ADEILADU ARBENIGRWYDD YNG NGHYMRU
CONSTRUCTING EXCELLENCE IN WALES

bre

Post Installation Performance of Cavity Wall & External Wall Insulation

Foreword

The need to continue to reduce carbon emissions is clear. Recent legislative changes, such as the Environment (Wales) Act 2016 (which sets a new framework for carbon budgets for Wales) and the Wellbeing of Future Generations Act 2015 mean that more than ever we need to ensure our actions today are for the best outcomes both for the present and the future. It is with this in mind that Constructing Excellence in Wales commissioned BRE Wales to undertake a review of refurbishment work in Wales, specifically the retrofitting of cavity wall or external wall insulation works to domestic properties.

Refurbishing our homes forms a key part of numerous policies; to reduce carbon emissions, fuel poverty and improve the health and well-being of residents. This report was commissioned to:

- Undertake a call for evidence from those who manage properties which have had cavity wall and external wall insulation installed
- Identify any long term legacy issues which are appearing following the installation of cavity wall and external wall insulation
- Determine what legacy issues may arise from such refurbishment works in terms of waste creation and remedial costs.

This report serves to scope the potential issues and unintended consequences regarding the retrofit of cavity wall and external wall insulation.

Two case studies demonstrating best practice for CWI installation are presented from North and West Wales.

The findings from reviewing domestic refurbishment work in Wales is indicative of work undertaken in the past 10 years. This work has informed further studies, such as the DECC (now Department for Business, Energy & Industrial Strategy – BEIS) report on solid wall heat losses and the potential for energy savings. There is growing evidence which demonstrates that the industry has much work to do to improve the quality of site surveys and on-site workmanship. Furthermore the industry needs to work with residents to educate and advise to support behaviour that avoids any unintended consequences of refurbishment, for example poor ventilation leading to condensation, damp and mould.

The report outlines findings with regards further investigations and site surveys to review more fully the scale of the issues raised by this scoping work.

Constructing Excellence in Wales will continue to work with the industry to improve performance, promote best practice and to share lessons learnt from on-going refurbishment work which is so needed for the communities of Wales.

Executive Summary

This scoping study presents the results of an investigation of unintended consequences (unplanned side-effects such as damp and cracking in walls or other faults) for a small sample of welsh dwellings which have been retrofitted with wall insulation. The primary aims of this study are:

- To identify the likely causes of any unintended consequences arising from the installation of cavity and external wall insulation in these locations
- To identify any improvements in processes or methods that may prevent faults from occurring elsewhere
- To suggest any additional work that may assist in assessing the extent of these unplanned effects in Wales.

Site investigations were undertaken in a sample of dwellings where unintended consequences have been reported by the property managers in the social rented sector and a smaller number of private properties. The investigations identified specific issues, including those that may be affecting the thermal performance of the walls and other associated issues such as with thermal bridging and condensation.
These specific cases also showed evidence of insulation being installed contrary to good practice, furthermore, there was strong evidence indicating that appropriate maintenance had not been undertaken following the installation of the insulation. These are likely to be contributory factors in the development of the observed unintended consequences.
The study also identifies potential high level system improvements to help avoid similar problems in future; the cost of any remediation work is relatively high when consequences develop, compared to the cost of installation.
Finally, the study recommends a larger, randomised survey of properties to identify the scale of unintended consequences at a national level and proposes mechanisms for avoiding unintended consequences in the future.

It is important to recognise that the sample of properties visited is very small and is self-selected – i.e. the properties investigated were proposed by housing managers, in response to a call for evidence, as having shown signs of unintended consequences (such as damp and cracking) following insulation.
These examples, therefore, should not be considered representative of the housing stock as a whole and results cannot reasonably be extrapolated to larger national or sub-national regions. The findings of this scoping study, however, illustrate the type of problems that can occur if insulation is installed and maintained contrary to good practice and provide some suggestions for future work to assess existing guidance and current practice, and to quantify the scale of unintended consequences at a national level.

The main conclusions of this report are that, in these specific cases, there is evidence that that cavity wall insulation or external wall insulation, has been installed in unsuitable properties, or without due regard for best practice. That as far as can be ascertained from the limited data available, all of the cavity wall failures occurred within the timeframe of the guarantee provision i.e. within 25 years, and in some circumstances less than 10 years. Regarding EWI the time frame for failure is not known, but all of the issues identified as part of this report occurred either at the point of installation, or within 2 years of the installation. The main recommendations of this report are as follows:

1. To undertake a larger and nationally representative, primary data collection exercise in Wales to identify the extent of the issues which have been identified.

2. To undertake an assessment of the competent person's scheme, in particular the surveying and installation elements, with a view to providing specific guidance for improvements to processes such as the assessment of risks regarding the level of exposure to wind driven rain.

3. To develop a concise maintenance guide for installers, housing managers and occupants to help ensure that basic measures are taken to protect the insulation installation and thus make failure less likely.

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Glossary

BBA
British Board of Agreement

BRE
Building Research Establishment Ltd

CERO
Carbon Emissions Reduction Obligation

CERT
Carbon Emission Reduction Target

CESP
Community Energy Saving Programme

CIGA
Cavity Wall Insulation Guarantee Agency

CO2
Carbon Dioxide

CSCO
Carbon Savings Communities Obligation

CWI
Cavity wall Insulation

DECC
Department of Energy and Climate Change

ECO
Energy Companies Obligation

EEC
Energy Efficiency Commitment

EED
Energy Efficiency Directive

EPBD
Energy Performance in Building Directive

EPC
Energy Performance Certificate

EPS
Expanded Polystyrene

EU
European Union

HHCRO
Home Heating Carbon Reduction Obligation

HHSRS
Housing Health and Safety Rating System

PSWMR
Provisional Solid Wall Minimum Requirement

SAP
Standard Assessment Procedure

SME
Small Medium Enterprise

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Scope

BRE have been commissioned by Constructing Excellence in Wales to undertake an initial study into the performance of cavity wall insulation (CWI) and external wall insulation (EWI) in Wales.

Within the UK, Wales has the oldest housing stock of all constituent nations. Approximately 30% of dwellings in Wales were built prior to 1919 and of these 90% have solid exterior walls. Analysis of National House Condition Survey data also indicates that Welsh Housing has particular problems with damp – see Table 1 below.

	England	N. Ireland	Wales	Scotland
Age - % pre 1919	20.8	13.0	30.2	18.9
Age - % pre 1945	37.3	23.4	41.1	32.5
% solid masonry walls (not cavity)	26.6	19.8	31.1	21.8
% penetrating dampness	3.2	1.4	6.9	4.2
% any dampness (incl. condensation)	7.6	4.1	12.9	12.5
Mean SAP (energy efficiency, out of 100)	51.5	57.6	50.3	58.0
% HHSRS Category 1 hazard excess cold	8.5	4.2	11.1	Not Measured

Table 1: UK national comparative housing statistics, 2008.
Statistics summarised from: Piddington et al, Housing in the UK, IHS BRE Press FB 62, Watford, 2013.

The last property survey in Wales was the 2008 Living In Wales Survey. At this time there were estimated to be ~ 1.3m dwellings in Wales, of which ~900,000 had cavity walls. It was estimated that from the Living in Wales 2008 that approximately 50% of all cavity walled dwellings were insulated at this time. The proportion of dwellings with insulated walls is likely to have risen considerably since this time.

Energy efficiency measures have been promoted and installed under a variety of schemes run by the Welsh and UK Governments, many of which have involved a mixture of External Wall Insulation (EWI) and Cavity Wall Insulation (CWI). Insulation measures, if installed and maintained appropriately, offer the benefits of reduced energy use, costs and carbon emissions, as well as quicker dwelling warm-up times and an improved ability of the dwelling to retain heat.

Good practice for the installation of these measures has been described within a variety of guidance documents since this measure began to be installed. These include BRE Guides, BBA Technical Papers, ISO guidance and guidance from the Cavity Wall Insulation Guarantee Agency (CIGA). The guidance recommends that these measures are only installed in locations which are appropriate. In particular, the local climatic conditions and level of exposure of the dwelling to wind-driven rain should be taken into account prior to installation. This is particularly relevant in Wales because of the high level of exposure to wind-driven rain of some locations. Other pre-existing aspects of the dwelling, such as cavity thickness, should also be taken into account prior to the insulation measure being applied. Furthermore, good maintenance of the external wall of the dwelling is required to prevent problems. It is believed that, if this good practice is not followed, then problems can occur following insulation, including poor thermal performance, damp and cracking render.

During the 1990's and 2000's the UK and Welsh Governments developed and implemented several large-scale programmes of work to improve the energy efficiency of properties in Wales. Insulating cavity walls became a common and prominent improvement measure because of its relative cost-effectiveness. These are summarised in Appendix A of this report and reported progress on measures is included.

This scoping study presents the findings of a selection of the submissions as part of the call for evidence and two detailed assessments of properties where unintended consequences following the installation of insulation, have been reported by the housing managers regarding the installation of CWI and for EWI. A summary of all of the submissions put forward is presented later in this report. An assessment is made of whether the insulation was installed contrary to good practice and whether this may be responsible for the observations.

Submissions and site visits are presented anonymously. The retrofit of internal wall insulation has not formed part of this scope of report.

Recommendations are then made for reviewing guidance, and for future research work.

It should be noted that the examples in this report are limited by the permissions granted by the housing managers to publish the findings. The two sets of assessments, however, can be considered representative of the types and causes of the problems seen within the properties proposed for investigation by all housing managers. It should also be noted, that the properties were proposed for investigation as having shown signs of problems and these examples should not be considered representative of all dwellings which have received these types of insulation measures.

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Methodology

This section of the report outlines the methodology of this research. This research took the form of:

a) A "Call for Evidence" to locate properties where unintended consequences have been reported.
b) Desk-based research on the factors which may be affecting the performance of insulation, and the possible causes of unintended consequences.
c) Surveys of properties which are showing evidence of unintended consequences, as identified by the Call for Evidence.

In order to investigate properties experiencing unintended consequences which may be related to thermal insulation works, the BRE contacted Community Housing Cymru, Constructing Excellence in Wales & Registered Social Landlords in Wales. BRE sought examples of properties where there has been reported problems with damp, mould or other moisture related issues in properties that had been insulated since the original construction date. This call for evidence was directed at locating properties with problems, and as such responses cannot be interpreted as representative of the wider housing stock.

Following the call for evidence, the BRE undertook physical inspections of nine of the submissions for reported issues related to CWI and all seven of the submissions related to EWI.

The selection of the CWI submissions was undertaken by selecting the cases with either the most properties affected and / or the properties with the most significant reported problems.

The purpose of the surveys and inspections were to investigate whether insulation had been installed, as far as could be assessed using the relevant standards which were in force at the time the insulation was applied. The standards for suitability for insulation are discussed in the next section but include;

- Location and exposure rating
- Suitability of the cavities to be insulated, width and condition
- For CWI, the condition of the property
- For EWI, a survey identifying any design features that may result in problems

Finally, the results from the surveys would be used to identify and recommend steps to improve processes, guidance for installers, and to specify further work which will help to identify the scale and extent of any problems in Wales as a whole.

3

Results of call for evidence

The Call for Evidence resulted in 31 submissions from either Local Authorities or Registered Social Landlords. Of these 24 submissions were relating to properties where there were reported problems with Cavity Wall Insulation (CWI) and described in Table 1, and seven related to the application of External Wall Insulation (EWI) and described in Table 2.

The submissions included areas with both multiple and singular reported problems. The total number of properties which have been contributed to this report were:

CWI - 503 properties

EWI – 330 properties

The locations of the reported issues provided as part of the call for evidence are shown right in Figure 1

The map shows the reported cases of external and cavity wall insulation. The circle markers on the map represent Cavity Wall Insulations and square markers, External Wall Insulation. The markers represent the general location of the properties. Therefore, one pin in certain circumstances could represent several properties or issues reported.

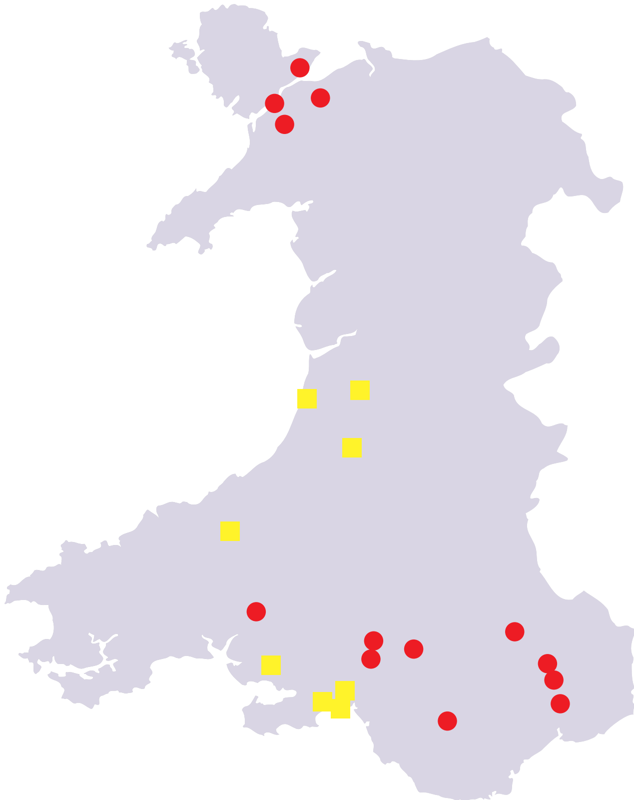

Figure 1: Location of cases reported as part of the Call for Evidence

Type of Insulation	Year of Installation	Tenure	Case
CWI	2010	Housing Association	During 2013-2014: 17 cases of Cavity Cleans / Extractions.
CWI	1997	Housing Association	Damp and mould on internal wall surfaces. 15 properties in exposed locations
CWI	2009	Housing Association	Wet insulation in cavity, mould growth on internal wall surfaces. Mould and mildew on resident's possessions
CWI	2007	Housing Association	Damp and condensation reported (40 properties)
CWI	Prior to 1990 exact date unknown	Housing Association	Damp, mould and general decay (129 properties)
CWI	2012	Housing Association	Damp and mould on internal wall surfaces
CWI	2012	Housing Association	Water penetration, damp and mould on internal wall surfaces (35 properties)
CWI	Unknown	Housing Association	Failed render and blowing electrical sockets. Walls saturated and high levels of damp and mould in the property. (1 property)
CWI	2009	Housing Association	CWI extraction (19 properties)
CWI	2010-2012	Housing Association	22 properties retrofitted, 45% have failed and resulted in extraction being carried out. (11 extractions)
CWI	2005-2012	Housing Association	During the period 2013-2014: 273 Cavity Cleans Extractions (45%) failure rate
CWI	2005	Housing Association	Damp internal walls, mould growth. (42 properties)
CWI	2012	Housing Association	Walls saturated, damp and mould internally. (16 properties)
CWI	2012	Housing Association	CWI led to damp and condensation. CWI was removed after 2 years of being installed. (40+ properties)
CWI	2012-2014	Housing Association	Number of properties insulated – 57% of failures – 3% up to date
CWI	2008	Housing Association	Full extraction completed in 2011. (36 properties)
CWI	2012	Housing Association	Problem- localised damp. Solution: Full extraction of insulation undertaken to front of property (the most vulnerable wall due to exposure). Cavity opened up and saturated insulation removed, cavity trays fitted. External walls hacked and re-rendered. (6 properties)
CWI	2008	Private	1 property CWI installed in 2008. Problem: Damp. CWI Extracted year 2011.
CWI	2008	Private	1 property CWI installed in 2008. Problem: Damp. CWI Extracted year 2011.
CWI	2010	Private	1 property Damp problems reported after CWI installation. Render on front elevation in very poor condition.
CWI	2013	Private	1 property reported Extent of damage – water even though Polystyrene bead insulation was used. CWI is waiting to be extracted.
CWI	2008	Private	CWI installed in 2008. Problem: Damp. CWI Extracted year 2011.
CWI	2010	Private	Damp problems reported after CWI installation. Render on front elevation in very poor condition. CWI should not have been installed. No extractions carried out to date.

CWI	2013	Private	Extent of damage – water even though Polybead insulation was used. Also had cracks on the gable and loose render. Also had cracks on the gable and loose render. CWI is waiting to be extracted.

Table 1: Summary of submissions relating to CWI

Type of Insulation	Year of Installation	Tenure	No of Properties and Findings
EWI	2011	Housing Association	Overheating problems (125 properties)
EWI	2011	Housing Association	Evidence of condensation (36 properties)
EWI	2012	Housing Association	Evidence of condensation and mould growth behind wardrobes and furniture. (17 properties)
EWI	2013	Housing Association	Mould growth and general decay. (35 properties)
EWI	2012	Housing Association	Water penetration and mould growth (46 properties)
EWI	2011	Housing Association	Condensation and mould growth. (29 properties)
EWI	2013	Housing Association	Condensation and mould growth, deposits on personal possessions. (42 properties)

Table 2: Summary of submissions relating to EWI

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Review of Standards for Insulation Suitability

Table 3 below summarises the standards and periods of time that they were in operation, for the stated period, regarding the installation of CWI these have all been superseded by the requirements of the relevant competent person's schemes[1]. These are discussed in more detail in the following section.

Part C earlier edition(s)	Part C 1992 edition	Part C 2004 edition

1980s | 1990s | 2000s | 2010s

8 9 | 0 1 2 3 4 5 6 7 8 9 | 0 1 2 3 4 5 6 7 8 9 | 0 1 2 3 4 5 6 7 8 9 | 0 1 2 3 4 5

BBA Information 10 (withdrawal date unknown, probably around 1995

BS5617:1978
BS5618:1978

BS5617:1985 Specification for UF foam systems suitable for thermal insulation of cavity walls
BS5618:1985 Code of practice for thermal insulation of cavity walls (masonry) with UF foam

DD93 Assessing WDR

BS8104 Code of practice for assessing exposure of walls to WDR

BS8208 Assessment of suitability of cavity walls for filling

CIGA established 1995 and guidance published 1996

Note: titles are sometimes abbreviated. WDR: wind driven rain

Table 3: Standards for Installation and Surveying of Cavity Wall Insulation

4.1 Building Regulations Approved Document Part C

When considering the suitability of a property to be insulated it is important that the physical condition, form of construction and exposure to wind driven rain is assessed properly at the point of survey. The Building Regulations and related guidance documents provide guidance on how to consider the effects.

Building Regulations Approved Document (now referred to as AD) Part C (England) 2004 and (Wales) 2004 refers to levels of exposure zones; there are 4 zones in the UK which indicate the approximate amount of wind driven rain which the building may be subject to. The regulations however recognise that local features and geographical terrain can effect this rating and allows for specific calculations to be undertaken using BS8104:1992. The principle set out in BS8104:1992 is also used in other guidance stated previously such as BBA information No 10, DD93 Assessing WDR and CIGA Guidance, but no specific reference is made to the standard. A common theme is that local features and topography should be considered when assessing risk from wind driven rain and the suitability of walls for cavity insulation.

AD Part C 1992 edition (now superseded) paragraph 4.14c refers to both mineral fibre and bead insulation, and includes the following final paragraph:

> *'Alternatively the insulating material should be the subject of a current British Board of Agrément certificate or a European Technical Approval. The work should be carried out in accordance with the terms of that document by operative either directly employed by the holder of the document or employed by an installer approved to operate under the document.'*

Following its revision, AD Part C 2004 edition, paragraph 5. 15e.includes the following paragraph:

> *'When the cavity of an existing house is being filled, special attention should be given to the condition of the external leaf of the wall, e.g. its state of repair and the type of pointing. Guidance is given in BS 8208-1:1985. Some materials that are used to fill existing cavity walls may have a low risk of moisture being carried over to the inner leaf of the wall. In cases where a third party assessment of such a cavity fill material contains a method of assessing the construction of the walls and exposure risk, the procedure set out below may be replaced by that method.'*

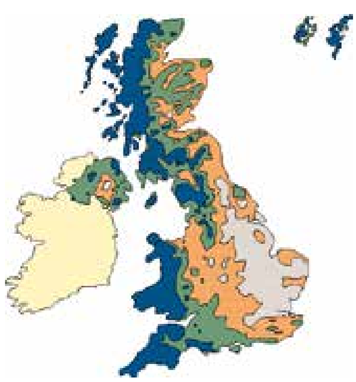
1 https://www.gov.uk/building-regulations-competent-person-schemes

The reference in the last line to 'the procedure set out below' is to the well-known map of driving rain exposure (see figure 2 below) and the associated table from BRE report BR262, 'Thermal insulation: avoiding risks'. This BRE report, paragraph 3.1(b), gives the same option when upgrading existing masonry walls to 'Follow the inspection, assessment and installation procedures in relevant British or CEN standards or third-party certificates.'

4.2 BRE Report BR262 (Thermal Insulation: Avoiding Risks)

BRE Report BR 262; thermal insulation avoiding risks[2] provides a simplified procedure for assessing exposure to wind-driven rain for walls up to 12 m high. It is primarily intended for low rise domestic buildings, but may also be considered suitable for other categories of buildings of similar scale. This simplified guidance is based on a map that defines zones in which calculations, in accordance with BS8104[3], predict similar exposure conditions. The zones are numbered 1 to 4 as shown below in Figure A1. It should be noted that any calculated wind driven rain rating of more than 100 litres/m²/ per spell, would classify the area as being in a "very severe" exposure location.

BR262 sets out clear guidance that for retrofit thermal improvements, the guidance set out in third party certification, EN or BS should be followed.



- Buildings that are sheltered by surrounding buildings and trees can be considered to be in an exposure category one lower in 'sheltered' parts. For example: if 'sheltered' in Zone 4 consider it as Zone 3.
- External cladding can improve the exposure rating and give resistance to rain penetration.
- Assess the exposure of the wall using BS 8104.
- See BRE Report 262: 'Thermal Insulation: avoiding risks' for guidance.

Key to map

Exposure zones	Approximate wind-driven rain (litres/m² per spell)
1	Less than 33
2	33 to less than 56.5
3	56.5 to less than 100
4	100 or more

Figure 2: Exposure Zones from BR 262

4.3 BS8208-1 Guide to assessment of suitability of external cavity walls for filling

Since the mid 1980's up until approximately 2010 the principles for assessing the suitability of cavities to receive thermal insulants was set out in BS 8208-1. This standard set out a clear approach and listed the factors to be taken into consideration when undertaking the assessment.

Factors to be taken into account when considering suitability for cavity fill were:

- Form of construction and site conditions
- Age of the building
- Condition of cavity
- Extent of cavity to be filled
- Outer leaf
- Inner leaf
- Services within the cavity
- Ventilation

The standard sets out a sequential process for each of the factors set out above, in the form of flow diagrams with clear instructions and guidance on suitability, or recommendations for remedial actions, before undertaking CWI.

[2] BRE Report BR262: 1994. Thermal insulation: avoiding risks.
[3] BS8104:1992 – Assessing exposure of walls to wind driven rain

4.4 BBA Certificate

As described above, the suitability of a wall for filling with insulation normally followed the requirements of a third party assessment of a cavity fill material, such as a British Board of Agrément (BBA) certificate.

As an example, a BBA Agrément Certificate for Rockwool cavity wall insulation, in use in 2003 and dated 1998 includes the following requirements.

- Minimum cavity width 50mm
- Walls must be in a good state of repair and must show no evidence of frost damage
- Mortar joints must not be raked or recessed and must not show evidence of more than hairline cracking
- This Certificate covers the use of the product in areas where the exposure factor does not exceed 120 (factor calculated using BBA Information No 10)
- As with all cavity wall insulation, the construction and detailing should comply with good practice as described in the BBA joint publication Cavity Insulation of Masonry Walls - Dampness Risks and How to minimise them. They are particularly important in areas subject to severe or very severe driving rain.

The above are in a section headed 'General'. A later section headed 'Existing buildings' states the following additional requirements.

- Existing buildings subject to the national Building Regulations should be suitable when assessed in accordance with BS 8208 Part 1:1985.
- In an existing building, the product may be installed only:

  – where there are no signs of dampness on the inner face of the cavity wall, other than those caused solely by condensation, and
  – where the cavity is not being used as a source of combustion air or as a flue for ventilation purposes.

A note at the end refers to an original 1989 Certificate; the amendments listed do not relate to the above requirements and therefore imply that the above requirements were probably in the original. This is supported by the 1983 date of the BBA Information No 10 document mentioned above. The introduction to this BBA Information No 10: 1983 document states that it '*is an extension and revision of the approach used by R E Lacy in the Driving-rain index (1976) and, compared with the original Agrément exposure scheme, provides a greater degree of flexibility, with respect to high buildings… The method defined in BS5618:1978 is based on this document.*'

According to CIGA, custom and practice in the 1990s varied, although the condition of the walls, of the rendering, and related local factors have always been the major issues for assessing suitability for cavity wall insulation. There was however a significant change in the 1990s with the start of schemes such as:

- EESoP (Energy Efficiency Standards of Performance) in 1994
- HEES (Home Energy Efficiency Scheme), followed by New HEES in 2000 renamed Warm Front in England
- Energy Saving Trust schemes

In the years before these schemes, most work was undertaken by organisations such as Housing Associations and Local Authorities. These were generally large projects and BBA Information No 10 was used by System Designers. However, research undertaken has discovered that this note was generally too complex for widespread use in the schemes involving private homes, where single property installations were undertaken and no information could be identified on what parameters were considered in these circumstances. With the establishment of CIGA their guidance, first published in 1996, was the standard to be followed.

4.5 CIGA Guidance

CIGA was established in 1995, providing a 25 year guarantee for cavity wall insulation fitted by registered users. CIGA's guidance documents include 'Suitability of external walls for filling with cavity wall insulation. Part 1 existing buildings'. The 2003 version of this document states the following:

2.4.1 EXPOSURE TO WIND DRIVEN RAIN

Almost all of the systems on the market are approved for use in all parts of the UK. However, this assumes that the outer leaf is constructed in accordance with the requirements for local exposure conditions – so that water penetration of the outer leaf is minimal.

The exception is urea formaldehyde foam, which is subject to restrictions in parts of the country and some forms of construction. BS 5617 and BS 5618 provide further information.

However, this 'all exposure' classification should not be taken as giving carte blanche to all installations. The form of construction, the quality of construction, local exposure and state of maintenance can conspire to defeat the *classification of 'all exposure' and could lead to water penetration through to the internal walls.'*

2.4.2 LOCATION

Historically towns in the UK have been built in sheltered locations.

However, it should be recognised that new towns and developments have been built in places that are more exposed to the prevailing winds, particularly from the prevailing south-westerly wind.
Some of these locations, which may be a short distance away from the historic town, can be considerably more exposed.

When a more exposed location has housing built, which is not in the local style (e.g. without render) it could be that the CWI may be in danger of being compromised by the out of character construction style.

2.4.3 BUILDINGS OUTSIDE OF NORMAL PARAMETERS

Where it is identified that the exposure, building or external walls fall outside normal expectations or parameters, specialist advice should be sought from the Assessor's management, from the system supplier or other expert.

The Guide continues with further guidance including the following:

- *Is the building free from unrectified signs of dampness or water penetration?*
- *Cracks in the external walls exceeding 1mm width should be investigated and resolved.*
- *Any other signs of distress such as bulging or leaning should be investigated and resolved.*
- *Is the brickwork, mortar and render in good condition?*
- *Are the walls free from spalled brickwork?*
- *Are there signs that the gutters and downpipes are leaking?*

4.6 Early polystyrene bead insulation requirements

The standards in force, for CWI, at the time of the insulation of the properties included in this research, BS5250 and BR262, and the first BBA certificates also made a requirement for weep holes to be present. Brick and stone are porous materials and can absorb and store water, the inclusion of weep holes in masonry walls is intended to serve two purposes:

1) Drainage: They provide an opening that allows the drainage of any moisture that may reach the back of a wall, or the inside leaf of a wall (such as a cavity in cavity wall construction) from the outside through penetration, capillary action, condensation, leakage or flooding.

2) Ventilation: They allow ventilating air to the back of a wall to help prevent mildew, dry rot and damp which might otherwise reduce the life or performance of building materials such as cavity wall-ties, cavity insulation and so on.

The Masonry Design Manual describes weep holes as, 'Openings placed in mortar joints of facing materials at the level of flashing, to permit the escape of moisture, or openings in retaining walls to permit water to escape'. Weep holes are typically found in the outer masonry leaf of cavity walls, just above the flashing. They can also be found above windows, doors or other penetrations. They should be provided at regular intervals so as to allow any moisture collected by cavity trays to escape. The recommended distance between weep holes is 450mm, measured horizontally.

4.7 Summary & discussion of CWI & EWI guidance

Although this is not a comprehensive historical review of the Building Regulations AD Part C, BBA certificates, and CIGA guidance, partly due to the difficulty at this distance in time in finding the information and being sure of how or if it was used. In addition, various British Standards have given similar guidance and may have been referred to. Nevertheless, it provides an overall picture that assessment in the 1990s and earlier focused, as they do now, on ensuring that the condition of the walls, render, and local factors were acceptable for retrofit cavity wall insulation. There does however not appear to be any clarity or hierarchy in the use of these standards and no records maintained on the use of the standards and surveys undertaken to verify that they were used.

Various schemes such as HEES and EESoP started in the mid-1990s and CIGA was established in 1995. Before this time, installations were in general undertaken by organisations such as Housing Associations and Local Authorities with reference to BBA certification which required an exposure factor not exceeding 120 calculated with BBA Information No 10.

After this time there was a significant change from these large schemes to installations in individual private homes and the BBA Information No 10 calculation was too complex for such general use. Assessment changed to following CIGA guidance and calculations of Wind Driving Rain indices or geographical zones were not required or in general used to give a 'threshold' determination as to whether retrofit cavity wall insulation should or should not be installed in a particular dwelling. Nevertheless, the guidance does make it very clear that local weather conditions should be taken into account with a more stringent assessment of the condition of the walls where exposure to wind driven rain is more severe.

In comparison wi*th existing dwellings*, it should be noted that for *new build dwellings*, the Wind Driving Rain indices and geographical zones play a much more significant role in assessing the suitability of dwellings for cavity wall insulation, both historically and in the present. There are a number of reasons that appear to have been use in justifying this difference. For new build, the cavity is often filled as it is built, so mortar snots dropping into the cavity on top of the insulation can form a moisture bridge. In addition, new build homes have no service history, are often in more exposed locations on the edge of towns, may be subject to inadequacies in building skills; and experience has shown that a number suffer water penetration even without cavity insulation.

The overall approach to assessing the suitability of homes for retrofit cavity wall insulation has not changed significantly since the 1990s, as can be seen from the Part C 2004 edition extract quoted earlier, which is still current today. In addition, current BBA Certificates explicitly state that '*This Certificate covers the use of the product in any exposure zone, subject to the following conditions being met. They are particularly important in areas subject to severe or very severe driving rain'*. The '*following conditions*' relate essentially to the condition of the walls and relevant local factors.

It is apparent that requirements and guidance in the 1990s and earlier focused, as they do now, on ensuring that the condition of the walls, render, and local factors were acceptable for retrofit cavity wall insulation. This is the main emphasis of the assessment, while taking proper account of local exposure to wind driving rain. In addition, before the start of schemes such as HEES and EESoP in the mid-1990s, BBA certification only covered use in areas determined by an exposure factor calculated using BBA Information No 10. This seems to have been used by System Designers for earlier schemes generally involving larger numbers of dwellings, no evidence or records have been identified that confirms its use.

For many of these standards there would have been a requirement for training of the installers and surveyors involved in this type of work. Prior to the creation of CIGA and the competent person's schemes, this would have been undertaken by the insulation manufacturers. But due to the period of time that has passed since this regime no evidence of the content, frequency or quality of this training could be identified. The more recent requirements of the competent person's scheme require "minimum technical competencies"[4]. These requirements set out standards and competencies that the registered competent persons scheme managers must ensure are in place.

Other guidance and standards would have had no training provision available to provide clear principles of use, such as BS8208, and BR262 and Building Regulations Part C, these are more guidance documents on how to undertake inspections and identify risk.

[4] https://www.gov.uk/guidance/competent-person-scheme-current-schemes-and-how-schemes-are- authorised#how-schemes-are-authorised

5

Cavity wall insulation

5.1 Site Surveys and Physical Inspection of Cavity Wall Insulation

Subsequent to the review of the submissions, physical inspections were undertaken on the selected sites. These were undertaken with access to the internal spaces of the properties, and where required physical investigation of the cavity spaces, or external details at high level.

5.1.1 Examples of properties that have experienced CWI failure

Surveys were undertaken on the sites selected as discussed earlier and this section of the report looks at the range of conditions that were observed during the process.

In this particular example the effect of rain water driving into the masonry of a building can be seen in Figures 3 and 4. The results are that the moisture penetrates the outer leaf brickwork leading to the wetting of the insulation materials, increased damp penetration and a reduced thermal performance of the material.

Figure 3: Example of saturated insulation

Figure 4: Example of saturated insulation

Other properties visited during the research were showing signs of issues associated with condensation and moisture ingress, which could be the result of saturation and the subsequent failure of the CWI.

Many of the properties had experienced damage and deterioration as a result of the exposure to the weather. Mortar and bricks used in the construction are already saturated, with discolouration and mould growth evident. Examples are shown in Figures 5 & 6 below.

Figure 5: mould on saturated brickwork

Figure 6: mould on saturated render panels

Many other issues were observed during the surveys which indicated that problems with building services within the buildings had either not been reported as faulty or had been repaired badly. This causes staining and increased risk of moisture penetration to the building, as shown in Figures 7 & 8.

Figure 7: Water dripping from extract fan cover and staining the walls

Figure 8: Leaking overflow pipe staining the brickwork

Closer surveys of the conditions of the walls indicated that in many properties the brick walls were moist and in shaded locations so do not benefit from the drying out potential from the sun, providing moss and plants with an ideal growing environment. If the plant growth is not addressed then this could help the wall become saturated, with an increased risk of the insulation in the cavity becoming damp. Examples of this damage are shown in Figures 9 & 10 below.

Figure 9: Plant growth attached to walls

Figure 10: Plant growth and mould, indicating wet substrate

Additional issues were identified in the site visits which would have contributed to any increased risk of mould and damp conditions within the properties, is erosion or cracked/missing mortar joints as shown in Figures 11 & 12 opposite. This damage in the main would have been created by exposure to wind driven rain. Deteriorated mortar joints are entry points for moisture which can lead to any insulation in the cavity becoming wet.

Figure 11: Erosion of mortar by weather

Figure 12: Cracked and missing

Other issues were identified where rainwater has overblown the roof and has saturated elements of the wall as shown in Figures 13 & 14 below.

Figure 13: Wall staining from water blown off the roof

Figure 14: Staining from roof water run off

The results of the site surveys undertaken indicated by figures 15 and 16 show walls that have at some stage been saturated, and then excessive cold weather has resulted in "Freeze – Thaw – Frost" damage. With the faces of numerous bricks being blown - severe frost damage and cracked rendering may permit higher than normal moisture content in the outer leaf. Insulation of the wall can be expected to increase the rate of deterioration.

Figure 15: Significant brick face loss

Figure 16: Missing brick faces

5.2 CWI extraction

5.2.1 Financial costs of CWI extraction

An element of the desk top research for this project involved making contact with a growing number of companies specialising in cavity wall extraction. BRE understand that the process of extracting CWI can be more than five times more expensive than the installation. While retrofit CWI is a direct result of UK Government policy, it is neither controlled nor overseen by the UK or Welsh Governments, but relies on competent person's schemes and self-regulation to deliver quality control. As a result, when problems do occur, this responsibility is left to the either the installer or system guarantor to resolve. When evidence has been submitted it is lengthy, challenging and rarely successful from the point of the complainant.

Another factor that the cavity insulation failure victims' cases have in common is the impact of the Cavity Insulation Guarantee Agency (CIGA), which issues insurance backed 25-year guarantees. However, it should be highlighted that under ECO 2 Guidance changes were introduced that when resulted in a stipulation of installing insulation (both EWI and CWI) that it is accompanied by an appropriate guarantee the standard lifetime requirements are[5]:

- 36 years for EWI – in legislation
- 30 years for insulation of a mobile home; and
- 42 years for CWI
  (including insulation of a party cavity wall)

For any complaints made, for CWI it is the responsibility of the guarantee provider to investigate the complaint, and where necessary, ensure that the appropriate remedial work is carried out free of charge, but only if the failure is deemed to fall within the causes set out in the documentation. From the evidence obtained during the compilation of this report none of the 24 sites included as part of this study have been successful with claims through insulation guarantee mechanisms.

During discussions with the housing stock managers, they reported that they failed to receive remedial works, including CWI removal free of charge. The responses from CIGA, in general, stated that the failure was not down to the installation, survey or material, but other reasons such as lack of maintenance or occupant behaviour.

Based on data provided by the welsh housing providers participating in this research and the discussions with the extraction companies the price of extracting CWI is approximately £30-40 per m^2. There is clearly further cost associated with remedial work and disruption to occupants. Table 4 below illustrates an indicative cost of CWI extraction for typical houses.

Type of house	Indicative cost of installation of CWI[6]	Average CWI area (m^2)	Average Costs for extraction of CWI
Terrace	£370	54	£1,890
Semi-detached	£475	106	£3,710

*For the calculation above the average figure of £35 per m^2 was used

Table 4: Costs of CWI extraction for the UK

[5] See OFGEM's guidance note for more information: https://www.ofgem.gov.uk/ofgem- publications/93714/deliveryguidance-pdf (p.60).
[6] http://www.energysavingtrust.org.uk/domestic/cavity-wall

5.2.2 Environmental costs of CWI extraction

Over the past few years, widespread attention has been given to "green" building and sustainability. Sustainability includes, at a minimum, both energy efficiency and recycling. Unfortunately, insulation materials are currently not being recycled after end of use but just sent to landfill

Taking into account the (UK) figure of 60,000 reported cases of failed CWI and that the average external wall area (70m^2 for a terrace house and 120m^2 external wall area for a semi-detached), based on a typical property size of a house constructed in the 1960's and 70's removing the openings, result in an area of fillable cavity wall roughly 54m^2 for a terraced property and 106m^2 for a semi-detached property. Based on the assumption that the cavity has a diameter of 75mm, we can calculate the approximate amount of insulation which may need to go to landfill.

- 60,000 x 80 x 0.075 = 360,000m^3

It is important to take into account that the figure above represents the minimum amount (e.g. an assumed 1% failure rate), made available through official figures.[7]

5.2.3 Potential for Environmental Impact reduction

In 2006, the Danish Environmental Protection Agency released a report[8] that concluded it would be technically possible to recycle a significant proportion (90%) of the collected and sorted insulation.

The recycling concept will primarily include the reprocessing of used materials to new commercial products. The research of the Danish Environmental Protection Agency on used rock wool materials also shows other potentials, for example as substrate in production of road materials. The latter could lead to a substantial reduction in production of new asphalts and would include significant energy savings. This may be relevant in cases where the used rock wool would not be able to meet the required specifications for new product standards, or when the rock wool manufacturers, due to time constraints, do not have the possibility to absorb all recycled materials.

A key challenge is to develop the recycling concept and the involved equipment, to such a level that the new insulation product can meet the market standards and compete with existing products.

In Australia[9] an EPS factory compacts EPS insulation boards. EPS factories usually recycle these waste EPS to give them a second life. For this purpose, an EPS Compactor is used, the feed hopper of which is suitably designed for throwing waste plastic in the shape of board.

With the recycling technologies developed, the main environmental impact would be reduced greenhouse gas emissions and mitigation of climate change. The tested technology can lead to energy savings at several levels. Besides the most obvious benefit, which would be energy efficient buildings, the recycled insulation product could demonstrate to have a more energy efficient life cycle, compared to new products where extra raw materials and processing of these will be required.

This report does not feature an example of CWI recycling as BRE are unaware of any such practise taking place in the UK.

7 http://www.ciga.co.uk/wp-content/uploads/2015/05/2015_Annual_Report.pdf
8 http://www.eco-innovation.eu/index.php?option=com_content&view=article&id=406:recycling-of-used- rockwool&catid=55:denmark
9 http://www.greenmax-machine.com/Australia-EPS-Factory-Compacts-EPS-Insulation-Boards.html

5.3 Case Study 1 – Cavity Wall Insulation in narrow cavities

This case study presents evidence of the surveys undertaken that identified that narrow cavities had been insulated in an area of very high exposure risk.

5.3.1 Form of Construction and Site Conditions

Of the 72 houses in the geographical area identified by this case study, a random sample of 49 insulated properties were subject to detailed surveys. The surveys indicated an almost identical construction type, (although some are partially rendered), with some minor variations in built form due to the introduction of extensions and conservatories at a later date to the original construction. The properties were located in four smaller sub-locations (number 1 to 4 and shown in Figure 17 below).

The properties were in an elevated site location approximately 338m above sea level with clear exposure to the prevailing weather and wind conditions. Figure 18 below shows the proximity to the valley, with the ground falling away to the right of the line between location 1 and 4.

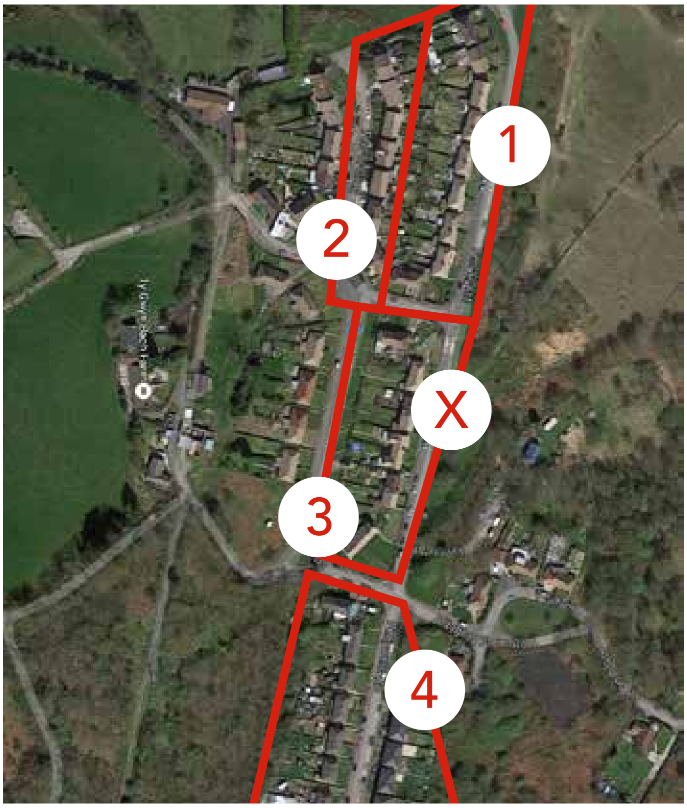


Figure 17: locations 1,2,3 and 4


Figure 18: Proximity of the properties to an open valley

The properties located in Location 2, 3 and 4 are offered some protection from local geographical features, such as trees and shrubs. These offer some protection from the prevailing weather.

The physical inspections, confirmed the houses as being traditional, cavity wall, semi-detached houses. The dwelling typology is shown in Figures 19 & 20 below.

Figure 19: Typical property at Location 3

Figure 20: typical properties at Location 1

5.3.2 Exposure Assessment

As discussed previously there were multiple methodologies for assessing the exposure of the property, which correspond to the methods and guidance in place at the time of the insulation: BBA Information No.10 and British Standard BS8104:1992. According to BS8104 and BR262 this property would be located in Zone 4.

However, undertaking an assessment of the sites using the methodology in BBA Information No. 10 indicates that the Exposure Rating would be E=97. According to the BBA Information No. 10, each insulating material is certified up to a specific level of exposure. For example, blown mineral wool can be used up to an exposure rating of 120. But the cavity must be clear of obvious defects, not have raked or recessed mortar joints, free from damp other than that caused by condensation, and the cavities should be clear of debris and not less than 50mm in width. Assuming that these qualifying conditions were met, this Exposure Rating indicates that mineral wool would be suitable for this location.

The British Standard for calculating exposure, BS8104:1992, which was also in place at the same time as these properties were insulated, indicates the quantity of rain that may strike the properties in extreme weather conditions. The standard states that as much as 80%[10] of water striking a building may be absorbed into the cavity if the wall becomes saturated, although 20-30% may be more typical.

The calculated quantity of wind driven rain, l/m2 per spell, have been calculated using this method. These calculations indicate a run off that categorises the locations as being in a "very severe" exposure location with the potential for a considerable quantity of moisture to penetrate the cavity, with a summary of the results for each zone shown in Table 5 below.

In addition to the assessment of the exposure level of the site, which has been calculated to be "Very severe", it is important to understand the particular characteristics of the cavity void condition, as these factors can affect the performance of any insulation.

	Location 1	Location 2	Location 3	Location 4
Run off (l/m^{2}per spell)	403.2	240.24	403.2	403.2

Table 5: Quantity of wind driven rain according to BS8104:2011

[10] BS8104:1992 Paragraph A.6.4

5.3.3 Assessment of the Quality of the Cavity

The quality of the cavity, at the time these properties were insulated, should have been assessed using British Standard BS8208. Although this standard has now been superseded by subsequent CIGA guidance, the BS8208 guidance was used for the site inspection by the BRE to endeavour to replicate the principle that should have / was used at this site, at the time of the original survey. The aim being to ascertain if the insulation was installed contrary to good practice at the time of installation, or not.

According to the surveys undertaken by the BRE, the cavities were inconsistent in width, varying between 35mm and 49mm. See Table 6 below.

Cavity Width Measurement Results using C = L – (TL + TF)				
Location in building	L	TL	TF	Width (C)
Front elevation beneath window	161 mm	107mm	19mm	35mm
Rear elevation beneath left hand window	168mm	104mm	15mm	49mm
Airbrick side elevation low level	164mm	105mm	18mm	42mm
Airbrick rear elevation high level	163mm	106mm	16mm	41mm

Table 6: Sample Cavity width measurements

In many locations the cavities were bridged by fallen mortar and debris, which on closer inspection were consistent with internal damp spots and mould growth in several of the properties.

5.3.4 Assessment of suitability of wall for cavity wall insulation

The site investigations indicated that the properties are located in a very severe exposure zone, as indicated by BS8104:1992, with cavities less than 50mm wide. There is no full-fill cavity wall insulation solution that can be safely used in this type of property. In addition, the presence of obstructions within the cavity would also usually preclude the application of CWI. Overall, we can conclude that there is evidence that the insulation applied to these properties were installed contrary to good practice and the standards in place at the time.

5.4 Case Study 2 - Cavity Wall Insulation

This case study, of just a single property, acts to illustrate an example of major problems developing in a property after cavity wall insulation has been installed inappropriately.

5.4.1 Form of Construction and Site Conditions

The building in question is of traditional brick and brick cavity wall construction, with gypsum plaster internal finish and rough cast sand cement render external rain screed. The property was in a highly exposed location, without any localised sheltering from topographical features or nearby properties.

5.4.2 Exposure Assessment

The location of this property is in Zone 4 and in an elevated location with no localised topographical features to protect the building from wind driven rain. The calculated quantity of wind driven rain is very high and classify the property as being in a Very Severe location. The calculations predicted a Run off (l/m2per spell) of 214, which would locate the property in a "Very severe" Exposure Zone.

Assessment of the quality of the Cavity

The investigations on site measured the cavity width as set-out out in BS8208 for ascertaining the width of a cavity. The results are shown in Table 7 below.

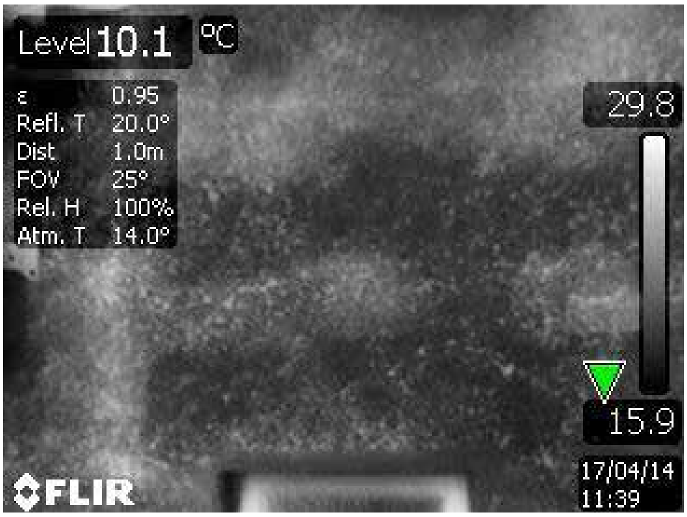
The minimum width of the cavity should be ≥ 50mm, as stipulated in the BBA Certificate. It can be seen from Table 7 that the width of the cavity is slightly below this in some places, albeit only by a few mm.

Cavity Width Measurement Results using C = L – (TL + TF)				
Location No 68	L	TL	TF	Width (C)
Rear elevation beneath window	167mm	105mm	14mm	48mm
Rear elevation beneath left hand window	168mm	104mm	15mm	49mm
Airbrick side elevation low level	169mm	102mm	16mm	51mm
Airbrick side elevation high level	167mm	104mm	16mm	47mm

Table 7: Cavity width measurements

5.4.3 Condition of the Insulation

During the surveys the use of a calibrated Flir Infra-Red camera was utilised to ascertain the consistency and continuity of insulation and the performance of the walls. Figure 21 below indicates the level of inconsistency and lack of continuity (voids) in the insulation, probably caused by either slump or incorrect installation procedures being used, with the darker areas indicating lack of thermal performance and cold bridging.



Dark patches indicating missing or slumped insulation materials.

Figure 21: Inconsistent insulation, shown on IR images

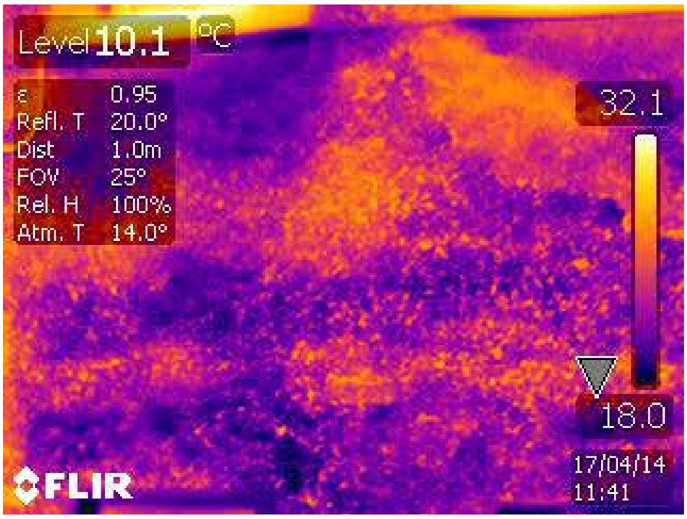


Figure 22: Inconsistent insulation in the same location

Close investigation of the voids being indicated by the IR imaging using a borescope camera confirms that in many places the insulation is in fact missing or slumped, examples of this can be seen in Figures 23, and 24 below.

Figures 23 & 24: Missing insulation below rear kitchen window and rear bedroom window

5.4.4 Condition of the inner and outer leaf

The BBA Certificate for the insulation material refers to the performance of the material in the event of moisture penetration. In particular, it refers to any moisture forming in the cavity running down the face of the cavity, this assumes the presence of weep holes to allow moisture to escape, there are however no weep holes in the property in question, as shown in Figures 25 & 26 below.

There are in addition other areas of cracked and spalled render shown in Figure 28. Cold bridging shown in Figure 27 may be leading to timber rot in the window frames to the property which will be allowing moisture ingress into the cavity area. We can conclude that the maintenance strategy for this property is insufficient and is likely to be leading to moisture entering the insulated cavity.

Figures 25 & 26: showing render to ground formation level at the rear of the property, and no weep holes

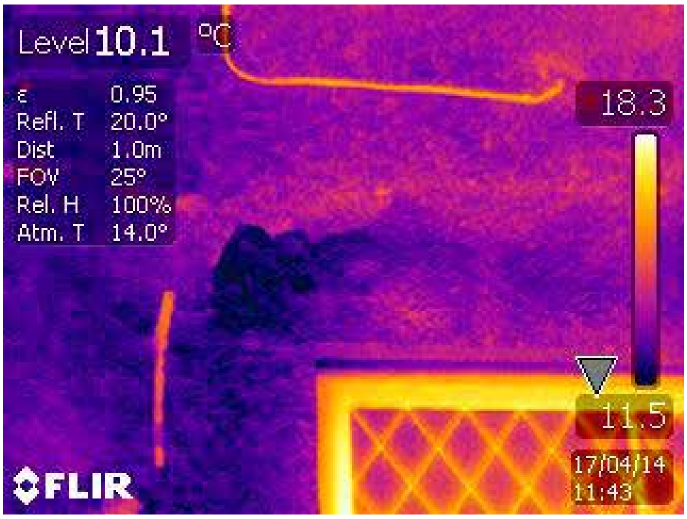
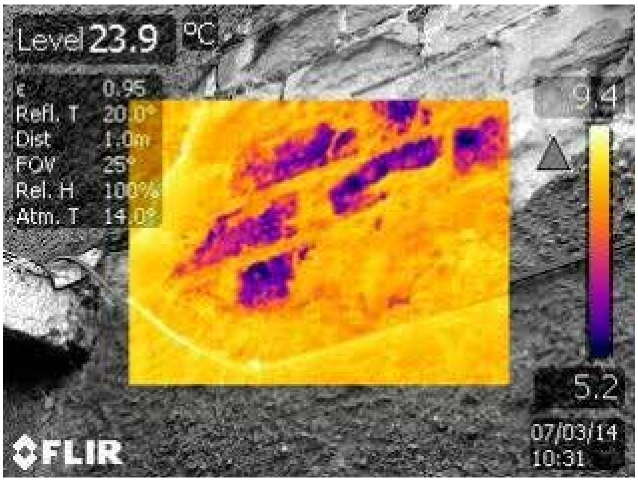


Figure 27: Cold Bridge introduced at area of spalled render.

Figure 28: Cracked render at the property



Figures 29 & 30: Gable end wall damage caused by saturation and blown render

Figures 29 & 30 show the level to which some of the render has deteriorated badly, due to the moisture content of the render and substrate.

5.4.5 Assessment of suitability of walls for cavity wall insulation

The site investigations indicated that the property is located in a very severe exposure zone, as indicated by BS8104:1992. In this case the cavity is only marginally narrower than the 50mm required as a minimum. There is evidence in this case of inconsistent fill. Although it is impossible to determine if this results from poor insulation practice, or the insulation has either slumped, or been obstructed by debris in its installation phase. Either cause is still an indicator of either poor surveying, or poor installation. Notwithstanding this uncertainty, the very severe exposure, and borderline width of the cavity, should have indicated that the property was not suitable for insulation.

5.5 Summary of Findings for CWI

The table below sets out a summary of findings for the 24 CWI submissions received. The findings provide narrative from site visits, discussions with property managers or desk study work.

Type of Insulation	Year of Installation	Tenure	Case	Findings
CWI	2010	Housing Association	During 2013-2014: 17 cases of Cavity Cleans Extractions.	Not visited as CWI already extracted
CWI	1997	Housing Association	Damp and mould on internal wall surfaces. 15 properties in exposed locations	BRE surveys indicate that the outer leafs were in poor condition with cracked render, poor pointing and weather damage to the upper gable areas, most likely a lack of maintenance.
CWI	2009	Housing Association	Wet insulation in cavity, mould growth on internal wall surfaces. Mould and mildew on resident's possessions	A general survey of wall conditions on the estate indicated that almost all of the properties have experienced damage and deterioration as a result of exposure to the weather
CWI	2007	Housing Association	Damp and condensation reported on 40 properties	A general survey of the conditions of the walls indicated that almost all of the properties have experienced damage and deterioration as a result of the exposure to the weather. Cavities narrower than guidance indicates is safe to insulate

Type of Insulation	Year of Installation	Tenure	Case	Findings
CWI	Prior to 1990 exact date unknown	Housing Association	Damp, mould and general decay (129 properties).	A general survey of the conditions of the walls indicated that almost all of the properties have experienced damage and deterioration as a result of the exposure to the weather. Cavities narrower than guidance indicates is safe to insulate
CWI	2012	Housing Association	Damp and mould on internal wall surfaces.	No identified link between the installation of CWI and the formation of efflorescence
CWI	2012	Housing Association	Water penetration, damp and mould on internal wall surfaces. (35 properties)	Survey of the condition of the walls indicated that in many properties the brick walls were moist and received no direct sunlight, providing moss and plants with an ideal environment to grow. Plant growth is an indication of wall saturation and may lead to serious structural damage if not remediated with proper maintenance.
CWI	Unknown	Housing Association	Failed render and blowing electrical sockets. Walls saturated and high levels of damp and mould in the property. (1 property)	Cracked/missing mortar joints deteriorated from exposure to weather. Deteriorated mortar joints are entry points for water. Narrow cavities and incomplete fill of insulation
CWI	2009	Housing Association	CWI extraction. (19 properties)	Survey of the condition of the walls indicated that in many properties the brick walls were moist and received no direct sunlight, providing moss and plants with an ideal environment to grow. Plant growth is an indication of wall saturation and may lead to serious structural damage if not remediated with proper maintenance.
CWI	2010-2012	Housing Association	22 properties retrofitted, 45% have failed and resulted in extraction being carried out. (11 extractions)	Incomplete fill, due to debris in the cavity.
CWI	2005-2012	Housing Association	During the period 2013-2014: 273 Cavity Cleans Extractions (45%) failure rate	Incomplete fill due to debris in the cavity
CWI	2005	Housing Association	Damp internal walls, mould growth. (42 properties)	Sporadic incomplete fill, lack of maintenance in sever exposure location
CWI	2012	Housing Association	Walls saturated, damp and mould internally. (16 properties)	Mixture of incomplete fill due to debris in the cavity and poor maintenance
CWI	2012	Housing Association	CWI lead to damp and condensation. CWI was removed after 2 years of being installed. (40+ properties)	Not visited as CWI already extracted
CWI	2012-2014	Housing Association	Number of properties insulated – 57 % of failures – 3% up to date	Visited properties during extraction, cavities blocked with debris and cavity base filled with mortar and earth
CWI	2008	Housing Association	Full extraction completed in 2011. (36 properties)	Not visited CWI already extracted

Type of Insulation	Year of installation	Tenure	Case	Findings
CWI	2012	Housing Association	Problem- localised damp. Solution: Full extraction of insulation undertaken to front of property (the most vulnerable wall due to exposure). (6 properties)	Cavity opened up and saturated insulation removed, cavity trays fitted. External walls hacked and re-rendered.
CWI	2008	Private	1 property CWI installed in 2008. Problem: Damp. CWI Extracted year 2011.	Not visited as CWI already extracted
CWI	2008	Private	1 property CWI installed in 2008. Problem: Damp. CWI Extracted year 2011.	Not visited as CWI already extracted
CWI	2010	Private	1 property Damp problems reported after CWI installation. Render on front elevation in very poor condition.	Poor maintenance to external render
CWI	2013	Private	1 property reported Extent of damage – water even though Polystyrene bead insulation was used. CWI is waiting to be extracted.	Not visited
CWI	2008	Private	CWI installed in 2008. Problem: Damp. CWI Extracted year 2011.	Not visited as CWI already extracted
CWI	2010	Private	Damp problems reported after CWI installation. Render on front elevation in very poor condition. CWI should not have been installed. No extractions carried out to date.	Poor condition of render, CWI not suitable if this was a pre-existing condition
CWI	2013	Private	Extent of damage – water even though Polybead insulation was used. Also had cracks on the gable and loose render. Extent of damage – water even though Polybead insulation was used. Also had cracks on the gable and loose render. CWI is waiting to be extracted.	Poor condition of render, CWI not suitable if this was a pre-existing condition

Table 8: Summary of findings relating to CWI

6

External Wall Insulation

6.1 Site Surveys and Inspection of External Wall Insulation

This section of the report relates to the seven submissions received where EWI had been installed.

Due to the relatively small number of EWI submissions provided it was decided that all would be visited and surveyed.

There are a variety of reasons why the application of EWI may not be as successful as anticipated. Recent work undertaken for DECC (now BEIS) demonstrates the likely cause and consequence of poor process through the procurement, design and installation of the systems[11] . One of the main causes of the underperformance of EWI is a lack of a robust national standard on the design, installation and aftercare of the systems on the market, with training of staff and surveyors being left to the system manufacturers to deliver.

6.1.1 Examples of EWI failure

At all of the site visited it was clear that there were a range of issues that were being experienced.

The main challenge for retrofitting external wall insulation is that of eliminating avoidable thermal bridging in locations such as: window and door openings; wall to roof junctions; and window sills. To overcome these challenges, it is essential that thorough preliminary surveys are undertaken. These should be followed by suitable technical details at the design stage and then quality execution on site.

The range of repeated and typical problems identified as part of the surveys are presented below.

Uninsulated window and door reveals

Window and door reveals are common areas of thermal bridging unless insulated. Where thermal bridging occurs, the internal surface will be colder. When warm moist air inside the property comes into contact with these cold surfaces, condensation can occur and mould growth may occur. To prevent thermal bridging at these points, insulation should be extended into the window and door reveals and jams etc. This can slightly reduce window sizes and in some cases may impact window functionality, if not considered carefully. If windows are to be replaced at the same time they should be brought forward so that the wall insulation will adjoin the window frame without having to be extended into the recess.

When undertaking insulation to the external reveals and heads it is not necessary to match the thermal performance of the main wall. It is however important that the improvement is such that it reduces the risk of accelerated heat loss, mould growth and that adjacent area are not put at an increased risk of mould growth or premature decay.

Examples of thermal bridging and poor installation of EWI are shown in Figures 31 & 32.

Figure 31: Uninsulated window reveal

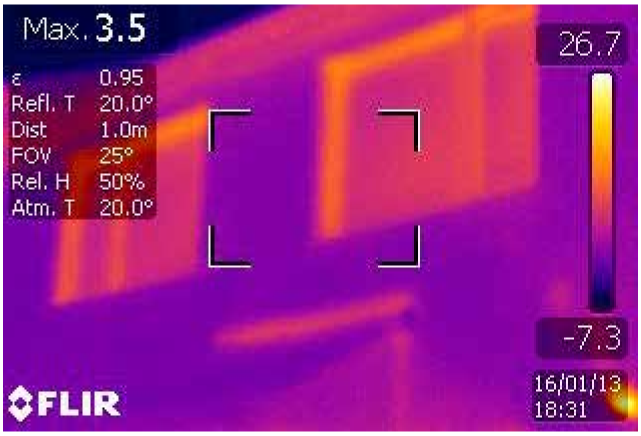


Figure 32: accelerated heat loss through an uninsulated window reveal

[11] https://www.bre.co.uk/filelibrary/pdf/projects/swi/UnintendedConsequencesRoutemap_v4.0_160316_final.pdf

Other common issues identified during the surveys occurred where the roof line had not been extended. This results in a verge detail that relies on flexible sealant to provide water tightness and is a common point of failure by means of water penetration. By extending the roof line this provides protection to the insulation and removes the reliance on flexible sealant to ensure water tightness. Good practice would dictate that roof line be extended by a minimum of 35-40mm passed the insulation, to provide protection to the top of the EWI system from inclement weather. An example of a typical roof that has not been extended is shown in Figure 33 below.

Figure 33: Roof of the building not extended to protect the insulation

6.1.1.1 Penetrations and services not sealed

To ensure the integrity of the insulation system and to provide a long term robust installation it is important that the detailing around penetrations and openings are fully weather tight. This will ensure that water cannot penetrate to the internal colder surface, minimising the risk of interstitial condensation and the reduction in performance of the insulation system.

In some of the properties surveyed, penetrations such as pipe penetrations and wire penetrations were left unsealed. Minimisation of unsealed penetrations of the thermal envelope is essential, whether by services or structure or construction. Where penetrations are unavoidable (ventilation exhausts and intakes, water supply, electricity and gas supplies), appropriate details for their proper execution should be developed. Where pipes or wires pass through the outside wall or the roof, installers should use a minimum seal around them to draught-proof the opening; this will help to reduce the potential for thermal bypass and a reduced efficacy of the insulation system.

Figure 34: Unsealed extract fan in a bungalow

Figure 35: Unsealed pipe penetration

Figure 36: Unsealed wire penetration

Figure 37: sealed penetration (good practice)

6.1.1.2 Cables not clipped

To minimise the risk of accidental damage by cables being snagged or caught, it is prudent to ensure that they are all clipped into position and sealed adequately.

The contractor is required to fit cable clips along the service route. These fixing elements should be spaced at maximum 250mm intervals for horizontal runs and 300mm for vertical runs. They must have sufficient strength to support the service cable. Unfixed cable may cause insulation damage in the future, by snagging or catching.

Figure 38 – cable clipped

Figure 39 – cable clipped (good practice)

6.1.1.3 Poor external finish or quality

When undertaking external wall insulation cladding it is important that the quality of the finish is maintained and that there are no weaknesses in the finish which could allow the substrate of the wall or the insulation material to be exposed to the external weather conditions.

Figure 40: hole in a wall (from scaffolding used during construction)

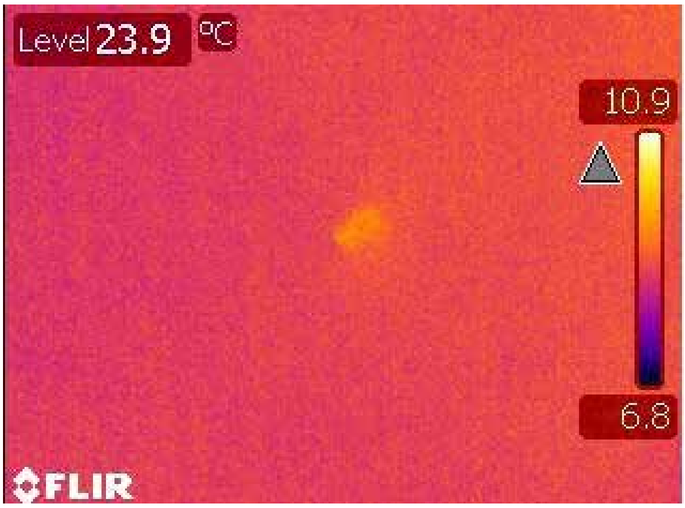


Figure 41: heat loss from the hole in a wall

Figure 42 illustrates the case, where either EWI render has already deteriorated and needs to be repaired, or that it was never finished adequately in the first place. In this case, it was only identified using a thermal camera, as visual inspection did not identify any failure.

6.1.1.4 Sign of deterioration by either damp or poor workmanship

It is important when undertaking external wall insulation work of this nature that attention to detail is paramount. Poor or inconsistent finishing of details can and will lead to a reduced level of integrity, causing either early failure or poor performance. Figure 42 below shows an EWI starter track already deteriorating, although only undertaken seven months before the site survey. This increases the risk of moisture penetration to the main wall, and reduced life span.

Figure 42: Penetrating damp potential in external wall finish

6.1.1.5 Poor Workmanship

Many examples of poor workmanship were observed during the site visits, including poor finishing of details around gutter stop ends as shown in Figure 43 below. This detail has allowed water to by-pass the gutter system and run down the wall, where the introduction of staining and mould can be seen. This can lead to a reduction in the longevity of the system. Where occurring at flexible joints, as in this case, an increased risk of water penetration behind the insulation.

Other similar examples of poor workmanship can be seen in Figure 44, which clearly indicates what can happen if gutters of different material are connected without care an attention. In this case an existing metal gutter has been connected to a new plastic gutter, the joint is poor quality and is leaking. The water is running down the expansion joint between the two properties and the survey indicated that this has already led to water penetrating the finish coat, allowing the finish to start to break away and deteriorate.

This type of poor detailing and workmanship can lead to reduced longevity of the systems, unsightly staining,external mould growth and to an increased risk of water penetration behind the insulation. This water penetration can lead to the wall becoming damp, due to the isolation from the effects of the sun this wall can then not dry out. The resulting effect is that the moisture tracks to the inner surface of the wall creating cold spots and the conditions were premature decay of the internal finishes, and mould can occur.

Figure 43: poor detailing

Figure 44: gutters connected of different material

External window sills incorrectly finished

Other examples of a lack of attention to detail where observed in many of the site surveys undertaken, the example shown in Figure 45 below, shows where a new sill has been built into the EWI system. This in itself is a reasonable decision, unfortunately, no capillary drip has been provided for the sill. This results in any water that runs off the sill but does not fall clear of the wall. This example shows where repeated striking of the wall by the sill run off is resulting in mould growth and staining of the external finish. If this is not addressed the repeated concentration of water run-off will result in the deterioration of the finish. An increased risk of penetration to the substrate layers of the system. Figure 47 shows where the sill has not been completed correctly allowing water to run off the sill against the side wall of the adjoining annexe.

These types of poor detailing are completely avoidable with better site supervision and quality control checks on site.

Figure 45: Staining by lack of capillary drip

Figure 46: Incorrect finish of sill

6.1.1.6 Introduced cold bridges in junctions

All of the submissions surveyed as part of this research had either not addressed the issue of cold bridging around openings and penetrations, or had introduced cold bridging through a lack of design and consideration at the scheme inception point. Numerous examples as the one shown in Figure 47, were identified on site. These occur where there are natural obstructions, such as walls, fences, gates and other connected to the properties. To reduce the risk of cold bridging and associated internal problems such as mould growth these should be cut back to allow the insulation to be fixed to the wall and then replaced to maintain the original function of the feature.

Common or standard practice results in the insulation being placed around the obstruction which increases the effect of the cold bridge, as discussed in FB61,[12] which demonstrates good practice and detailing when undertaking solid wall insulation.

Figure 47: Cold bridge exacerbated by placement of insulation around an obstruction

[12] FB 61 Reducing thermal bridging at junctions when designing and installing solid wall insulation. IHS Press

6.1.1.7 Plants

Although only a few examples were identified during the surveying, Figures 48 and 49 below show the potential risk that can be attributed to a lack of design and enabling works before the introduction of EWI.

Figure 49 shows where a wall abutment has initially not been cut back to reduce the risk of cold bridging and in addition, the poor detail constructed has allowed the invasion of a plant into the void left around the insulation. This plant is no doubt also sending roots behind the insulation which over time could lead to a destabilisation of the insulation boards and allow water ingress. Figure 49 shows plant growth on the existing wall that should be removed and cut back before the installation was undertaken, the site visit for this survey was undertaken less than one month after completion.

Figure 48: Plant growth allowed by poor detailing

Figure 49: Close proximity of plant requiring pruning

6.1.1.8 Ventilation

Conversations with the Housing Providers of all the submissions identified that none of the schemes were assessed or surveyed prior to the installation of the EWI systems for adequate ventilation. The application of EWI reduces the quantity of air infiltration (draughts) this is one of the prime mechanisms for energy efficiency measures that EWI delivers. However, it is essential that infiltration is replaced with ventilation to ensure that excess moisture laden air is extracted from the buildings.

Figures 50, 51, 52 & 53 show examples of early mould growth in properties that had recently received EWI, and reported by the tenants as not being there before the works were undertaken. Although this was anecdotal evidence, closer inspection showed that the properties did not have minimum extract fans in the wet rooms (kitchen & bathroom) and that the trickle vents that were present were all shut, malfunctioning or sealed up.

It is not known in all of the cases whether this is entirely due the basic lack of mechanical extraction or whether there may be contributory factors, such as occupants actively reducing ventilation by closing or blocking trickle vents or turning off fans.

In the examples, where damp was reported in the wardrobe and behind the mattress, an obvious contributory factor was the lack of air circulation.

In the longer term, the issue with inadequate ventilation may prove to be more significant. Some housing providers reported issues with damp where none existed before, even though the EWI measures had only been fitted very recently.

Figure 50: Damp in the kitchen

Figure 51: Damp in the bathroom

Figure 52: Damp in the wardrobe

Figure 53: Damp behind a bed, removed for inspection

6.2 Summary of findings on EWI

Type of Insulation	Year of installation	Tenure	Case	Findings
EWI	2011	Housing Association	Double glazing and improved insulation had been installed, resulting in reported increased condensation. Mould was reported as occurring, in this particular circumstance appeared as pinpoint black spots, most frequently on the reveals around windows and external walls, in corners and in poorly ventilated spaces, such as behind cupboards and wardrobes. Overheating problems were reported from occupants of flats and bungalows in summer.	Cold bridging not addressed around reveals, heads and jambs etc. Trickle vents closed, but mechanical ventilation provided and tested as meeting the manufacturer design rate.
EWI	2011	Housing Association	Improved insulation increased reported condensation. Evidence of condensation was observed including water forming on the inside of windows, particularly the bedroom windows.	Cold bridging not addressed around reveals, heads and jambs etc. No trickle vents and mechanical ventilation that did not meet the manufacturers design rate.
EWI	2012	Housing Association	Evidence of condensation and mould growth had been observed behind wardrobes and furniture.	Cold bridging not addressed around reveals, heads and jambs etc. Mechanical ventilation and trickle vents correctly operating, significant levels of household furniture and obstructions around reported mould growth.
EWI	2013	Housing Association	Households continued to experience damp issues and mould after the improvements, had been undertaken. However, the tenants suggested that after the installation of the EWI the situation deteriorated.	Cold bridging not addressed around reveals, heads and jambs etc.
EWI	2012	Housing Association	Double glazing and improved insulation increased levels of reported condensation.	Cold bridging not addressed around reveals, heads and jambs etc. Trickle vents evident but closed, and mechanical ventilation that did not meet the manufacturers design rate.
EWI	2011	Housing Association	Households continued to experience dampness and mould after improvements. However, tenants suggest that after the EWI installation the situation became worse.	Cold bridging not addressed around reveals, heads and jambs etc. No trickle vents and mechanical ventilation that did not meet the manufacturers design rate.
EWI	2013	Housing Association	Households experienced damp and mould, which were still in evidence 1 year after the improvements had been undertaken.	Cold bridging not addressed around reveals, heads and jambs etc. No trickle vents and mechanical ventilation that did not meet the manufacturers design rate.

Table 9: Summary of findings on EWI

Although a limited number of submissions of EWI were received and surveyed, it would seem apparent that there are common repeated issues, such as lack of attention to detail during the surveying stage, no attempt to address the issues of cold bridging and a lack of ventilation assessment to ensure that reduced infiltration is replaced with good ventilation. These findings are in line with a wider study undertaken for DECC[13], with identified weaknesses in the whole process of undertaking EWI, ranging from surveying, design and installation to handover.

[13] https://www.bre.co.uk/filelibrary/pdf/projects/swi/UnintendedConsequencesRoutemap_v4.0_160316_final.pdf

7

Discussion on the unintended consequences of undertaking insulation retrofit works

On-going research at the BRE, and by other organisations, has identified a number of unintended consequences of undertaking insulation to properties. Although not an exhaustive list, the most commonly identified and accepted risks are indicated below in Tables 10 and 11[14].

Unintended consequence	Cause
Internal Environment	Increased levels of condensation and mould
Condensation and Mould	Drop in internal wall temperature caused by insulant becoming wet
Electrical safety	Electrical sockets on external walls more likely to trip or become unsafe to use
Health and Wellbeing	Increased levels of respiratory illness in properties with mould and condensation
Fuel Poverty	Properties becoming more difficult to heat due to walls becoming wetter.
Structural Failure	Premature corrosion of wall ties due to increased humidity in the cavity
Certification	Insulation certified for use in ventilated or cavities with weep holes, where investigations identified that no weep holes existed.
Premature Decay	Premature decay to timber lintels in properties of older construction

Table 10: Current topics of Unintended Consequences CWI

Unintended Consequences	Cause
Overheating	Observed through both modelling and in the field. It is recognised that overheating can be a problem in all dwellings which have received solid wall insulation. This is particularly a problem for (but not restricted to) those that have been treated with internal wall insulation as a result of decoupling of thermal mass from the dwelling.
Increased relative humidity, and associated damp and mould growth	As a result of increasing air-tightness (not correctly alleviated e.g. through extract fans), increases in internal humidity can occur. This can lead to damp problems, and mould growth, with associated health problems for the occupants. The problem can be particularly associated with un-treated thermal bridges within dwellings

[14] 2014, BRE. The SERS Report: External Wall Insulation Current Practice Review and Guidance for Improvement.

Unintended Consequences	Cause
Negative effect on neighbouring dwellings	There is the potential for the installation of solid wall insulation on one property to affect neighbouring dwellings. This is because the relative temperatures of the walls of the dwellings will be adjusted. As a result, moisture can condense on a neighbouring property in a place where it did not previously causing damp, mould and other problems.
Shifting of thermal bridging to new points	The application of solid wall insulation can affect the internal condensation points. This can create new points which are incapable of withstanding exposure to condensation.
Increased risk of dry or wet rot to timbers	The risk of dry rot developing increases with increased levels of humidity which can occur following the installation of solid wall insulation. An increase in wet rot can be caused by high levels of moisture or humidity in timbers due to poor detailing.
Increased risk of insect attack on timbers	Insect attack to timber structures is increased if the timbers are not kept dry. In older solid wall dwellings (where timbers are more prevalent) any increase in the relative humidity can lead to an increased risk of insect attack on timbers.
Increased risk of dust mites, bed bugs, clothes moths and other insects within the home	A number of household pests including dust mites, bed bugs and clothes moths are more active and prevalent in increased humidity which can follow the installation of solid wall insulation.
Increased Radon risk	In areas of the country prone to Radon (e.g. areas of South West England) increasing airtightness following the installation of solid wall insulation could potentially result in an increase in the risk of exposure to occupants.
Rot of internal floor and roof timbers	With internal insulation floor and roof joists can become significant thermal bridges unless particular care is taken. Due to increases in humidity, these thermal bridges can then rot as moisture condenses on them, causing significant structural problems.
Damage to the external wall structure, or failure of internal finishes, due to water fill and frost damage following internal insulation	The application of internal wall insulation can mean that an external wall is no longer dried by heating the interior of the dwelling. As a result, moisture is not driven out of the walls, which can cause structural damage and the failure and decoupling of the internal finishes (including the internal insulation itself). One mechanism for damage is ‘frost damage’ to the brick as the water in the wall freezes. It is important to understand the physics of how solid walls perform and deal with moisture transference based on their levels of humidity.
Increased interstitial condensation	An increase in humidity can result from the application of solid wall insulation, leading to condensation in interstitial spaces (such as in roof eaves etc.), or within the structure of the walls
Short-term reduction in air quality following installation of solid wall insulation (Formaldehyde and other VOCs)	There is a risk of increased levels of toxic volatile organic compounds (VOCs) including formaldehyde from the adhesives and other substances used in insulation products. These substances can have significant short and long- term effects on the health of occupants, with many being carcinogenic.

Unintended Consequences	Cause
Long-term reduction in air quality following solid wall insulation (CO, CO_2 levels)	A reduction in air quality over the longer term as a result of reduced levels of ventilation following solid wall insulation may occur. This may lead to increases of Carbon Monoxide and Carbon Dioxide, both of which can have short and long term effects on physical and mental health of occupants.
Aesthetics	From a cultural or aesthetic point of view, the use of external wall insulation may have a significant impact on the character and vernacular of many towns and cities throughout the UK.
Property value	The effect of solid wall insulation on property value is uncertain. While some value can be assigned to the lower levels of energy consumption, lower values may result from any reduction in aesthetic appeal, or reduction in internal space resulting from the works
Daylighting	Research undertaken by BRE indicates that the use of wall insulation can have a detrimental effect of internal day light factors. This has a counter factual outcome of providing insulation to reduced energy demand, with the potential for increased energy demand on lighting, and less benefit from solar gain.
Durability and maintenance and repair consequences	Solid walls with no insulation applied either internally or externally are very robust and sturdy structures. The introduction of materials that are effectively air traps and less resilient to impact could potentially have an unintended consequence of an increased demand for maintenance and repair, as a result of damage or even normal usage.
Disturbance	The installation of solid wall insulation has the potential for disturbing not only the occupiers but also the surrounding vicinity, with the erection of scaffolding, deliveries and other incidental activities. As a consequence, when residents understand the extent of disturbance, it may become a disincentive to having the improvement works undertaken.
Fire safety	Applying solid wall insulation internally or externally may introduce a potential for increased fire risk to buildings, unless this consequence is fully considered. There are potentially significant risks of creating a fire bridge between dwellings with external wall insulation systems over several dwellings (e.g. a block of flats).

Table 11: Currently identified Unintended Consequences EWI

8

Case studies of best practice

Some examples of best practice have been selected below to demonstrate cases where retrofit work and solutions have been successful.

8.1 Peulys Estate in North Wales

The Peulys estate in North Wales is a good example of retrofit of non-traditional "Lowton Cubitt" construction which involved EWI. The "Lowton-Cubitt construction" refers to dwellings constructed during the mid-1960s and early 1970s by the Lowton Construction Group. They are a hybrid of steel frame construction, with gable and separating walls of a cavity arrangement returned around the front and rear walls, using gas concrete panels for the inner leaf and brickwork for the outer leaf. Cartrefi Conwy is the registered social landlord for the estate.

The project demonstrates the additional benefits of carrying out refurbishment works in line with current best practice including extended roof lines, isolated porches, window reveals and cut back fences and installed gravel soakaways. Further details are included below.

Draining trench at ground floor level

At some of the dwellings in particular the gable ends, raised soil adjacent to the walls led to concerns regarding the installation of an appropriate damp proof course (DPC). This is because the surrounding soil may effectively trap moisture and prevent it from leaving the wall structure, potentially leading to damp problems. It was therefore decided that a trench would be dug adjacent to the wall below the DPC and floor slab level then filled with free-draining gravel, to ensure that there was a suitable means for moisture to leave the wall construction and drain away.

Figure 54: Ongoing works to provide soak away on raised ground areas.

Remove and refit adjoining fences and gates

Fences and gates were tied into the dwellings at boundary edges see Figure 55. Fortunately, in this instance it was feasible to take down these features to allow the external insulation to be applied continuously to the walls at these points. This is preferable to installing the insulation around the existing feature, which would lead to a thermal bridge. There are some instances where it is not so practical to do this, such as at adjoining structures or porches (as is discussed below). In this case, fences and gates would be replaced after the EWI installation, ensuring that their mode of fixing would not damage the insulated render and would not introduce new detrimental thermal bridging points.

Figure 55: Typical fencing abutting main walls prior to EWI installation

Isolating porches from the main construction

While it was possible to remove and replace some features around the dwellings to accommodate the externally applied wall insulation without introducing potential thermal bridging issues, the porches of the dwellings were more problematic because they were integrally tied into the structure of the buildings. It was therefore recommended that the porches be removed from the buildings and insulation applied behind where the porches had previously been tied into the structure. This would allow the continuation of the EWI across the front of the building where the porch had previously been attached. This could then be subsequently enhanced by the use of high performing insulation to minimise the cold bridge of the rebuilt porches, as shown in Figure 56 below.

Figure 56: Porch removed and cold bridge removed

Extend eaves over insulation

It is often the case in existing dwellings that the as-built original eaves and gable overhangs are insufficient to accommodate an additional layer of externally applied insulation. In such cases, it is common for installers to apply a finishing cap at the top of the insulation. However, there are reasons why this may not be considered ideal. The first is the overall visual appearance of the dwelling after such treatment, although this may go unnoticed by many people and is generally considered a low priority issue, and secondly this detail is reliant on flexible sealant to provide a watertight seal, which increases the risk of water penetration if not undertaken correctly or regularly maintained. Figure 57 shows good practice employed by Cartrefi Conwy, which is not only is more aesthetically pleasing, but also reduces the cold bridging effects and potential risk of condensation and poor performance.

Figure 57: Extended eaves detail

Return insulation at window reveals to minimise cold bridging

The choice of detailing of external wall insulation around windows can also introduce or exacerbate thermal bridging at the window reveals if the substrate wall surface remains exposed to the external environment behind the newly applied external insulation layer. This is quite common since often the thickness of the visible window frame is deemed to be insufficient to allow additional insulation to be returned into the reveal to cover the substrate wall and seal against the frame. Windows or doors may also limit the potential for this additional insulation to be applied if its thickness introduced an obstruction to the opening casement.

This problem can sometimes be addressed when new windows are installed as part of a dwelling refurbishment at the same time as EWI. Thicker window frame profiles could be specified that would provide a wider area against which the returned insulation could abut and due consideration to the arrangement of openings may prevent the risk of this new insulation interfering with the opening. Thicker frame profiles may carry an additional cost and the visible thickness of frame may still not be deemed sufficient to apply a reasonable thickness of insulation material (and render finish) to the reveal.

Figure 58: Insulated reveals and head

As the windows to the properties were modern and well performing, it was not a cost effective measure to remove and refix the windows to completely address the issues of cold bridging. The next best approach was taken the introduction of high performing insulation to the reveals and heads, as shown in Figure 58.

8.2 Llandysul, West Wales

This case study is of the work completed by Willmott Dixon Energy Services in Llandysul, West Wales. It has been selected as an example to show a project which has involved the retrofit of domestic properties with external wall insulation, in a manner that is worthy of replication.

Willmott Dixon are scheme managers of the Arbed 2 EDF project which are undertaking energy efficiency works on domestic properties with the aim to improve 2500 properties across mid and North Wales over three years. One of selected schemes is Llandysul, Ceredigion.[15]

The properties are of solid wall construction and the off gas network where fuel efficiency is poor. The scope of work has included external wall insulation and boiler upgrades, with the aim to improve energy efficiency for thermal comfort and reducing energy bills. The external wall insulation system used has been designed specifically to meet the challenges of the wet British climate and so provides extremely low water absorption and protection against algae and mould growth. Adding to the lifespan of properties, additional benefits included upskilling 5 local SME's in the area and those from adjoining councils with training on how to use the external wall insulation system used for the ARBED scheme in Llandysul. This was an important part of the scheme given the issues with poor workmanship previously stated in this report. In summary the project has:

- Treated 105 homes in Llandysul
- Provided over £1500 benefit in kind with works on family centre
- Carbon saving and SAP benefits
- Long term protection of the structure resulted due to the added protection provided to the elements
- Two members of the local community who live on the estate employed by the Welsh contractors on the scheme and trained as external wall insulation installers
- Training on the installation and maintenance of external wall insulation provided by the supply chain working on the scheme to operatives from Tai Ceredigion and Cantref, to help them with their future works.

[15] http://www.willmottdixon.co.uk/energy-services

9

Discussion

Cavity Wall Insulation and External Wall Insulation are measures applied to the housing stock in order to improve energy efficiency. These measures, however, cannot be applied to all properties in all situations. Known risks exist where these measures are applied incorrectly, or in the wrong circumstances. This report has acted as an initial scoping study for a wider piece of research, and highlighted examples where both CWI and EWI have been applied in a manner contrary to good practice.

When considering what constitutes good practice and what may be in breach of good practice, consideration needs to be given both to the methodologies in guidance at the time of installation.

The guidance in place for CWI throughout the period of the installation of the surveyed properties, indicates that there are three crucial factors when considering a cavity to be suitable for filling. Carefully considering these factors can reduce the risk of unintended consequences, three key factors are:

- The need for proper assessment of exposure of the location of the property with a detailed survey e.g. using BBA Note 10, BS8208 or CIGA technical guidance.
- The inspection of the cavity voids to ensure that it is free from obstructions (services, fallen mortar, or other debris) that can cause a blockage and prevent a full fill of the void.
- On-going and timely maintenance provision in place, it is essential that the property is kept in a good state of repair to ensure its integrity to prevent moisture penetration.

If the required level of care and attention to detail is not undertaken in the surveying, and installation process of CWI, it can result in an incomplete fill, introducing cold spots which increase the likelihood of cold bridging and formation of condensation and mould growth. All of these factors have a direct impact on the performance of CWI.

The examples described in this report, highlight examples of where guidance in place at the time of installation have not been followed. In the case of the CWI examples in particular, practices, methods and guidance have developed since the time of the insulation. What is unclear at present is whether all retrofit insulation work occurring today is avoiding the same mistakes and following the current guidelines. The recommendations include a review of the current guidelines, and further research to determine if modern methods are avoiding the problems identified.

The properties visited as part of this study were proposed for investigation (by housing managers) as having developed problems following the installation of insulation. We therefore have a situation where properties are developing problems and there is evidence of poor practice in insulating and maintaining them. What is difficult to say with confidence, is that these two are definitively linked. It is impossible to determine if any of the problems were present prior to insulation (as no comprehensive survey records for the period prior to insulation exist), or indeed if many of the problems would have developed irrespective of whether the insulation had been applied. To be able to determine this, a much more structured and comprehensive assessment process would be required, including detailed "pre-insulation" surveys, and regular visits to the properties in the following months and years. Ideally, this would be accompanied by an ongoing assessment of control properties. Despite this lack of definitive evidence, it seems likely from some aspects of the surveys (e.g. co-location of cavity bridging or missing insulation to internal damp spots) that the inappropriate installation of insulation may, at the very least, be exacerbating problems in these properties. These case studies, therefore, act to highlight the types of problems that may occur if insulation is not installed correctly, or properties are not maintained correctly. The examples also suggest that there may be a temporal factor to failures and that the potential for problems to be exacerbated by extended periods of poor maintenance, or extended periods of exposure to wind driven rain. The short term problems of living in a damp home are quickly apparent to occupants but longer term problems to the building structure also need to be considered. These investigations and case studies can only provide initial insights into these areas but within recommendations for future work, we discuss the need for a more structured set of site investigations.

From the limited number of surveys and the mechanism of sample selection, it is also inappropriate to draw any conclusions on the prevalence of these types of problems at local, regional or national levels. This type of assessment needs a completely different approach, in particular in the choice of sampling method. This is also discussed further in the recommendations section below.

Regarding the installation of EWI, the lack of a national standard for all stages of the work provides weakness and elevated risk of premature failure. All the properties surveyed exhibited common problems, such as lack of good detailing to address cold bridging, poor quality design and installation on site and a lack of understanding regarding the importance of replacing infiltration (draughts) with good ventilation. All of the issues identified with good process are capable of being designed out.

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Recommendations for future work

This scoping study has provided an initial assessment of four groups of dwellings where problems have been reported by housing managers following insulation retrofit works. The observed problems include damp, mould growth, cracking render, poor thermal performance and other issues. It has been observed in the cases presented that cavity walls have been insulated in situations that would not have been recommended under good practice, including unfavourable climatic circumstances and where narrow cavities exist.

Furthermore, appropriate maintenance of the properties has not been undertaken in the time since the insulation was installed. From the work undertaken in this review it is impossible to determine what led to these failings in the process for installing cavity wall insulation, or to prove conclusively that these failings led directly to the unintended consequences observed, although there is evidence that strongly implies a direct connection between the installation of CWI in narrow cavities and damp. Consequently, it is now **vital** that further work is undertaken to help ensure that the cavity wall insulation is procured, installed and maintained in line with good practice and to help to ensure that any unintended consequences do not occur in future.

A key objective of this work was to scope the requirement for future work and research in this area. The work to date has highlighted a number of areas which should be considered for future work.

Our first recommendation is for a nationally representative survey to identify the scale of unintended consequences after insulation. This research is not able to identify the extent of poor practices, or the development of problems following insulation locally, nationally or regionally. To do this, an entirely different type and structure of survey is required. Such a survey needs to be nationally representative and should therefore, be sampled randomly from the population. Ideally this should include an assessment of a both insulated and uninsulated properties (acting as controls). An existing example of this type, which may prove a model for a future survey in Wales, are the follow-up surveys of wall U-values undertaken in England which follow-up on the nationally representative English Housing Survey. Such a survey could follow-up on any future Welsh House Condition Survey undertaken by the Welsh Government. The last national survey of this type in Wales was the 2008 Living in Wales Survey. An alternative would be to undertake a large national postal survey, to be followed up with site visits. A model for this exists in work undertaken for BRE in the 1990s, which investigated failure rates in dwellings with CWI (described in BRECSU Best Practice Programme GIL 23).

Our second recommendation is for a review of current practices, guidance and methodologies. This research has highlighted examples where good practice in the installation of insulation has not been followed, such as the installation of CWI in areas of very high exposure. We would therefore recommend that the current practices, guidance and methodologies for the installation of cavity wall and external wall insulation are thoroughly reviewed. An assessment should be made of whether existing guidance is being followed and if it is not, identifying why. Guidance should be assessed for clarity and usability in particular.

The findings suggest that the procedures for ensuring adherence to guidance were insufficient to prevent poor practices at the time the properties were insulated. Although the research to date, which has focussed on historic installations, is unable to provide an insight into the adequacy of the current procedures this scoping study has highlighted that a review of current practices is needed to ensure they are adequate and prevents the practices which can be observed in these older installations. In particular, the surveying and installation elements should be assessed, with a view to providing specific guidance for improvements to processes such as the assessment of risks regarding the level of exposure to wind driven rain. It is also likely to require the assessment of the processes for quality assurance of insulation installations, as well as a review of the procurement process.

Case studies 1 & 2 identified that the cavities were insulated in locations of severe exposure and with a width that was narrower than the recommended requirements of the standards in force at the time of installation.

There was also evidence in a number of the cases submitted that the maintenance of the properties (e.g. the render / brickwork) may have been insufficient to prevent moisture passing through the outer leaf of the cavity. We would, therefore, further recommend that any future review of guidance includes reviewing the maintenance guidance for installers, housing managers and occupants to help ensure that basic measures are taken to protect the insulation installation and thus make failure less likely.

Our final recommendation is for a more controlled assessment of a sample of dwellings to establish causality of problems. Establishing definitively that reported problems of damp, mould growth etc. result from the inappropriate installation of insulation is almost impossible without comprehensive pre-insulation surveys (including direct measurement of the thermal performance of cavity walls) and a period of ongoing monitoring. This research is able to strongly suggest that the two are linked but without this more structured assessment, this cannot be said beyond doubt. We would therefore recommend that a more structured survey is developed to assess this, which would monitor a sample of dwellings throughout the entirety of the insulation process. Many of the problems appear to have developed over a period of time. It therefore is further recommended that an extended period of monitoring is set-up in order to assess whether additional failures occur progressively over time.

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Conclusions and recommendations

Following a call for evidence to housing providers and managers in Wales, reports were made to BRE of properties encountering possible unintended consequences following the installation of Cavity Wall Insulation (CWI) and External Wall Insulation (EWI). On-site surveying by BRE of a sample of the properties was undertaken in a range of locations where problems following insulation had been reported.

Two case studies were presented in this report as having shown signs of unintended consequences following CWI installations and being indicative of where good practice had not been followed.

The primary reported problems include:

- Damp and mould growth
- Thermal bridging and poor thermal performance
- Cracking in render (although pre-existing cracking may also be a causal factor)

This case study evidence indicates that the insulation has been installed contrary to the standards in force at the time of installation.

The more general examples shown with CWI; identify cases where wall insulation appears to have been installed contrary to good practice. In particular, these include:

1. Narrow cavities having been insulated
2. Properties in areas of high exposure risk having been insulated with no local features to provide shelter and protection
3. Adequate maintenance works not completed on insulated walls

For EWI, a general view of the state of the installations have been provided. These show common and repeated faults with the process undertaken, including the initial surveys for obstructions, and features that require bespoke construction details or enabling works, the design of the systems, around wall, fences and other obstructions, and the general lack of understanding of the importance of replacing reduced infiltration with good ventilation.

The properties visited as part of this study were proposed for investigation (by housing managers) as having developed problems following the installation of insulation. In some cases, internal problems of damp and mould coincided directly with issues with the insulation, including debris and other objects bridging the cavity, and areas of missing or slumped insulation. However, it is not possible using the evidence available here to definitively assign the installation of the insulation as the sole or primary cause of the observed problems. To allow us to do this would require access to a comprehensive pre-insulation property survey and for there to have been regular inspections post-insulation. It does seem likely, however, that the installation of insulation in inappropriate dwellings or in a manner that is not in line with good installation practice may, at the very least, be exacerbating problems in these properties. The evidence supporting this is particularly strong where internal problems coincide with observed problems in the cavity. In order to confirm the extent to which these problems may be being caused by the insulation, we therefore recommend that more structured monitoring on an additional sample of dwellings, at different stages of the development of unintended consequences, and over a longer period be undertaken. This would be required to more definitively assign causality of the observed problems to the application of the insulation.

The number of properties visited is low and was specifically selected from properties which had reported problems. As a result, it is not possible to ascertain how prevalent these unintended consequences are nationally. It is clear from these examples, however, that there are problems developing in properties which have been insulated in the relatively recent past. We therefore recommend a more representative survey is undertaken to ascertain the prevalence of these problems in Wales.

In these specific cases presented in this report, there is evidence that insulation has been installed in unsuitable properties (due to the building construction or the local climate), or without due regard for best practice (including installation and maintenance). We have, therefore, recommended that guidance and current procedures covering these installations are thoroughly reviewed. This would include a review of the competent person's scheme and development of guidance for maintaining insulated properties.

Recommendations Table

Research (UK and WG)	Standards & Policy (UK and WG)	Standards & Policy (WG)	Training & Behaviour (Industry)
1. More in situ Testing Move away for reliance on unrealistic lab results. Wider research into walls that have received CWI for moisture content	**4. Standards update** Updates to BS5250:2011 to account for performance gap (UK wide)	**7. Building Regs U-value update** Remove encouragement to achieve 0.3 in all instances	**10. Training provision for surveying for exposure and building condition** Training on exposure and building defects
2. Wider scoping study of failure rates A comprehensive review of failure rates and causes in Wales and the wider UK. Including improvements in internal conditions post extraction of CWI	**5. Process control improvements** Review PAS 2030 and CWI competent persons schemes. Regarding On-site controls and sign off and increased inspection rates	**8. Creation of standard details for EWI** Creation of proven thermal bridging details and principles to reduce risk	**11. Training of professionals** Review course content for professionals to cover the principles of condensation and moisture movement in structures
3. New weather data Weather data for modelling performance (wind driven rain included)	**6. Funding linked to performance** Ensure funding schemes are tied to best practice and require consideration of whole house and moisture issues	**9. Building Regulations ventilation and moisture risk** update Part C and F reviewed and considered as part of thermal upgrades	**12. Encourage good occupant behaviour** Requirement for guidance on hand over to the occupants of improved properties

Figure 59: Route map for change from DECC Report

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Appendix A

Drivers and Incentives for Energy Efficiency Measures

A1 European Union

The European Union has three climate and energy targets to be reached before 2020: a 20% reduction in greenhouse gas emissions, 20% of energy derived from renewables and a 20% increase in energy efficiency. If these 2020 targets are not met, a sustainable, secure and affordable energy system will be exceedingly difficult and expensive to achieve.

The 2012 Energy Efficiency Directive (EED) establishes a set of binding measures to help the EU reach its 20% energy efficiency target by 2020. Under the Directive, all EU countries are required to use energy more efficiently at all stages of the energy chain from its production to its final consumption.

The EED is a framework directive which sets overarching objectives and targets to be achieved by a coherent and mutually reinforcing set of measures covering virtually all aspects of the energy system: from supply, transformation, transmission and distribution to consumption. Member States (MSs) had to transpose the EED into national law by 5 June 2014 within their own legal, social, environmental and economic culture.

MSs often transpose EU directives with a view to meeting only the minimum levels of ambition, avoiding complexity or changes to existing national law, even though going beyond minimum requirements can often bring numerous economic advantages and other types of benefits. All actors within the value chains of the sectors covered in the EED, be it industry, buildings, appliances, transport or energy supply, have a vested interest in supporting good implementation.

A1.1 Buildings under the EED

The Energy Efficiency Directive places energy savings requirements on EU countries' buildings. This includes making central government buildings more energy efficient and requiring EU countries to establish national plans for renovating overall building stock. The JRC report on environment improvement potential stated that the current situation of the European residential buildings stock, in terms of environmental performance, is far from the currently discussed low-energy standards and there lies a tremendous potential for improvements. The report concluded that the emissions of greenhouse gases from buildings may be cut by around 30% to 50% over the next 40 years. The expected benefit in both environmental and socio-economic aspects are huge: CO2 emissions will be reduced, higher housing quality will be achieved and the building value will be increased.

The current Directive is set to promote the improvement of the energy performance of buildings with four requirements to be implemented by the Member States:

- general framework for a methodology of calculation of the integrated performance of buildings (Art. 3);
- setting of minimum standards in new and existing buildings (Art. 4, 5, 6);
- energy Certification of buildings (Art. 7);
- inspection and assessment of heating and cooling installations (Art. 8, 9) by Independent experts (Art. 10).

The Energy Performance of Buildings Directive (EPBD) and the Energy Efficiency Directive contain provisions to increase renovation rates, especially for public buildings. However non-technological barriers hamper the implementation of these provisions and also prevent other market actors in the residential and private sectors from following the example that the public sector is expected to set.

EU countries have drawn up strategies to show how they plan to foster investment into the renovation of residential and commercial buildings. These strategies are part of their National Energy Efficiency Action Plans. They:

- provide an overview of the country's national building stock
- identify key policies that the country intends to use to stimulate renovations
- provide an estimate of the expected energy savings that will result from renovations

A1.2 United Kingdom

Emissions from buildings accounted for 37% of total UK greenhouse gas emissions in 2012. Residential emissions account for 66% of buildings emissions, with commercial and public sector emissions accounting for 26% and 8% respectively. They comprise 45% direct CO2 emissions (i.e.

from burning fossil fuels) and 55% indirect (grid electricity-related) emissions.

In the UK improving energy efficiency through home insulation was found important both for reducing emissions and for reducing energy bills. The final year of operation for the Carbon Emission Reduction Target (CERT) and the Community Energy Saving Programme (CESP) was 2012. During these programmes the UK energy companies had to deliver large numbers of installations to ensure they met their targets.

CERT

The Carbon Emissions Reduction Target (CERT) ran between 1 April 2008 and 31 December 2012 and followed the Energy Efficiency Commitment (EEC) 2005-2008. CERT required certain gas and electricity suppliers to achieve targets for reducing carbon emissions within domestic properties.

The Gas and Electricity (Carbon Emissions Reduction) Order 2008 and subsequent amendments (the Order) stipulated the levels of savings required and the way in which these were to be achieved. Under the Order, suppliers had to reduce carbon emissions by 293 million lifetime tonnes CO2 and achieve 40% of these savings in the Priority Group. People over 70 and on certain qualifying benefits achieved 73.4 million lifetime tonnes of CO2 via professionally installed insulation measures and promoted 16.2 million tonnes worth of carbon savings to those on certain qualifying benefits, such as low income households receiving child tax credits.

Energy companies were required to achieve an overall target of 293 million lifetime tonnes of carbon dioxide (Mt CO2) by 31 December 2012. Energy companies achieved 296.9 Mt CO2.

CESP

The Community Energy Saving Programme (CESP) came into force on 1 September 2009 and the obligation period ran from 1 October 2009 to 31 December 2012. CESP was created as part of the government's Home Energy Saving Programme.

The Department of Energy and Climate Change (DECC) had responsibility for setting the overall CESP target and the policy framework and were responsible for administering the programme.

DECC set an overall carbon emissions reduction target of 19.25 million tonnes of carbon dioxide. This was to be met through requiring gas and electricity suppliers and electricity generators to deliver energy saving measures to domestic consumers in specific low income areas of Britain. This obligation was placed on all licensed gas and electricity suppliers that had at least 50,000 domestic customers and all licensed electricity generators that had generated on average 10 TWh/yr or more in a specified three-year period.

CESP was designed to promote a 'whole house' approach and to treat as many properties as possible in defined geographical areas selected using the Income Domain of the Indices of Multiple Deprivation (IMD) in England, Scotland and Wales.

In England, the lowest 10 per cent of areas ranked in IMD qualified. In Scotland and Wales the lowest 15 per cent of areas qualified. Consequently, CESP contributed to the government's Fuel Poverty Strategy.

Energy companies were required to achieve an overall target of 19.25 million lifetime tonnes of carbon dioxide (Mt CO2) by 31 December 2012. Energy companies achieved 16.31 Mt CO2, almost 85% of the overall target.

Cavity walls: Installations of cavity wall insulation measures were also up in 2012 by 22%, with a total of 637,000 installations, almost exclusively under CERT.

Solid walls: Overall, around 68,000 solid walls were insulated under CESP, compared to just 14,000 under CERT. Although the levels remain low, this represents a fourfold increase from installation rates in 2011.

The UK has put in place a broad range of energy efficiency policies as part of the first ever overarching national energy efficiency strategy launched by Prime Minister Cameron in 2013. Through the introduction of the Green Deal and the Energy Company Obligation the UK Government is helping households insulate their homes and ensuring that they have access to trusted information about energy efficiency.

The Government has also published its Building Renovation Strategy. The Strategy has been published in accordance with Article 4 of the EED and it sets out the UK's portfolio of policies that stimulate investment in energy efficiency building renovation, supported by an overview of the UK's national building stock to help understand the opportunities for further cost-effective renovation.

GREEN DEAL

The UK Government announced on the 23rd July 2015 it had stopped funding the Green Deal.

ECO

The Energy Companies Obligation (ECO) is an energy efficiency programme that was introduced into Great Britain at the beginning of 2013. It replaces two previous schemes, the Carbon Emissions Reduction Target (CERT) and the Community Energy Saving Programme (CESP).
ECO requires energy suppliers with more than 250,000

domestic customers to:

- provide free or subsidised home energy efficiency measures in harder to treat homes
- pay in part or full for the installation of efficient boilers, insulation and heating improvements into the homes of lower income households across Great Britain.

ECO is intended to work alongside the Green Deal to provide additional support in the domestic sector, with a particular focus on vulnerable consumer groups and hard-to-treat homes. ECO measures will help save carbon by supporting energy efficiency measures in hard to treat homes.

The major energy companies who have to fulfil ECO often work with third parties, for example local installer companies or, in the case of loft insulation and appliances, the DIY retailers.

The transition to ECO2 commenced on the 1st April 2015. It is the latest in long line of domestic energy efficiency schemes and carries on from ECO1. However, ECO2 aims to provide more transparent information than its predecessor and ensure the supply chain has the information it needs to identify and install eligible measures. Changes to come relate to both the Provisional Solid Wall Minimum Requirement (PSWMR) and ensuring appropriate guarantees for insulation.

The change in the PSWMR is that:

- 4MtCO2 must be achieved through delivery of SWI measures – known as PSWMR
- not additional: Can be achieved through CERO, CSCO and HHCRO
- carbon savings achieved by SWI measures can be delivered through ECO1 and ECO2 measures
- 4MtCO2 equivalent to approx. 100,000 SWI measures
- new definition of SWI in legislation: 'internal or external insulation of a solid wall, but does not include insulation of a mobile home'

With regards to appropriate Guarantees for insulation there are a number of changes, outlined below:

- a wall insulation measure (SWI or insulation of a cavity wall) receives the relevant standard lifetime if the installation is accompanied by an appropriate guarantee
- also require an appropriate guarantee for insulation of a mobile home
- appropriate guarantees have not changed but the legislation now refers to appropriate warranties for SWI

Where the installation is accompanied by an appropriate guarantee, the standard lifetime is:

- 36 years for SWI – in legislation
- 30 years for insulation of a mobile home
- 42 years for CWI (including insulation of a party cavity wall)

A1.3 Wales

There have been a number of Welsh Government initiatives to improve the energy efficiency of the Welsh housing stock over recent years.

The Welsh Government's Climate Change Strategy (2010) set a 3% per annum target reduction in greenhouse gas emissions in areas of devolved competency, leading to a total reduction of 40% in greenhouse gas emissions by 2020 against a 1990 baseline. The strategy specified target emissions reduction 'ranges' for each sector to which the target applied (transport, domestic, business, agriculture, public sector and waste). The Welsh Government has introduced a suite of policies and programmes to meet these targets, notably the Fuel Poverty Strategy (2010) and National Energy Efficiency and Savings Plan (2011). The policy focus of the Welsh Government is primarily on expenditure on retrofit programmes to address fuel poverty, enhanced planning policy/building regulations and support for the supply chain. Its programme includes Welsh Government Warm Homes Nest, an all-Wales, demand-led fuel poverty programme that provides households who are struggling with their energy bills with access to a range of advice and support, alongside 'whole house' assessments and free energy efficiency improvements for qualifying households. Nest focuses spend on the households on the lowest incomes and in the most inefficient properties, on a house-by-house basis. Nest aims to support up to 15,000 households per annum, with up to 4,000 of these households benefiting from a package of energy efficiency improvements. Alongside Nest, Welsh Government Warm Homes Arbed is the area-based 'whole house' retrofit programme, with the EU funded element of Arbed targeted with retrofitting over 4,500 homes across Wales in 2012-15. The Welsh Government has also made available an additional £80m to leverage investment from the energy company obligation (ECO). Building regulations were devolved in 2011, enabling the Welsh Government to consult on and amend Part L. These amendments set a higher level of energy performance for new and existing buildings from 2014, with a review in 2016. This continues a pre-devolution policy trend which set more stringent buildings regulations for energy performance in Wales than those in England or Scotland. From autumn 2014 the Welsh Government provides integrated resource efficiency support services for the domestic, community and public sectors and will strengthen its support for business through Business Wales.

Welsh Government Warm Homes Nest

Households who are struggling with their energy bills are able to access support from Welsh Government Warm Homes Nest through the freephone telephone service, website, or referral from a partner organisation. No cold calling is undertaken.

Households who meet the eligibility criteria for a free 'whole house' assessment receive a visit from a qualified Nest energy assessor. The assessor surveys the property and examines key items such as loft insulation, domestic boiler, hot water tank, radiators and windows for double glazing. These observations are entered into a software program which calculates the energy efficiency. The assessor uses the software to provide recommendations on the most appropriate and cost effective package of energy efficiency improvements that can be installed within the spending limits for the scheme. Where high cost measures, such as EWI, are recommended, the scheme manager will also carry out a value for money assessment and this, together with the assessor's recommendations, will be used to determine the final package of measures for a particular property.

Nest measures are designed for individual properties so there is no standard package, but measures can include:

- a new boiler (all fuel types)
- central heating system
- loft and cavity wall insulation
- renewable technologies external wall insulation.

There are three qualifying criteria for a 'Whole House' Assessment:

1. someone in a household must receive a means tested benefit

2. the property must be privately owned or privately rented (where privately rented the landlord must give permission for the measures work to be undertaken)

3. the property is very energy inefficient and has an Energy Performance Certificate (EPC) rating of E, F or G.

These observations are entered into a software program which calculates the energy efficiency.

Householders who do not meet these criteria can still receive support to insulate their home through referral or signposting to other schemes offering free or subsidised home energy improvements. Vulnerable households can also apply for a Nest partial grant. The partial grant provides £125 towards the cost of loft insulation and £140 towards the cost of cavity wall insulation.

Welsh Government Warm Homes Nest is managed by British Gas. All installation work is undertaken by Small and Medium Enterprises (SMEs) who are sub-contracted by British Gas. The Energy Saving Trust is a material sub-contractor to British Gas. Every installation is inspected by a qualified Nest inspector and every household that receives energy improvements is provided with a 12-month aftercare service. The scheme does not cold call and all marketing materials carry the 'Nyth/Nest' and Welsh Government Warm Homes logos.

Welsh Government Warm Homes Arbed

Welsh Government Warm Homes Arbed is the Welsh Government's scheme to improve the energy efficiency of homes within an area. This reduces energy bills and makes homes warm and comfortable. As Arbed is an area-based scheme, householders cannot apply directly for support.

Arbed funds projects submitted by local authorities in some of the most deprived areas of Wales. It helps those most in need by:

- improving insulation in existing properties
- replacing inefficient boilers
- switching homes to more affordable or renewable fuel types
- installing energy efficient systems.

Arbed also creates local opportunities for energy efficiency businesses, and local jobs. Training people for jobs in the industry is also an important part of every project.

The first phase of the Arbed programme 2010-12 was delivered by registered social landlords in Welsh regeneration areas. Existing houses were fitted with measures including solid wall insulation, solar panels and heat pumps. Since then Welsh Government Warm Homes Arbed has continued to fund area based schemes submitted by local authorities.

A1.3.1 Welsh Context

It is important to understand the wall construction of dwellings in Wales, this will indicate the context of the Welsh Housing Stock in order to understand the build profile of dwellings in Wales.

The percentage of dwellings in Wales with Cavity Walls (as a percentage of the UK stock) is 68%. Of the cavity walls, 44% have CWI[16]. The Living in Wales Survey carried in 2004 documents the wall type against dwelling age, as illustrated in Table 12 below.

[16] 2013. Piddington, J. et al. Housing in the UK: National comparisons in typology, condition and cost of poor housing.

Predominant type of wall structure	Dwelling Age					Total
	Pre 1919	1919 - 1944	1945 - 1964	1964 - 1980	Post 1980	
Mixed types	28683	1917	3346	1616	1755	37317
Masonry cavity	29053	110218	202286	219722	207429	768708
Masonry single leaf	2293	0	405	1602	1211	5511
9 inch solid	99795	14013	4973	0	0	118781
>9 inch solid	198918	9579	1716	632	1747	212592
In situ concrete	0	781	17522	8075	533	26911
Concrete panels	0	581	14452	4532	518	20083
Timber panels	2091	478	803	5547	4637	13556
Metal sheet	248	237	3990	736	391	5602
Total	**361081**	**137804**	**249493**	**242462**	**218221**	**1209061**

Table 12: Classification of wall structure in Wales by dwelling age (2004 figures)

ADEILADU ARBENIGRWYDD YNG NGHYMRU

CONSTRUCTING EXCELLENCE IN WALES

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