External Wall Insulation & Its Use In Retrofit

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Nicholas Heath
Director, NDM Heath Ltd
Technical Director, STBA
‘All you need is someone standing in front of the building with a brain’
(Colin King, Director, BRE Wales)
‘As it happens, the majority of detailing that may be deemed visually unappealing is also likely to introduce an enhanced risk of thermal bridging and subsequently more physical problems’
‘For EWI in traditional buildings, there is a clear – and considerable – gap between recommended best practice and actual application. This gap relates not only to finer details but also to many of the fundamental principles’
SURVEY & MAINTENANCE
‘Survey and preparation of the building is key to obtaining a successful specification and finished installation. If this is done incorrectly the success of the EWI system and/or the existing fabric will be at risk’
MOISTURE
‘Moisture movement in buildings is highly complex’
'In some cases due to alterations, modernisation and poor maintenance the building fabric may be **at the limits** of its capacity to handle water vapour or rain ingress…'
‘There is a limited knowledge of how moisture moves in and out of solid wall construction, and in particular what happens to moisture movement when insulation is added and natural ventilation is reduced ...’
‘The use of EWI...can be made more difficult by the fact that some product assessment methods can imply that there is little or no risk of moisture accumulation’
VENTILATION & AIR QUALITY
‘The drive to reduce energy costs, by creating homes with tighter ventilation, could be making the situation worse’
‘Thought and care is required on any building ventilation strategy. One size does not fit all! Systems should be responsive to individual buildings. Ventilation strategies are never clear cut’
‘The risks of inadequate ventilation and its impacts need to be considered and understood by all involved’
‘Despite all efforts made in its provision, ventilation is still one of the most difficult aspects to safeguard in use’
HOLISTIC APPROACH
‘Insulating solid walls should only be done as part of a whole-house retrofit process – not as a single, isolated measure (unless other measures have previously been taken’
‘It’s alright – but if I want to replace my windows I’m f**ked, aren’t I?’
COVERAGE
‘Thermal bridges ... allow a heat flow entirely disproportionate to their surface area resulting in excessive heat losses’
‘Thermal bridges...can undermine the overall effectiveness of the EWI, ... lead to internal condensation on the walls and ceilings and thus damp and mould growth, which poses a health risk to occupants’
‘Current industry practice does little or nothing to minimise the effects of thermal bridging or inconsistency in thermal envelope performance when installing insulation in solid wall dwellings’
Gas Boxes

Best practice would be to move the gas box and re-fix on a timber ground to the thickness of the new EWI system, however timescales do not always allow this.

No current regulations exist with regards to the acceptable dimensions for existing gas boxes, however there should be a review on the type of gas box existing on site.

Many gas boxes are required to be removed, so that access to the regulator valve can be provided. Access to the regulator valve using a stub screw driver or spanner can be achieved in a dimension of 50-60mm. The valve is generally lower than the box cover therefore a dimension of 50mm should be sufficient to access.

An assessment of the box and position of the regulator valve should be undertaken, and the dimension checked to ensure access can be provided.

There may be occasions where the existing gas box can be accessed and maintained from the front access panel. Therefore the system can be taken tight to the box.

Proprietary box surrounds are available and these should be used where possible.

Note: *It is the responsibility of the client / main contractor to advise which detail is acceptable for each specific project.*
The detail where no head reveal insulation is provided is not ideal, and will cause localised cold bridging, however it is recognised that in certain circumstances it can not be avoided. Development of proprietary insulated reveal trims should be considered.

Detail 15 - Head detail where existing frames are retained, however there is insufficient frame margin for cold bridge insulation

Note:
A cold bridge will occur
Detail 22 - Detail where existing flush fascia retained and existing gutter and rainwater down pipe are retained.
QUALITY & DETAILING
‘The Achilles heel of any installation can be the attention to bespoke details and appropriate consultation…’

(INCA Contractor Member)
‘Retrofitting EWI is not without its challenges, for example, adaptation is likely to be required at roof verges and eaves, services inlets and outlets, and window and door reveals’
Special gutter detail between main roof and secondary roof including new flashing

New gutter likely to project over existing window-reveal

Fence post on boundary line

Improved ventilation beneath ground floor

Added wall depth projects over existing inspection chamber

New SWP outlet to existing drain

Awkward junction with parapet party wall

Protruding downpipe has to be tied back to existing masonry wall

Raised sill to allow for built-up floor and kitchen units below
UNDERSTANDING
Where SWI is appropriate, well planned, well designed and well implemented in a joined-up process, with good communication between everyone involved in the project, it can be a very beneficial and positive measure that considerably enhances a property’
‘Where SWI is appropriate, well planned, well designed and well implemented in a joined-up process, with good communication between everyone involved in the project, it can be a very beneficial and positive measure that considerably enhances a property’
‘Advice and education will be critical in changing the way mass-scale EWI projects are undertaken’
A Bristolian’s guide to
Solid Wall Insulation

A guide to the responsible retrofit of traditional homes in Bristol

https://warmupbristol.co.uk/content/planning-guidance-your-home
3.3 Understanding retrofit: principles for insulating traditional homes

Once you’ve established the characteristics of your home, you can start thinking about how best to retrofit it.

Before you start choosing improvement measures, however, there are a number of key principles that you need to take on board. Rather than providing detail on specific measures, these are holistic ‘rules’ that apply to every traditional building retrofit – so they are things you should think about regardless of the improvement measures you have in mind:

1. **A whole-house approach is essential.** This is perhaps the most important principle of traditional building retrofit. Measures should not be selected or installed on a one-off basis, but as part of an approach that considers the whole building (fabric and services), and the impacts of one measure on other aspects of the building. It should also be noted that this approach isn’t just for the building, but also extends to the people using the building, and its setting (i.e. neighbouring houses and environmental context). Of course, you may not be able to afford to treat your whole house at once, but it could be staged over time, and as a minimum it will help reduce risks if you understand the principles of the whole-house approach.

2. **A joined-up process is essential.** This is the second guiding principle of responsible retrofit. It means ensuring good communication between all parties, in particular Assessors, Designers, Installers and Home Owners. Good communication means that each should understand the overall aims of the project and work together to achieve these. If problems or unexpected issues arise (for example, discovering rotten timbers when insulating the building or having to deal with bad weather delays), then it is important that any changes to the project are discussed with all relevant parties, and new measures agreed. Just as important is feedback after the project as to what worked, what was difficult or expensive, and what
didn’t work. Feedback from householders, particularly after living in the retrofit for some time, is especially useful and important. Again if there are problems then these can be addressed at this stage. A project is not ‘finished’ until at least a couple of years after physical completion: ‘finished’ means that things are all working well and any snags or misunderstandings have been resolved safely and satisfactorily.
4.2 When should you consider insulating your walls?

If you’ve read this guide from page 1, you should have gone through a fair amount of questioning by now, about you, your home and the retrofit measures available to you. If you’ve done this, your answers should give you a reasonable indication of whether SWI is something you should be thinking about – either now or in the future.

SWI is something you can be thinking about if you can answer ‘yes’ to the following questions. Do you know:

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<tr>
<th>Why you want to retrofit your home?</th>
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<tr>
<td>What your key goals are?</td>
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<tr>
<td>How your house was built, and how it’s changed over time?</td>
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<td>How efficient your house is now and how it ‘behaves’?</td>
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<tr>
<td>Where the weak areas and problems are?</td>
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<td>What maintenance needs to be done?</td>
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<td>Your house type, conservation status and local conditions?</td>
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<td>The principles for the responsible retrofit of traditional buildings?</td>
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<td>About the balance between insulation, ventilation and airtightness?</td>
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<tr>
<td>What measures are likely to be best for your lifestyle?</td>
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<tr>
<td>What other measures you should be installing before / as well as SWI?</td>
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<tr>
<td>What your budget is, and whether you need to stage works?</td>
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<td>Your tolerance levels to disruption?</td>
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Having gone through all of the above, you can now go into more detail on SWI. You’ll need to know whether it will be permitted on your home, what consents and fees you’re likely to need, and the technical details of EWI and IWI. All of this is covered in more detail in the rest of this guide and the online SWI tool.
# 6.0 Solid wall insulation: When, where and how

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6.2 When is solid wall insulation NOT appropriate?

There are some situations where SWI is not appropriate for a traditionally-built house, either internally or externally. The situations can broadly be divided into a) aesthetic / cultural considerations (sometimes described as 'heritage' considerations) and b) technical considerations. These are outlined below:

AESTHETIC / CULTURAL BARRIERS:
- Heritage or historic features on both the inside and outside of external walls that cannot be sensitively addressed through design when SWI is applied – outside features may include bay windows, decorative window and door surrounds, ornate brick/stone work, or overall appearance, while inside features might include historic cornicing, wood panelling, paintwork, stone mullions and so on. Even if these features are only present on both sides of some of the external walls, and there are other walls that could be insulated, following the whole-house approach means that partial SWI is not recommended (unless a specialist analysis can confirm that this would improve thermal performance without creating other risks).
- Buildings with a listed status of Grade I or II* (this may extend to some Grade II listed buildings as well)

TECHNICAL BARRIERS:
- Complex building shapes that make coherent coverage of SWI (either internally or externally) impossible or very difficult
- Buildings in poor or fragile condition, where significant repairs or strengthening are required prior to any application of SWI
- Buildings where there is excessive dampness – repairs, lowering of external ground levels, installation of rainwater goods and drainage, and other measures may be required, and buildings should then be allowed to dry before SWI is considered

It should also be said that where there are only small amounts of external wall (and large amounts of windows) SWI is often not appropriate for reasons of high cost and low energy benefit.

These issues are all raised in the online tool www.warmupbristol.co.uk, which can help you decide whether or not SWI is appropriate for your building.

Building defects affecting SWI

Where there are major problems with these issues, they should be resolved and the building repaired and allowed to dry out before going ahead with SWI. Where the issues are minor they can sometimes be addressed as part of an SWI whole house retrofit.

- Outside damp
- Brick pointing loose
- Inside damp
- Cracked and loose render
- Leaky gutter or pipes
- Brick capping stone
- Rotten windows
- Ground above ground floor level
6.3.1 External wall insulation

Earlier sections of this guide have covered the principles of the whole-house approach and joined-up processes, and the issues of planning and building conservation. This section is concerned with principles covering assessment, design, application and use of EWI.

Initial assessment is critical. Design should be based on a whole-house survey of your home (i.e. not relying on generic details and assumptions), and installation should not commence until all details have been confirmed and installers have been given a specification to work to.

The following issues need to be considered as part of the assessment, design, application and in-use processes – each of these steps is critical to minimise the risk of inappropriate installations and unintended consequences and to maximise benefits such as comfort, health and ease of installation.

<table>
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<th>Assessment issues</th>
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<td><strong>Heritage and community value</strong></td>
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<td>Although the assessment of the heritage and community value of a house is sometimes covered by designated status in planning, often beautiful buildings are not listed or part of conservation areas. It is essential in all cases that you think about the beauty and character not only of your building, but also of the street and surrounding area, and how EWI might impact on this. It is always advisable to talk to your neighbours and to people with expertise in heritage.</td>
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| **Building form** |
| The more geometrically complex a building form, the more difficult it will be to insulate with a whole-house approach. Bay windows, for example, are very difficult to insulate externally without either creating cold bridges or radically changing their appearance. Brickwork which stands out from the face of the wall, or ornate door posts are also very difficult to deal with. Building form is therefore important in assessing whether EWI is viable, and how much care and cost will be needed to get it right. Basically, the simpler the form (flat, square), the better in terms of EWI design and installation. |

| **Exposure and orientation** |
| It is important to understand not only how a building is performing when visited, but also what the likely challenges are in the middle of Winter, for example, or during an Autumn storm. This requires an understanding of your local weather and differences depending on orientation (i.e. South-facing façades often receive more sun and rain than North-facing façades). Traditional buildings sometimes demonstrate this understanding and have different finishes or protections on different sides according to exposure and orientation. In Bristol, some areas are much more exposed to driven rain (particularly on the South-West side) than houses in the centre, so more care in detailing to prevent rain ingress is essential here – this may include wider gutters, more care at the bottom of walls and around windows and cills in particular. |

| **Materials and construction method** |
| Knowing what your building is made of, how it was constructed and how it has been altered over time will help inform what’s possible and what risks may be involved. For example, some wall materials are much more porous than others, and some are very soft. Some walls are very well built and some are not so good. These all make a difference to how you insulate with EWI, as well as determining where the risks might be. |
Assessment issues continued

Condition
Building condition is one of the most important considerations is deciding whether or not to proceed with EWI (or any retrofit measure). If a building is in poor condition it is much more likely that there will be problems with a retrofit. On the other hand, a retrofit project can sometimes be a good opportunity to address both superficial and underlying problems. The key point is that if there are structural or moisture problems in your existing building, they must be fully investigated and taken into account in any work that is planned. If there is excessive moisture in your walls, then it is always best to address the cause of this moisture and to let the building dry out before undertaking any EWI work.

Use
Use is also an important context. First, understand how the building was used in the past, what it was designed for and how that differs from today’s use. Secondly be aware that moisture risks and potential energy savings are very different in a house which has a large young family living in it, compared with that of a single occupant who is often out of the building. This context makes a lot of difference to the benefits of EWI, and to the disruption of application. Projects should take account of the use of the building throughout the design and installation.

Design issues

Rain
Rain ingress can lead to damp, damage to building fabric and the EWI system, harm to human health and also loss of insulation effectiveness (a wet wall, and wet insulation material, will lose more heat than if they were dry).

The main risk areas to be addressed through robust detailing are as follows:
- The junction between the roof and external wall – particularly with regard to how eaves and verges are extended, and how the rainwater goods will work
- At ground level – particularly with regard to splashing
- Around openings (e.g. windows and doors) – particularly with regard to how insulation can be added within what is normally a limited space
- Existing architectural details – i.e. building features such as raised bands, historic plaques, decorative brickwork, protruding cills and so on. (Replication of certain features may or may not be an option, depending on the individual situation.)

In most cases leaving any such features exposed would create a risk of moisture ingress as well as introducing thermal bridges; in such cases IWI should be considered instead of EWI (possibly leading to the use of HWI)

- Boiler flues – Some older boiler flues may need to be replaced, to avoid having to leave an uninsulated area around the flue which again creates a vulnerable area for rain penetration
- Existing moisture within the walls – this can be trapped by EWI and result in damp and rot within the walls

The severity of these issues is largely dependent on context, particularly the local exposure and orientation of your home: in Bristol, for example, Clifton is much more exposed than the centre, and the South-West side of the city is more exposed than the North-East side. The presence or otherwise of other buildings, trees and the general local landscape can also significantly affect the risk of rain problems. However, regardless of the local area and conditions outlined above, if the detailing or subsequent application is incorrect, then rain is likely to cause problems in the future.

Where there is a possibility of moisture getting into or behind the EWI system, or where there are minor problems with existing dampness in walls, then a moisture-open insulation system should be preferred as this will allow drying of the wall to the outside.

Insulation coherence
Uninsulated areas create cold areas or ‘thermal bridges’. These can lead not only to heat loss, but also to moisture problems such as mould growth and condensation.

The main risk areas to be addressed through robust detailing are as follows:
- The whole façade should be insulated. Leaving certain features, such as dentil courses or floor plinths (i.e. the area of wall just above ground) and especially around windows, uninsulated leads to considerable thermal bridging and should be avoided. Where such features cannot be insulated, IWI should be considered instead of EWI (possibly leading to the use of HWI)
- Pipes, service boxes, boiler vents and similar – these must be removed and replaced over the insulation; this may require building regulations consent, permissions or separate work contracts from utility companies or the Council. These same applies to lamp posts, road signs, fence posts and similar features on or adjacent to the walls being insulated, where access to install EWI would otherwise be impossible. If these cannot be addressed EWI should not be installed
- Fixings should be ‘thermally broken’ (i.e. not create a thermal bridge from inside to outside) and non-conductive, well-sealed and system-compatible rails, beads and so on should be used. This includes fixings for external lights, drainpipes, hanging baskets, satellite dishes and similar
### Design issues continued

**Airtightness**
Your home’s airtightness should be improved wherever necessary and possible, or the effectiveness of the insulation will be compromised. The application of EWI presents an opportunity to do this, as shown in the following examples:

- Closing air leakage around windows, doors and areas where services penetrate the walls
- For poorly-pointed buildings, using a ‘bonding’ or ‘slurry’ coat behind the insulation

**Windtightness**
It is important to stop air movement between the insulation and the wall (known as ‘thermal bypass’), as this will reduce the effectiveness of the insulation. Ensuring that the insulation is fully bonded to the wall should remove this risk.

**Ventilation**
In increasing airtightness of the building it is essential to also ensure that the building has an effective ventilation system. This is covered in detail in Section 6.3.

**Homogeneity and streetscapes**
This is an aesthetic rather than technical design concern. It is essential that any EWI application is sensitive to its surroundings; this must be determined on a case-by-case basis. This principle extends to avoiding ‘pepper-potting’ of EWI on terraced houses – i.e. some frontages treated and others not – as this breaks up the homogeneity of streets and generally creates an unsympathetic appearance. The long term risk here is of creating a radical, immediate and effectively irreversible change to whole streets and areas.

In reality, this means applying EWI at the fronts of detached buildings only, or semi-detached / terraced homes where all properties will be treated. For terraced houses, HWI will generally be more appropriate, with IWI at the front and EWI at the sides / rears.

### Application issues

**Quality of installation**
This is essential in any SWI project, and is key to a successful and happy retrofit project. Firstly, this means that the contractors should strictly follow the design and specification – if they find a problem with this, then they must consult with both you and the designer before proceeding further.

Of course installers should also be suitably trained and experienced. If there are inexperienced workers on site, then at least they should be supervised by a trained and experienced colleague or manager. Ideally there should be someone on site with a sound understanding of the principles and details in this guide, who is able to liaise with you and the designer if needed.

**Weather**
It is important that application of insulation is not undertaken where the insulation gets wet or if there is a risk of freeze-thaw damage to the render (many render systems specify a minimum application temperature, 5°C for example). For this reason Winter-time work needs to be carefully controlled, and may be best avoided where possible.

**Capacity and caution**
Projects often fail because of unexpected or unplanned factors. If there is not sufficient capacity (i.e. time or money) to deal with these, then a job is more likely to be poorly done, with corners being cut or some areas just left out altogether. So ensure that there is a contingency fund if at all possible, and make sure your timescales have some flexibility.

### In-use and maintenance issues

**In Use**
Once EWI has been installed, it is essential that owners and occupants know what can and can’t be done to their walls, for example if they want to add lights, hanging baskets, signs and similar to the outside of their house.

On a more general note, it is very important that the end-users of the house are a) involved throughout and b) well informed about the changes they are likely to notice and any different behaviours they should adopt (e.g. being more aware of ventilation). If a dedicated ventilation system is installed as part of the project, it must have simple, user-friendly, reliable controls and its operation and maintenance should be explained clearly to the occupant, so they can use it properly and identify any faults quickly.

**Maintenance**
EWI is not a ‘fit and forget’ measure. Many EWI systems are likely to require repainting or sealing every few years, particularly in exposed areas. The most robust systems will not use mastic joints around openings and junctions – but if mastic joints cannot be avoided, these will require renewal at frequent intervals.
6.3.1.1 Example details for external wall insulation

EXAMPLE DETAIL DRAWINGS
Every home is different, so no guide can show you how all building details should be treated. However, principles do not change, and the following drawings will give you an idea of the sort of considerations and detailing you are likely to need. These are indicative illustrations only, based on the principles of responsible retrofit – they are not necessarily the details you will need for your own home. But look at them carefully – if you are offered a design that either doesn’t relate directly to your building (i.e. is generic) or doesn’t address the problem areas highlighted in these drawings, you should ask whether they can be amended accordingly, or look elsewhere.

Eaves

TYPICAL EXISTING ARRANGEMENT

- Eaves board which protects after ends and provides tidy edge.
- Partially protected by gutter. Water can freely drip from it.
- No cold bridge as whole wall is conductive. This energy transfer help keep the wall relatively ‘dry’.
- Masonry wall originally moisture open and still likely to be so now.

WATCH POINTS
- Check roof covering is weather proof
- Check condition of timber
- Check condition of wall
- Check that loft is ventilated at eaves.
- High heat loss but likely to be free of moisture problems so long as fabric in good condition
TYPICAL EXISTING ARRANGEMENT

Eaves board which protects rafter ends and provides tidy edge.

Partially protected by gutter. Water can freely drip from it.

No cold bridge as whole wall is conductive. This energy transfer helps keep the wall relatively 'dry'.

Masonry wall originally moisture open and still likely to be so now.

WATCH POINTS
- Check roof covering is weather proof
- Check condition of timber
- Check condition of wall
- Check that loft is ventilated at eaves.
- High heat loss but likely to be free of moisture problems so long as fabric in good condition
POOR PRACTICE

Eaves board may by subject to accelerated decay due to rain splashing from trim.

Junction between wall/eaves board and trim – normally sealed with silicone – remaining vulnerable to water ingress and associated problems (see previous drawing).

Metal trim fixed to wall provides some protection to insulation. Junctions between lengths of trim should be silicone sealed but this is not always possible. Complex junctions at corners or at rain water pipes present greater vulnerability.

Ability of wall to dry out to the weather side reduced by imposition of layers of insulation, adhesive and render.

Strong cold bridge

Exacerbated by conductive effect of metal trim which partially extends down back of insulation.

WATCH POINTS

- Poor workmanship and/or harsh climate increases vulnerability to water penetration
- Lack of jointing pieces means detailing on site is often ad-hoc and can create weaknesses
- Reduced drying potential of wall due to EWI and possible moisture ingress present dangers
GOOD PRACTICE
EXTEND RAFTERS

New tiles, battens and extended membrane fitted at base of roof

Dotted line indicates line of extended rafter

Eaves board and gutter approx 100mm further forward

Ability of wall to dry out to the weather side reduced by imposition of layers of insulation, adhesive and render. Risk of moisture ingress at top of wall reduced to almost nil.

Heat loss through eaves significantly reduced and internal surface temperature along this zone likely to be closer to rest of wall. Therefore reduced risk of condensation and mould growth.

WATCH POINTS

- Risk of water penetration almost eliminated
- Work requires skill and care to avoid damage that may require further roof stripping
- Fixing of bottom tiles may present difficulties
- New bottom tiles may stand out from rest
- May require separate trade to prepare roof edge prior to EWI work
GOOD PRACTICE
MODULAR GUTTER EXTENSION

- Roof membrane extended into gutter with proprietary eaves piece
- Ventilation to roof strip
- Eaves board removed, and with it weak junction with trim. Water ingress risk reduced
- Wide gutter section protects insulation below
- Insulation installed behind gutter
- Ability of wall to dry out to the weather side reduced by imposition of layers of insulation, adhesive and render.
- Risk of moisture entering at top of wall eliminated.
- Heat loss through eaves significantly reduced and internal surface temperature along this zone likely to be closer to rest of wall. Therefore reduced risk of condensation and mould growth.

WATCH POINTS
- Risk of water penetration almost eliminated at head
- Less intervention with existing roof may reduce risks and costs
- Eaves work likely to be within skill set of EWI installer
EXISTING TYPICAL ARRANGEMENT

OUTSIDE

Heat loss through wall and floor.

Ventilation grille: May be painted closed or blocked with debris behind.

INSIDE

Wall plate supporting joist end.

Dwarf wall with hit and miss brickwork to promote ventilation.

Air leakage through boards.

Ventilation void below joists to moderate moisture levels. This space may be blocked with debris from previous building work.

At the bottom of wall the ability of the wall to maintain an appropriate moisture balance is helped by ventilation grilles which also moderate humidity within the suspended floor zone.

WATCH POINTS

- Check floor ventilation
- Check timber condition
- Check condition of wall and foundations
POOR PRACTICE

External wall insulation poorly fitted to external wall allowing heat to wick away due to convection behind the insulation.

Ventilation grille, covered with insulation, reducing floor void ventilation.

Heat loss through wall and floor and through cold bridge.

Air leakage through boards.

Wall plate supporting joist end may be prone to decay due to reduced ventilation below floor.

Dwarf wall with debris from previous build encouraging damp conditions.

Reduced level of ventilation and debris from previous building work will work for me.

Cold bridge at base of wall increases risk of condensation and mould growth along the skirting level.

WATCH POINTS
• Check floor ventilation
• Check timber condition
• Check condition of wall and foundations
GOOD PRACTICE

EXTERNAL

External wall insulation well fitted to external wall to prevent heat loss due to convection behind the insulation.

Ventilation grille fitted with external wall insulation.

Water impermeable insulation such as XPS fitted below DPC level and as deep as feasible into the ground. Ensure waterproof render applied to brickwork first.

INSIDE

Air tightness membrane or new sheathing layer eliminates drafts.

Dwarf wall with debris removed from around it and hit and miss brickwork open to air flow.

Floor void cleared of debris to allow air flow under floor and promotes drying of wall at low level.

Cold bridge at base of wall minimised to reduce condensation risk along skirting.

Floor void adequately ventilated.

WATCH POINTS

- Ventilation to floor improved
- Cold bridge at base of wall minimised
- Floor insulation and draft proofing fitted as part of whole house approach
'Regardless of your reasons for retrofitting, the key to success is **understanding**. Understand your home, your lifestyle, your environment, your priorities, the upgrade measures available, the importance of careful planning and detailing, and the ‘whole-house approach’ and joined-up process'
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Sustainable Energy Services

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