. Similarly, SWIGA (the Solid Wall Insulation Guarantee Agency) is developing guarantees for SWI. Some guarantees exist, particularly for EWI for which the market is well-developed. Of the existing guarantees, some are insurance backed and some are backed by workmanship. The SWIGA is developing guarantees further, including those for IWI. This is especially important given the expected increase in installations through the introduction of the Green Deal and ECO⁶³.

The guarantee is needed to provide confidence and reassurance to the householder and/or other stakeholders involved with SWI. This is particularly important given the rapid expansion of the SWI market. SWIGA will develop: a technical framework, surveillance scheme, training plan, guarantee scheme, pilots and trials, and promotion. The guarantee scheme will mean that approved installers will carry out a

⁶⁰ Kingspan presentation (Swift, M.) <http://www.changeworks.org.uk/uploads/5%20Materials%20for%20solid%20wall%20insulation%20Mark%20Swift%20Tony%20Millichap.pdf>

⁶¹ BCA Insulation presentation (Shaw, W.) <http://www.changeworks.org.uk/uploads/8%20The%20installer's%20perspective%20Wilson%20Shaw.pdf>

⁶² Consumer Focus (2011) Scaling the solid wall <http://www.consumerfocus.org.uk/publications/scaling-the-solid-wall>

⁶³ SWIGA presentation (Weaver, M.) <http://www.changeworks.org.uk/uploads/9%20Solid%20wall%20insulation%20guarantees%20Mark%20Weaver.pdf>

pre-installation assessment of the property, carry out the installation in accordance with requirements and provide the customer with a guarantee. Post-installation most problems will be resolved by the installer in line with a set of standards, or otherwise dealt with by SWIGA. The guarantee will be aligned with the Green Deal framework, although it will not need to be fixed to the Green Deal agreement in terms of its length⁶⁴.

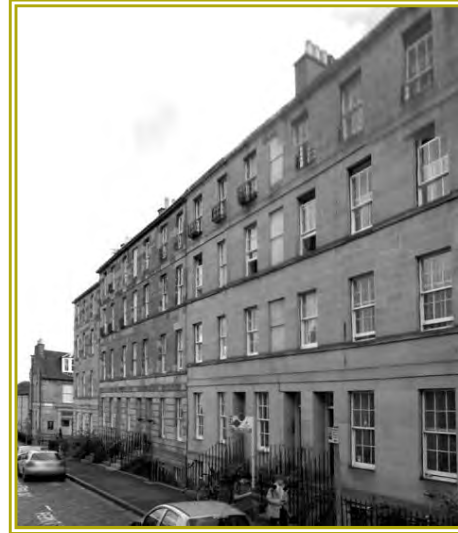
⁶⁴ SWIGA presentation (Weaver, M.)
<http://www.changeworks.org.uk/uploads/9%20Solid%20wall%20insulation%20guarantees%20Mark%20Weaver.pdf>

9. CASE STUDIES

The SWI case studies presented at the conference are outlined in this section.

9.1 Blown-bead insulation in an Edinburgh tenement flat

Castle Rock Edinvar Housing Association has undertaken pilot installations of internal wall insulation in some of their Edinburgh tenements⁶⁵. As the pilot project included properties in a conservation area and a listed building, retaining the character and appearance of the properties was essential. This consisted of blown bonded bead insulation between the stonework and lath and plaster, double glazed secondary glazing timber units, rigid insulation behind the shutters and reinstatement of shutters to working order on completion. (A video illustrating this is available on the Changeworks website⁶⁶).



Case study tenement flat in Edinburgh
Source: Castle Rock Edinvar

Properties before intervention were a 'C' EPC rating of 65; it is estimated that the renovation increased this by 6 points and Castle Rock Edinvar are monitoring the energy bills of tenants to determine the fuel bill saving. Additional benefits include the reduced noise levels in the flats.

The process was achieved without the need to de-cant tenants as it was carried out room-by-room, and the housing association realises that this is the preference of most tenants. Tenants were generally very satisfied with the installation (an interview with one of the tenants is available on the Changeworks website⁶⁷). Castle Rock Edinvar is now installing the system into 14 more of their tenement properties.

9.2 Historic Scotland internal wall insulation trials

Historic Scotland presented the results from several IWI insulation trials at the conference⁶⁸. These are:

- Tenement in Glasgow (blown bonded bead insulation behind lath and plaster)
- Tenement in Edinburgh (aerogel insulation 'blanket' behind mesh)

⁶⁵ Castle Rock Edinvar presentation (Thomson, C.)
<http://www.changeworks.org.uk/uploads/7%20The%20householder's%20perspective%20Chris%20Thomson.pdf>

⁶⁶ <http://www.changeworks.org.uk/projects/solid-wall-conference-downloads/647/>

⁶⁷ *Ibid.*

⁶⁸ Historic Scotland presentation (Curtis, R.)
<http://www.changeworks.org.uk/uploads/11%20Internal%20wall%20insulation%20trials%20in%20traditional%20buildings%20%20Roger%20Curtis.pdf>

- Cottage in Cumnock (wood fibre insulation bats finished with clay board)
- HS property in Edinburgh (cellulose fibre blown behind lath and plaster)
- NTS property in Cupar (calcium silicate board applied directly onto plaster)
- Colbeck place, Rothesay (aerogel insulation plastered and painted)



Tenement flat in Glasgow involved in IWI trial. Source: Historic Scotland presentation



Cellulose fibre blown onto wall. Source: Historic Scotland presentation

Historic Scotland is testing these methods to ensure they respect the fabric, improve thermal performance, are applicable to different house types and therefore widely applicable. In this respect, they must also be affordable. Historic Scotland has had promising results and is continuing to test out new approaches.

Summary documents of Historic Scotland's trials can be found at <http://www.historic-scotland.gov.uk/index/heritage/technicalconservation/conservation-research.htm> and further information about technical conservation is <http://conservation.historic-scotland.gov.uk/home.htm>.

9.3 Sustainable Uist: renovation of a stone cottage

Chris Morgan from Locate Architects presented the results of a renovation of a stone cottage on the Isle of Uist⁶⁹. The cottage was split into two equal rooms: one was fitted with IWI (Kingspan 150mm phenolic insulation boards and plasterboard) and the other (carried out by Locate Architects) had lime plaster applied to the internal wall, careful airtightness detailing, but no insulation. Both sides had the same floor insulation installed, insulated ceilings and upgraded windows. The property was not occupied.



Stone cottage on Uist trial. Source: Locate Architects

⁶⁹ Contact Chris Morgan (Locate Architects) for information on his presentation chris@locatearchitects.co.uk

Some of the conclusions from this pilot were:

- Reducing air leakage does make a difference, though not as much as anticipated and does not outweigh insulation;
- The best solution appeared to be a conventional approach (i.e. insulating walls) with added focus on air-tightness. However, this is an expensive solution.

9.4 Comparison of dry-lining and internal render insulation on a slate cottage

The Centre for Alternative Technology (CAT) undertook a pilot study on a solid slate cottage on their site⁷⁰. They applied an internal hemp-lime insulating render onto the cottage, with a control section of the wall renovated using the conventional dry-lining technique using mineral wool, allowing a comparison of the methods. The heat flux, temperature and relative humidity were measured in the renovations (as well as the internal and external relative humidity and temperature). Findings from the research are outlined in a recent article⁷¹.



Hemp lime render on the slate cottage.
Source: Centre for Alternative Technology



Wooden battens for internal wall insulation.
Source: Centre for Alternative Technology

The pilot study indicated that:

- Dry-lining caused moisture to accumulate in the wall causing potential problems;
- The hemp render dries out the external wall due to its properties (breathable and hygroscopic) potentially reducing risk of rot and mould;
- The dry-lining had a better U-value than predicted (by 22%) (most likely because an underestimation of the U-value of the slate wall in combination with a small thermal mass effect);
- The U-value of the hemp was worse than anticipated, but there were extenuating circumstances meaning it took a long time to completely dry out (> 2 years). However, the surface was dry leaving a functional wall within 2-4

⁷⁰ CAT presentation (Miskin, N.)

<http://www.changeworks.org.uk/uploads/14%20Comparison%20of%20dry-lining%20and%20internal%20render%20insulation%20Naomi%20Miskin.pdf>

⁷¹ Wright, M., Miskin, N., Flower, A. and Rhydwen, R. (2011) Dry-lining versus a hemp and lime insulating render for internal thermal renovation of a stone cottage in West Wales, including embodied energy assessment, interstitial wall monitoring, In-situ U-Value and WUFI modeling
http://gse.cat.org.uk/images/hemp/retrofit_paper.pdf

weeks and in other buildings the same thickness has been shown to have dried completely in 6 months- 1 year. It could have been applied less thickly, which would accelerate drying but result in a higher u-value.

Furthermore, hemp has a number of environmental benefits. The growth of hemp absorbs CO₂ meaning that it has a positive effect on reducing climate change, and it encourages a greater biodiversity, unlike many other crops. It also has a low embodied energy (the amount of energy required to create it). This is contrary to the manufacture of many building materials which require a high energy input and create harmful waste.

9.1 Energy Action Westray, a community-based scheme

Energy Action Westray is a community group in Westray, Orkney, focusing on tackling climate change and energy use on the island⁷². The group has carried out energy audits on almost half of the properties on the island, and enabled multiple installations of heat pumps, loft insulation and solid wall insulation, as well as a community owned wind turbine.



Cottage on Westray. Source: Energy Action Westray

The group recently managed the installation of IWI into 13 houses. It was decided to use IWI since there were uncertainties as to whether EWI would be suitable in the exposed climate with high wind speeds and driving rain. IWI was also cheaper.

The product was chosen as they could purchase this directly from installers and delivered in one shipment (using 70mm ecotherm PIR). Buying the product in bulk reduced purchasing costs and transportation costs. Costs were reduced further by employing one person to install all the insulation (who moved to the island for the duration of the project). These factors reduced costs of installing insulation to around £65/m².

The Energy Saving Trust has installed data loggers onto houses in order to calculate U-values. These are still to be determined although it appears that the level of ventilation behind the insulation may affect the U-values.

Lessons Energy Action Westray derive from their projects are to not underestimate the time and management resources for such a project. The complexity of funding

⁷² Energy Action Westray presentation (Risbridger, C.)
<http://www.changeworks.org.uk/uploads/13%20Community-based%20wall%20insulation%20project.%20Westray.%20Orkney%20Colin%20Risbridger.pdf>

schemes created confusion and it was important to have one trusted common point within the community. Multiple visits to households were also required.

10. SUMMARY

A number of conclusions and recommendations arose from the conference:

- Solid walls perform thermally better than currently assumed as measured in-situ U-values are often better than those used in energy modelling (e.g. SAP). This means that SWI may create lower energy savings than assumed and this has implications for the Green Deal and associated financial benefits. More research is needed to determine typical in-situ U-values of Scottish masonry solid walls.
- SWI has an important role in reducing carbon emissions and fuel poverty. However, SWI should be taken in the context of the entire building and may not always be the highest-priority measure. For example, a tenement flat has a larger proportion of external envelope as windows not walls, in which case, installing secondary or double glazing may be more effective than installing SWI. However, under ECO proposals, subsidies for hard-to-treat properties will only be available for SWI or a package of measures including SWI.
- EWI is technically easier and creates fewer problems than IWI and there is general consensus that this is the lowest-risk approach where applicable. However, IWI must be explored in cases where it is not possible e.g. where exterior walls cannot be covered, in multi-tenure buildings, listed buildings, and where the building has insufficient load capacity.
- There is a large array of options for solid walls with a number of different techniques for both IWI and EWI, and different materials. Those interested in installing SWI lack clear guidance and impartial advice on which approach suits which property type best, and a clear understanding of the associated costs, benefits and risks. This is exacerbated by the gap between 'mainstream' advice and commercial products, and approaches advocated by others (e.g. conservation bodies, academia) and highlighted by Changeworks' conference.
- Moisture transfer and condensation in walls due to SWI are major concerns but there is still an ongoing debate as to the importance of these issues and how to overcome them. There is a lack of data and consensus, which could lead either to a) demand for SWI not increasing due to concerns over the potential impact of SWI or b) SWI causing damage to properties as a result of poorly specified or installed SWI. More research is needed into the impact of SWI in increasing risk of moisture and condensation, and how this differs with different types of insulation, property construction and location. This will prevent such situations arising. Such concerns are of prime importance in Scotland where the wet and windy climate worsens damp problems.
- Although widely used, the moisture modelling method adopted by many SWI manufacturers may not be appropriate when applied to solid masonry walls, as

it was developed for use on timber-framed buildings. Implications of this require further research.

- Natural materials could reduce moisture problems and are more environmentally-friendly to produce. However, costs and availability hinder uptake.
- The wide range of SWI types and materials, combined with concerns over moisture, indicate that a bespoke design is often needed to address issues for specific properties⁷³.
- The scale of expected uptake of SWI in the UK and Scotland due to the Green Deal is huge. There are concerns that there are insufficient numbers of installers and training programmes to meet such a demand, as well as a lack of knowledge in other professions such as electricians, that could affect the future quality of installations. This is a particular problem in remote parts of Scotland where the number and range of contractors is inherently limited. Such issues need to be addressed before the Green Deal can take place on a large scale in Scotland.
- Cost is a major barrier to SWI. More information is needed on exact costs, and the support available from Green Deal/ECO.
- Other barriers for households proceeding with SWI include the lack of impartial advice, permissions needed from multiple tenants and owners in multi-tenure blocks, disruption during installation (e.g. needing to move out) and other changes required to property (e.g. reduction in room size).
- Such barriers, and recent research, suggest that householder demand for SWI through the Green Deal or ECO will initially be difficult and costly to promote.

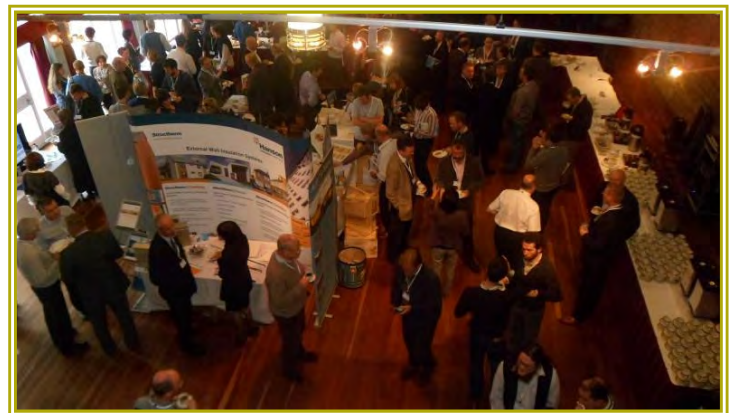
⁷³ This was also a conclusion found in Consumer Focus (2011) Scaling the solid wall <http://www.consumerfocus.org.uk/publications/scaling-the-solid-wall>

Appendix A: Conference Details

Solid Wall Insulation Conference, April 2012

The aim of the conference was to explore barriers, solutions and new approaches to insulating Scottish solid masonry walls. Ahead of the forthcoming Green Deal and Energy Company Obligation (ECO), which will drive an increase in the number of SWI installations, the conference would explore the different ways of insulating walls. Bringing together experts, researchers and practitioners, the conference aimed to discuss key issues with differing views relating to SWI including such as breathability and moisture movement in walls, and thermal performance.

200 delegates attended the conference including architects, local authorities, housing associations, energy consultants, community group, householders, installers, academics, building surveyors and government bodies.



The list of conference presentations and exhibitors are listed on the next page.

Feedback from conference delegates was very positive, as highlighted by the following comments:

- *“Congratulations to Changeworks on putting together one of the most interesting, informative, well organised and well attended events I have ever been to!”*
- *“Very interesting and thought provoking conference”*
- *“I thoroughly enjoyed the event and came away much the wiser!”*
- *“Excellent event in all respects”*
- *“Overall a good conference; an interesting area which requires greater research/understanding”*
- *“Don’t know how you managed to get so many well-educated presenters”*
- *“Excellent topics, very well structured, good range of speakers – excellent and helpful conference overall”*

Conference presentations

Presentation Title	Name & Organisation
Overview & key issues	Nicholas Heath, Changeworks
How a solid masonry wall works	Roger Curtis, Historic Scotland
Solid walls U-values and interstitial condensation	Caroline Rye, SPAB
Moisture transfer in solid walls	Joseph Little, Building Life Consultancy
Materials for solid wall insulation	Mark Swift, Kingspan
Natural materials	Niall Crosson, Ecological Buildings Systems
The householder's perspective	Chris Thomson, Castlerock Edinvar Housing Association
The installer's perspective	Wilson Shaw, BCA Insulation
Solid wall insulation guarantees	Mark Weaver, SWIGA
Costs and funding mechanisms	Russell Ogg, EWI Ltd.
Internal wall insulation trials in traditional buildings	Roger Curtis, Historic Scotland
Internal wall insulation vs. draughtproofing trials, South Uist	Chris Morgan, Locate Architects
Community-based wall insulation project, Westray	Colin Risbridger, Energy Action Westray
Comparison of dry-lining and internal render insulation	Naomi Miskin, CAT/On Site Generation

All presentations are available to download from Changeworks' website at:
<http://www.changeworks.org.uk/projects/solid-wall-conference-downloads/647/>

Conference exhibitors

BCA Insulation Ltd.

ECL Contracts (a British Gas company)

Eden Lime Mortar Ltd.

GTi

Lawtech Ltd.

Saint-Gobain Weber Ltd.

Structherm Ltd.

The A Proctor Group Ltd

Thermal Shield (in association with Sustainability Treatments Ltd and Adam Dudley Architects Ltd)

Ty Mawr

Vynylit Fassaden GmbH

Warmfill Ltd.

Information on all of the exhibitors is available on the Changeworks' website:
<http://www.changeworks.org.uk/projects/solid-wall-conference-exhibitors/649/>

Appendix B: Further Reading

- BRE Report BR262 (2002) Thermal insulation: avoiding risks
<http://www.brebookshop.com/details.jsp?id=556>
- Centre for Alternative Technology (CAT) hemp research project
<http://gse.cat.org.uk/hemp-building-research>
- Centre for Sustainable Energy (2011) Evaluation of solid-wall insulation in fuel poor households in the private sector. Interim report for eega Charitable Trust.
<http://www.cse.org.uk/downloads/file/solid-wall-insulation-in-fuel-poor-households-in-the-private-sector.pdf>
- Consumer Focus (2011) Scaling the solid wall
<http://www.consumerfocus.org.uk/publications/scaling-the-solid-wall>
- Energy Saving Trust website <http://www.energysavingtrust.org.uk/scotland/In-your-home/Roofs-floors-walls-and-windows/Solid-wall-insulation>
- Historic Scotland Technical Conservation <http://conservation.historic-scotland.gov.uk/home.htm>
- Historic Scotland Technical Papers <http://conservation.historic-scotland.gov.uk/home/publications.htm>
 - Technical Paper 10: U-values and traditional buildings, Dr Paul Baker
 - Technical Paper 15: Assessing insulation retrofits with hygrothermal simulations – Heat and moisture transfer in insulated solid stone walls [to be published shortly]
 - Technical Paper 16: Green Deal Financial Modelling of a Traditional Cottage and Tenement Flat, Changeworks
- Locate Architects and Sustainable Dunblane: ‘Improving energy efficiency in ‘Hard to Treat’ houses (2011)
<http://www.locatearchitects.co.uk/download/SDReportfinal.pdf>
- Morgan, C. (2008) Breathing Buildings
<http://www.locatearchitects.co.uk/download/moisture-in-buildings.pdf>
- Purple Market Research (2009) Solid Wall Insulation Supply Chain Review, a report for the Energy Saving Trust
http://s3.amazonaws.com/zanran_storage/www.eeph.org.uk/ContentPages/45617343.pdf
- Rye, C. (2011) The SPAB Research Report 1: U Value Report
<http://www.spab.org.uk/downloads/The%20SPAB%20Research%20Report%201.%20U-value%20Report.%20Revised%20October%202011.pdf>
- Rye, C. and Hubbard, D. (2011) The SPAB Building Performance Survey 2011 Interim Report
<http://www.spab.org.uk/downloads/The%20SPAB%20Research%20Report%202.%20The%20SPAB%20Building%20Performance%20Survey%202011%20Interim%20Report.%20October%202011.pdf>

- Sustainable Uist (2012) Uist HtT Housing Report Part 1 and Part 2
<http://www.sustainableuist.org/news/uist-htt-housing-report-published/>