EXTERNAL WALL INSULATION IN TRADITIONAL BUILDINGS:

Case studies of three large-scale projects in the North of England:

ENGLISH HERITAGE

RESEARCH REPORT

Thanks to the following organisations and individuals who participated in this research:

Blackpool Council
BRE
Bristol City Council
Helena Partnerships
Householders
Natural Building Technologies
Riverside
Sefton Council
STBA
Synergize
URBED

(Cover image: A traditional street in Blackpool)

NDM Heath Ltd. Registered office: 21 Kirkgate, Knaresborough, North Yorkshire, HG5 8AD
T: 07763 110264 | E: enquiries@ndmheath.co.uk | W: www.ndmheath.co.uk
Registered Company Number: 8587277

ENGLISH HERITAGE

EXTERNAL WALL INSULATION IN TRADITIONAL BUILDINGS: Case studies of three large scale projects in the North of England

Prepared for English Heritage by

NDM Heath Ltd

2014

CONTENTS

Forword

1.0 INTRODUCTION 4

2.0 EWI IN TRADITIONAL BUILDINGS: CURRENT ADVICE........ 5
- 2.1 Specialist Advice 7
- 2.2 Uncertainty and Precaution........ 10

3.0 CASE STUDIES 12
- 3.1 Stockton-On-Tees 13
  - 3.1.1 Background........ 13
  - 3.1.2 Project Details 16
  - 3.1.3 Images........ 20
- 3.2 Liverpool 29
  - 3.2.1 Background........ 29
  - 3.2.2 Project Details........ 31
  - 3.2.3 Images 35
- 3.3 Blackpool 39
  - 3.3.1 Background 39
  - 3.3.2 Project Details........ 40
  - 3.3.3 Images........ 45
- 3.4 Other Feedback........ 51

4.0 ANALYSIS, CONCLUSIONS AND RECOMMENDATIONS........ 53
- 4.1 Analysis 53
  - 4.1.1 Funding........ 53
  - 4.1.2 Materials and Detailing 53
  - 4.1.3 Site Management 54
  - 4.1.4 Coverage and Thermal Bridging 54
  - 4.1.5 Planning and Permitted Development 54
  - 4.1.6 Aesthetics 55
  - 4.1.7 Moisture-related Problems 56
  - 4.1.8 Property Condition 57
  - 4.1.9 Knowledge, Advice and Education 57
- 4.2 Conclusions 57
- 4.3 Recommendations for Further Research 58

Foreword

The drive to reduce energy use and carbon emissions is one of the greatest pressures for change in the historic environment today. The impetus comes from policies and initiatives to mitigate climate change, maintain energy security, reduce domestic energy costs and tackle fuel poverty.

Measures to improve the energy and carbon performance of older buildings can affect the character and significance of historic places to varying degrees, depending on their nature and the context in which they are proposed and undertaken. Satisfactorily resolving the heritage impact of such measures requires informed decisions being made from a sound evidence base which can also help with developing good practice advice.

As part of building this evidence base, English Heritage commissioned NDM Heath Ltd to undertake case studies of three large-scale external wall insulation projects in the North of England. The report focuses on a range of issues including methods of funding, pre-installation assessments, selection of materials and systems, design, specification, procurement and implementation, and highlights factors affecting the quality of work. In addition, the report assesses the heritage impact of the measures, and reviews the perceptions of stakeholders, including building occupants.

It should be noted that the views expressed in this research report do not necessarily represent those of English Heritage.

1.0 INTRODUCTION

Insulating solid walls has become a considerable focus in recent years, particularly with the introduction of the Government's Green Deal and Energy Company Obligation finance schemes which place an emphasis on the thermal retrofit of traditional solid-walled housing. Given the technical risks inherent in insulating walls internally, external insulation is likely to be a serious consideration for many traditionally-constructed properties, where aesthetics allow. However, there are numerous considerations – technical and otherwise – to be addressed when considering this measure, and further research is required in order to have a fuller understanding of these.

This report provides an overview of three recently-completed external wall insulation (EWI) projects in Northern England – Liverpool, Blackpool and Stockton-on-Tees. The background and technical details of each project are provided, together with householder feedback and analysis to identify common and diverging findings. The projects are then analysed to highlight common conclusions and areas requiring further research.

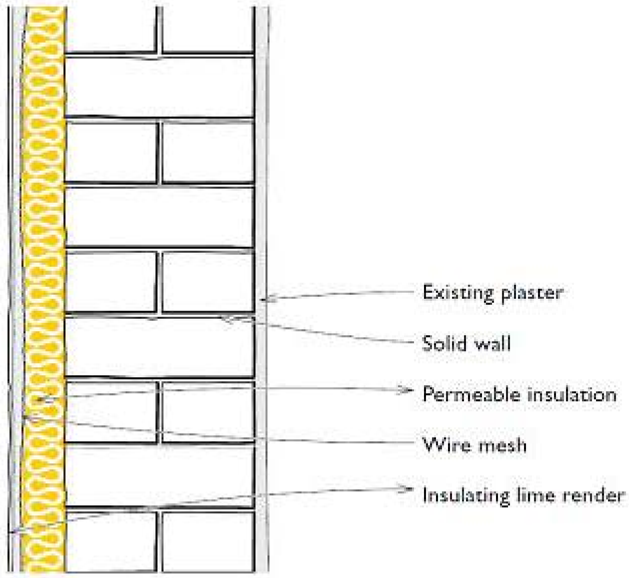
In researching the three case study projects site visits and interviews were conducted in Autumn 2013 and numerous sources were accessed, to ensure the capture of different perspectives and experiences. These include local authorities, scheme managers and co-ordinators, contractors, occupants, websites, news articles and technical documentation. It should however be noted that some of the organisations involved in the projects did not wish to participate in this research, and so it has not been possible to include their views in this report. It should also be noted that commentary provided in this report is within the context of a) interviews with individuals involved in the projects and b) the recommendations and principles for traditional building solid wall insulation as detailed in Section 2. In regard to this latter point, other views and approaches do exist. These points should be borne in mind when reading the report.

In addition, related research is being conducted by other bodies concurrently with this research, in particular by the Building Research Establishment (BRE), the Sustainable Traditional Buildings Alliance (STBA) and the Society for the Protection of Ancient Buildings (SPAB). This report should therefore be taken as part of a wider picture, as the findings from other research projects will overlap, providing greater context and shedding more light on the issues raised in this report. Some details of these other research projects are contained within the main report.

2.0 EWI IN TRADITIONAL BUILDINGS: CURRENT ADVICE

The image below shows a possible insulation method for EWI, and is taken to recent advice by English Heritage[1]. In practice, the installation of EWI can often be a complex project for traditional buildings, with extremely careful detailing required to achieve a 'low-risk' finish.

SOLID WALL: EXTERNAL INSULATION



05 This shows a permeable solution with an insulation such as hemp-lime or wood-fibre batts fixed to the masonry and finished with a 'breathable' lime render. Alternatively a non-breathable external insulation could be used such as expanded polystyrene (EPS) depending on the type of construction.

Figure 1 A suggested approach to EWI provided by English Heritage

In reality, advice differs and conflicts, which can cause confusion not only for the householder but for the industry. The following quotation condenses a great deal of the complexity surrounding SWI and traditional buildings: *'The large range of options and the difficulty in finding impartial advice could lead to market paralysis, i.e. lack of uptake of SWI for fear of damaging properties. This risk is exacerbated where conflicting advice exists, with recommendations or notes of caution varying between advice sources'*[2].

By way of introducing some of these issues, consider the below mainstream advice provided by the Energy Saving Trust (EST):

> *'To insulate a solid wall from the outside, a layer of insulation material is fixed to the walls with mechanical fixings and adhesive, then covered with protective layers of render or cladding … To prevent condensation, recessed areas around windows must be insulated as well as the walls – with the depth of insulation depending on the width of the window frame … All external pipework and other fittings will have to be removed and replaced, and it may be necessary to extend window sills and even the roof overhang to protrude beyond the new layer. It is often possible to fit additional sills to avoid replacing any of the original structure … Cladding comes in a variety of attractive colours and forms: timber panels or shingles, stone or clay tiles, aluminium panels or a brick finish. Render can either be a thick sand and cement mix applied over a wire mesh – or a thinner, lighter cement over a*

strong fibre mesh … Insulating the outside of your property, provided it's done properly, will give you a new weather proof layer that will protect you from penetrating damp for years to come, and should deal with any existing penetrating damp problems you may have had due to poor wall finish. The insulation will also increase the temperature of the internal surface of the wall, making it less likely that you will get condensation problems on your walls'[3]

Mainstream advice has to be generic, to a degree. However, when considering EWI for traditional buildings more detailed advice is required in order to understand fully the possible risks associated with different options. This can be both hard to find and hard to follow, as it has not yet entered the mainstream and some research is the subject of ongoing investigations, i.e. it is not yet definitive.

Some of the specific issues relating to SWI in traditional buildings are outlined below. These are presented from an impartial 'middle ground' perspective – in this case the Scottish sustainable development organisation Changeworks, neither a conservation body nor an active proponent of SWI[4]:

- *'The most common insulation materials are mineral based (e.g. rockwool, glasswool) or plastic based (e.g. foams, polyisocyanurate (PIR), phenolic) … Some experts believe that using natural materials for SWI has strong advantages. In particular, natural materials are vapour permeable, meaning they allow moisture to transfer through them. As old buildings with solid walls share this characteristic, natural materials are more likely to be suitable as they allow the walls to continue to be vapour permeable'*
- *'Measuring the moisture content of solid walls is difficult and modelling software can be inaccurate … Some models use standard climatic information that is accurate only to London or assume…that the greatest moisture load is from inside the house. Moisture moves through walls in more complex ways than is often assumed and understanding this, and the effect of insulation, is therefore argued by some to be more important than pursuing ever-lower U-values'*
- *'Whether solid walls are vulnerable to moisture depends on a number of factors: exposure to driving rain; ability of wall to absorb moisture; thickness of walls; moisture from inside the property; and type of insulation … The characteristics of the wall and the climate tend to be the most important factors in determining the risk of moisture problems. Therefore, choosing the system, thickness and material of the insulation should depend on the characteristics specific to that building'*
- *'Whilst the problems associated with moisture retention due to SWI can be severe, it is important not to let inaccurate assumptions about risk prevent SWI being installed. Instead, what is needed is an assessment of the correct approach to take. Part of this approach is including safety margins in calculations, which might mean installing less insulation. More research…is needed. This will provide a better understanding of the risk associated with different approaches and in different locations'*

The following sections explore the key issues in more detail, identifying sources of current advice and research and extracting key elements from them.

2.1 SPECIALIST ADVICE AND RESEARCH FOR TRADITIONAL BUILDINGS

The table below (ordered by date) is by no means exhaustive but provides some examples of recent publications containing relevant research or advice:

TITLE	AUTHOR	DATE
Old House Eco Handbook	Surh, M. & Hunt, R.	2013
Responsible Retrofit of Traditional Buildings	STBA	2012
The SPAB Research Report 3: The SPAB Hygrothermal Modelling Interim Report	SPAB	2012
Short Guide 1: Fabric Upgrades for Energy Efficiency in Traditional Buildings	Historic Scotland	2012
Solid Wall Insulation in Scotland: Exploring Barriers, Solutions & New Approaches	Changeworks	2012
Energy Efficiency and Historic Buildings: Insulating Solid Walls	English Heritage	2012
Warmer Bath: A Guide to Improving the Energy Efficiency of Traditional Homes in the City of Bath	Bath Preservation Trust / Centre for Sustainable Energy	2011
Advice Series: Energy Efficiency in Traditional Buildings	Government or Ireland	2010

All of these documents broadly agree on a number of fundamental principles regarding EWI. These are highlighted in the following quotes which have been grouped by topic, with commentary where necessary.

2.1.1 Advantages of EWI over IWI

- *'External insulation has certain advantages over internal insulation: the benefits of high thermal mass of a solid masonry are retained; there is a reduced risk of condensation between the insulation layer and the masonry wall; the building fabric remains dry and heated from the interior and there is no impact on internal finishes and room sizes'* [5]

It is self-evident that the above statements are dependent on appropriate installation. With regard to the last point there are IWI systems that can be blown behind existing wall finishes, and very slim-profile insulating 'blanket' materials, neither of which have a meaningful impact on room sizes.

- *'Exterior insulation is the most effective and the least risky, **as long as a comprehensive approach is taken'*** [6]
- *'EWI is generally seen as the 'safest' option where it is applicable, as there are fewer potential problems associated with moisture and condensation'* [7]
- *'Where wall insulation is considered necessary and appropriate, external insulation is technically a better option than internal insulation in most situations'* [8]

2.1.2 Permeability and moisture movement

- *'On the whole traditional buildings allow the absorption, movement and evaporation of moisture within the building fabric rather than attempting to exclude it, as is the case with most modern buildings. Consequently retrofit interventions of traditional buildings based upon modern building methods* *and concepts can radically change their moisture performance and bring considerable risks. On the other hand good understanding and practice in retrofit can benefit old building fabric performance as well as occupant health and general well-being. However this situation is complicated by a lack of understanding of moisture physics, lack of data concerning material properties and the use of inappropriate models'*[9]

- *'Moisture physics is a developing science and there are still many uncertainties and unknowns. The application of moisture physics to buildings, particularly in traditional complex building types, is at nascent stage of development. Traditional buildings deal with moisture in a different way to modern buildings. Traditional buildings 'breathe' using vapour permeability, hygroscopicity and capillarity of fabric in combination with controlled and uncontrolled ventilation to create a safe environment (Hughes, 1987), while modern buildings are usually designed to rely on moisture barriers and have specific ventilation systems to deal with moisture'*[10]

'Breathability' is a term that can be misused, and does not cover all of the issues associated with moisture movement in solid walls. As well as vapour permeability, capillarity and hygroscopic qualities can also affect the suitability of an insulation system. (In related research, cases have been cited of moisture-related problems with insulation systems even where mineral wool – a permeable material – was used.)

- *'The development of moisture-related pathologies in fabric or occupants can happen over several years or even decades (Ridout, 2000) therefore moisture-related problems are often not immediately apparent following the completion of work which causes them. This can create a problem in terms of liabilities, as well as a false sense of the success of a particular measure'*[11]
- *'The use of BS 5250:2011 (and its recommended calculations given in BS EN ISO 13788:2002) which form the basis for most moisture-risk calculations within the building industry is not sufficient to provide an accurate interpretation of risks, particularly for traditional buildings. These moisture models cannot account for situations where excess air leakage or penetrating moisture from driving rain or ground water is a factor, "[T]he Glaser method does neither account for hygroscopic sorption nor for liquid transport. Therefore its application is more or less limited to light-weight structures." (Künzel, 2000, para. 2.1). This means it is not suitable for traditional masonry buildings. A more sophisticated protocol is BS EN 15026:2007, which is a dynamic hygrothermal model that takes account of driven rain and moisture mechanisms in materials, but even here there are still uncertainties regarding building physics, data and operation'*[12]
- *'When it comes to insulating solid walls, it is crucial to find a solution that is compatible with their breathable characteristics'*[13]
- *'There will be situations where conventional external insulation is appropriate and…it should be moisture vapour permeable … Boards and spray-applied materials that do not allow a degree of moisture movement through the structure should not be used as these could result in a build up of moisture in the fabric of the wall'*[14]
- *'Because of the importance of breathability in traditionally built buildings, any material being applied to the walls should be vapour permeable'*[15]
- *'It is important to preserve the permeability of the wall by using a moisture-permeable insulation and finish'*[16]
- *'It is important that the insulation and protective finish installed externally should have low vapour*

resistance in order to retain the necessary 'breathability', and allow moisture to evaporate away harmlessly'[17]

One aspect of this perhaps requiring more research, or at least more clarification, is the relative permeability of different types of traditional solid wall. They are commonly grouped together into a single entity, but in reality different traditional materials have different permeability characteristics, and many solid walls are not homogenous. Brick and stone types differ, as do mortars; stone wall cores are a varying mix of rubble, mortar and air pockets; voids and open joints may be present in both brick and stone walls; and so on. All these factors affect the permeability, moisture movement and thermal properties of a solid wall.

Aside from this, the issues surrounding moisture and permeability in traditional walls are very clear, with explicit mention of some of the risks and inadequacies of some current practices.

2.1.3 Thermal bridging

- *'Details around window and door openings need careful consideration to ensure a neat finish and continuity without any gaps or thermal bridging'*[18]

Thermal bridging is generally viewed as more of a risk for IWI than EWI. However, as illustrated in some of the case studies elsewhere in this document it also poses risks in many EWI installations. This is potentially of great significance and requires further research.

- *'Whenever insulation is added to an existing building there is a danger of creating thermal bridges at critical points where the coverage may be interrupted. When insulation is added externally these weak points are typically at window and door reveals … Great care needs to be taken to ensure adequate detailing around window and door openings to avoid potential thermal bridges, and this can considerably increase the overall cost of both design and installation. The necessary level of detailing can even be impossible to incorporate in certain circumstances, in which case, depending on the potential severity of the consequences, it may even be better not to install insulation at all'*[19]

The above point in relation to the cost of 'adequate' detailing is significant, and almost certainly contributes to a lack of such detailing on occasion both at design and installation stages. Funding streams are generally designed with mainstream approaches in mind; the best practice principles emerging for traditional solid-walled properties do not yet fall into this category.

2.1.4 Materials

- *'The need to prevent impermeable layers within the external insulation precludes the use of modern closed-cell foam and other plastic-based insulations, as well as the use of protective finishes which bar moisture vapour movement … Useful materials for the external insulation itself include hemp-lime composites, mineral wool and wood fibre panels. All these insulation materials need to be protected from both the weather and mechanical damage… Suitable moisture-permeable finishes include lime renders and rain-screen cladding…with lapped joints'*[20]
- *'Examples of incompatible materials and systems which should be avoided include: closed cell and extruded plastic insulation; plastic vapour barriers; cement or acrylic based renders; cement pointing; [and] plastic based external wall paints'*[21]

Note that several of the above materials 'to be avoided' are included both in mainstream advice (see quote, Section 2.0) and in the case studies (see Section 3).

2.1.5 Detailing

- *'Risks can be minimised with good design, appropriate materials and adequate ventilation'*[22]
- *'The boards need to be protected from direct moisture, and special edge and drip detailing is required to keep driven rain away from the board. Such board-based external insulation generally requires a render system to make it fully weather proof and it is important that this is also vapour permeable'*[23]
- *'Everything on the outside of the building has to be replaced or adjusted: window reveals and sills, door architraves, roof overhangs, decorative features, gutters and downpipes, soil and vent pipes and other services'*[24]

As highlighted by some of the cases studies (see Section 3), in reality many of these details are not adjusted. Instead they are 'worked around', doubtless driven by constraints of time, cost and technical complexity. This includes leaving eaves and bay windows untreated in many cases.

- *'The increased depth of an external render or insulation system will require adaptation to the roof and wall junctions, around window and door openings and the repositioning of rainwater downpipes'*[25]
- *'In many cases it will be necessary to actually relocate windows and doors further forward in the overall wall thickness in order to minimise the danger of creating cold bridges at the reveals'*[26]
- *'By insulating on the outside, the thickness of the wall will increase. This will almost certainly mean an adjustment to roof details such as at the eaves and verge to provide a wider overhang'*[27]

Again, the case studies demonstrate that efforts are sometimes made to avoid having to adjust roof details, with insulation stopped short of the eaves, particularly where there is ornate brickwork at eaves level. This presents a thermal bridging risk and an added risk of water ingress behind the insulation if it is not appropriately sealed (seals can break down over time).

- *'Whichever solution is finally agreed, it is crucial that it is well detailed and supervised by professionals with expertise in the type of building involved. The more complex the solution, the more care needs to be taken when installing or fitting, so choice of contractor, coupled with on-site supervision, becomes critical'*[28]

This point is of critical importance and is highlighted in the case studies. Clerks of Works for social housing projects were felt to be essential. Unfortunately where considerable time pressures exist (driven by funding timescales) there can be a risk of care and supervision falling by the wayside.

2.1.6 Permissions

- *'Even where a building is not a protected structure…planning permission will be required where the works would materially affect the external appearance of the structure so as to make the appearance inconsistent with the character of the structure or of neighbouring structures'*[29]
- *'Planning permission will be required…in the majority of instances, whether or not the building is listed'*[30]

Recent changes to Permitted Development have superseded the above statements, with the requirement for planning permission becoming less of a focus in some cases. However, in this respect the waters remain muddy; this is explained in more detail in Section 4.

2.2 UNCERTAINTY AND PRECAUTION

It must be recognised that – at the time of writing this report – we do not have all the answers. No-one knows for sure how great a risk is posed to traditional buildings by these issues, and in any case risks vary according to individual situations. It is, then, perhaps not surprising that much of the specialist advice explored above adopts a precautionary approach – an 'if in doubt, don't' stance. This is demonstrated by the following extracts:

- *'Traditional solid walls pose huge questions when it comes to deciding on insulation, many of which remain unresolved. In some situations, wall insulation may be best avoided. Inappropriate solutions risk considerable damage to the building's structure, character and the wellbeing of its occupants'*[31]
- *'Wall insulation in solid-walled structures is a highly controversial and technically difficult issue. There is much disagreement about how it should be done, and some experts suggest that many of the products on the market will create problems of dampness and mould growth in the future'*[32]
- *'The moisture modelling method adopted by many SWI manufacturers may not be appropriate when applied to solid masonry walls, as it was developed for use on timber-framed buildings. Implications of this require further research'*[33]
- *'With thermal insulation at the top of the eco agenda, many firms are offering quick and easy solutions for insulating old walls without understanding the long-term consequences'*[34]

While this is understandable and very likely sensible, care is also required not to create excessive concern or conflict within the insulation industry.

Most publications covered in this section are also consistent in providing markedly less detail on EWI than on IWI. This is likely to be due not only to the perceived increased technical risks and research associated with IWI, but also to the relative lack of knowledge and pilot projects of EWI on traditional solid-walled properties. This is significantly at odds with the reality of SWI installations, where nearly all involve EWI rather than IWI: this is highlighted by current Green Deal and ECO statistics, showing (at the time of writing this report) that *'of the 23,313 solid wall measures installed virtually all were external wall insulation'*[35]. This predominance of EWI over IWI emphasises the clear knowledge gap and corresponding need for detailed advice on the principles and recommendations specifically for EWI in traditional buildings.

In reality, it would seem that EWI should be less technically risky than IWI, but only where it is carried out thoroughly and with appropriate attention to detail. Unfortunately this is not necessarily always the case. This raises the possibility that similar levels of technical risk may be present for EWI in reality. The conclusion that may be drawn from this is a clear need for more research and monitored installations of EWI on traditional buildings, to identify with certainty the levels of risk that exist and inform future advice.

In the meantime, as the case studies in Section 3 show, it seems that those involved in retrofit projects may or may not be aware of the advice and research detailed above, but in any case most projects proceed with a more conventional approach often not following the recommendations contained in this advice.

3.0 CASE STUDIES

This section considers three refurbishment projects in the North of England (it also draws upon other projects, to a lesser degree). The main projects are based in Blackpool, Liverpool and Stockton-on-Tees. Locations are shown on the map below (alongside a rainfall map which highlights that none of the projects is in an area disposed to severe levels of wind-driven rain – although wind-driven sea-spray was highlighted as being an issue for the Blackpool properties).

Figure 2: Case study locations[36]

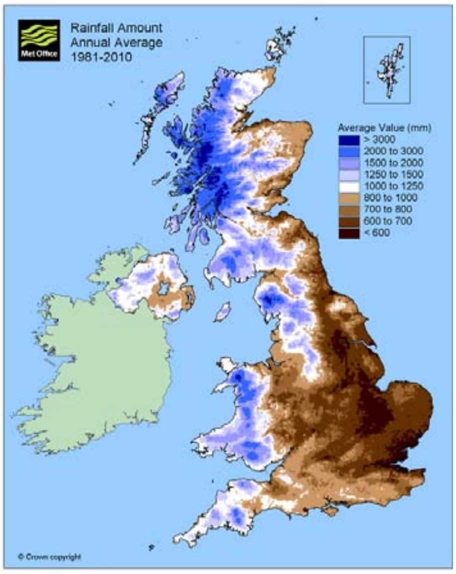


Figure 3: UK rainfall map[37]

Due to the nature of the funding (see Section 4), all projects took place in deprived areas. This means that energy saving, while an important priority for many parties, was not the sole driver of the projects. In some cases this was just one element in larger-scale regeneration plans for entire areas, to make them more attractive and desirable areas in which to live. As such, in some instances EWI on existing properties was carried out as part of larger projects involving demolition of other housing and construction of new domestic and non-domestic buildings. Indeed, it is feasible that without these projects some of the stock in question would itself have been at risk of demolition in the future.

While all projects are broadly similar, each is different in its details and approach. Details are based mostly on interviews with individuals working for the relevant organisations involved in the projects, and with householders, together with background research and a literature review. All of the individuals are anonymous, and it must be recognised that:

a) some of the commentary is subjective and may not represent the view of the author;

b) it was not possible to engage with all relevant parties in the different projects; and

c) commentary (positive and negative) on some of the more general issues has on occasion been provided by individuals not directly involved in the works.

3.1 STOCKTON-ON-TEES

Project Overview	
Dates:	2011- present
Dwelling types:	Pre-1919 terraced houses, solid brick walls
Number of dwellings:	c.1,600+
Occupancy type:	Private & social housing
Funding:	CESP & ECO
Insulating material:	EPS + silicone render

It should be noted that many of the organisations involved in this project did not take part in the research. As such, the information in this case study is sourced mainly from site visits, householder interviews and research drawn from reports and articles published online.

3.1.1 Background

As with the other case studies, this large-scale EWI project took place in a very deprived area of England, focusing on the Parkfield and Mill Lane regions of Stockton-on-Tees. Note the photographer's caption to the following image of the area:

Figure 4 'Stockton 2011 – so rough it was used as a film set!' (© Kenny W)[38]

The location of the Parkfield and Mill Lane areas is shown on the map below.

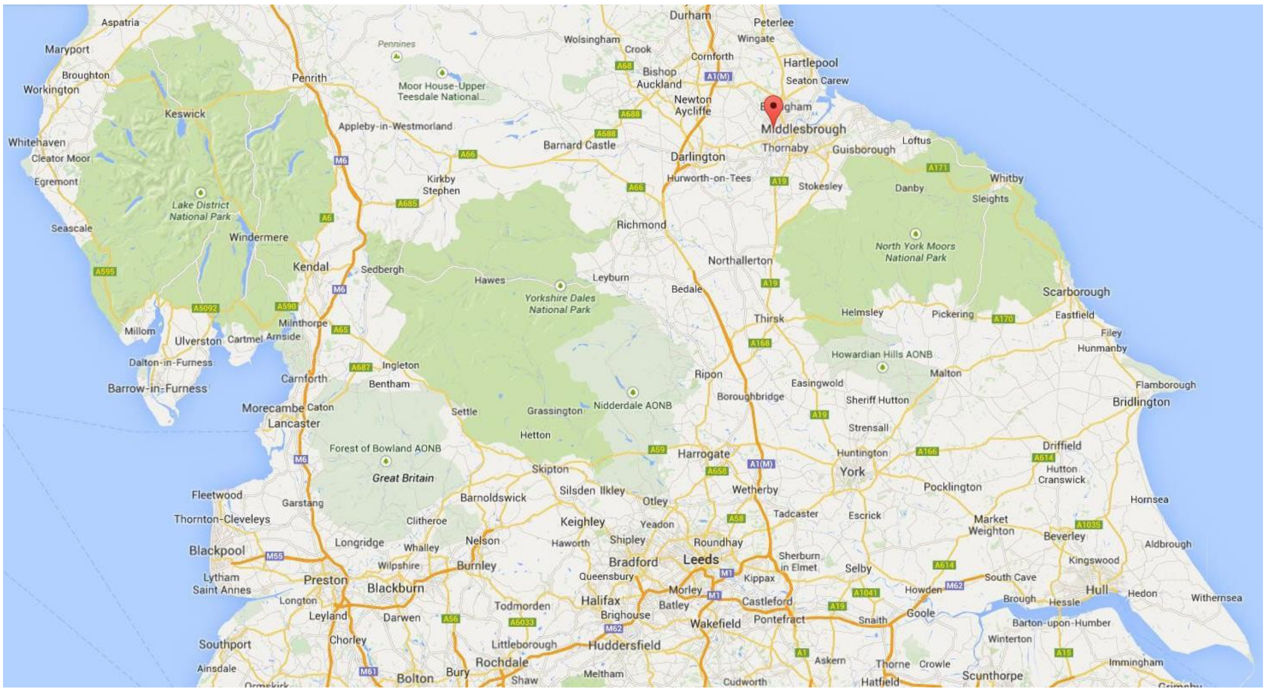


Figure 5 Location of Stockton-on-Tees EWI project (© Google Maps)

This regeneration project has grown considerably since its inception, and comprised several phases. An initial project in the Parkfield area of Stockton-on-Tees commenced in December 2011, with £3.9m funding through the Community Energy Saving Programme (CESP) to tackle over 400 properties[39]; this gradually increased to encompass a further 500 homes in the Mill Lane and Newtown areas[40], then two further areas in Thornaby to the South of Stockton-on-Tees[41]; and in mid-2013 ECO funding was announced to tackle the towns remaining 5,000 solid-walled homes[42]. It seems the first phase of the project focused largely on social housing, with the subsequent phases mainly tackling private homes.

In total, the CESP funding amounted to £8m and it seems that over 1,600 homes have been treated – although it is not clear whether all of these have had EWI. The ECO-funded project will run until the end of 2015, and for the purposes of this report may be regarded as a separate project. Likewise, the refurbishment project at Thornaby was not included in this research.

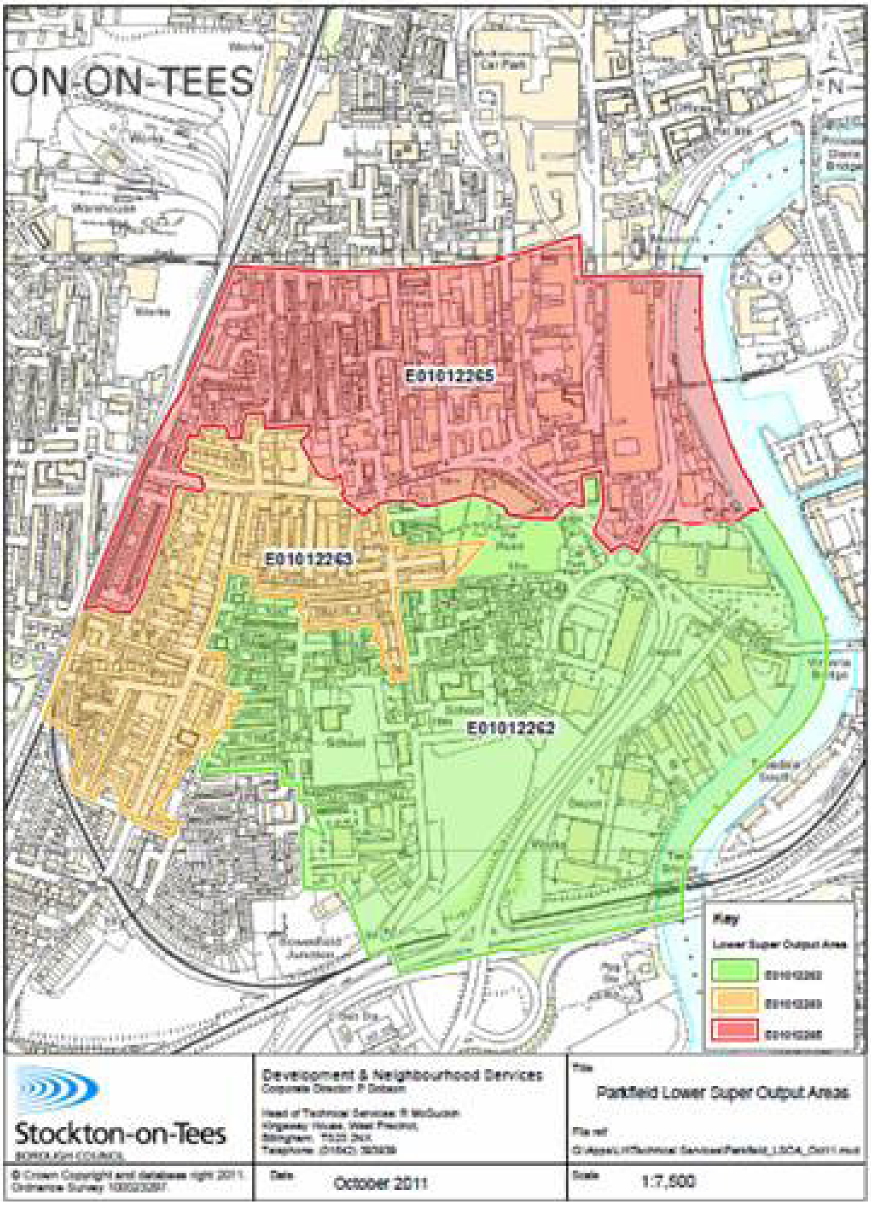


Figure 6 Map showing the targeted Parkfield and Mill Lane areas of Stockton-on-Tees[43]

The first phase of the EWI project followed a masterplanning exercise carried out on the Parkfield area. The following extract provides a strategic view of the objectives of the planned regeneration:

'There is an opportunity…to implement a phased development programme…aimed at stabilising the neighbourhood in the short term and creating the conditions for private sector led development in the long term. Particularly in prevailing market conditions, developers will not build houses unless they are confident they will sell, and houses will not sell if the area in which they are being built is unattractive as a location in which to live. Parkfield requires a comprehensive transformation in order to turn it into a location in which people will want to live and developers will be willing to invest'[44].

Much of the area was earmarked for demolition and new build (this is already underway). More detailed site plans are available in the Masterplan, and further details of the regeneration aims and current project status are also available from the local Council's website[45].

Within the demolition, several rows of terraced solid brick houses were to remain, and these were targeted for EWI (among other improvements) with funding provided by CESP – this seems to have been the first phase of the EWI project. The following extracts provide fuller details of the refurbishment objectives:

'The refurbishment of properties to be retained should be limited to external / non structural works only. The rationale for refurbishment is twofold: firstly it must improve the overall appearance of the area, making it an attractive area for developers to invest; secondly, it must improve the appearance of individual dwellings, incentivising owners to invest further in the properties for major external/structural works and internal improvements. We would envisage the following types of refurbishment being undertaken:

- 'External works – this would include minor structural improvements only such as some limited roof repairs, repointing, damp-proof course, replacement fascia boards
- 'Facelift works – this would include such activities as brick cleaning, replacement doors and windows and where appropriate porches.

'…The Council has recently secured a partnership … to deliver a … scheme which will deliver a programme of investment to properties surrounding the clearance area. This programme will deliver energy efficiency measures and external property improvements via external wall insulation/cladding.' [46]

'The improvement of these properties and the streetscape should consist of a 'visual enhancement' and/ or creation of more energy efficient units. This would provide a qualitative lift to the character of the area, which in turn will provide an improved setting for the redevelopment that takes place within the main site of Parkfield II, and also provide the basis for a more sustainable community, and reduced energy bills for home owners and tenants. The proposed CESP scheme…will help meet this objective.' [47]

3.1.2 Project details

The buildings in question are described by the local Council as '*poor quality, low value pre-1919 terraced houses (and 1960s system built social housing) providing cramped accommodation with poor amenity space'* [48]. They have now been upgraded with EWI (among other improvements). Due to the size and different stages of the project, several different contractors and insulation systems have been involved in the works. It is not clear which stages of the project employed which products or application procedures. This report focuses mainly on one section of the project which was overseen by a project manager in collaboration with the local Council. (As stated above, neither of these organisations participated in this research, and so it is not possible to include their views in the report.)

The site visit and associated research has confirmed at least two different insulation systems being installed: Polyisocyanurate (PIR) and Expanded Polystyrene (EPS) insulation boards, in most cases with a silicone render finish. Both PIR and EPS are impermeable, plastic-based insulants; summaries of both materials are provided below:

- <u>PIR</u> provides low U-values and requires less depth of insulation to achieve the same performance as other systems such as EPS. The system seen in this project[49] includes foil facings to both sides of the PIR board.
- <u>EPS</u> boards are a very lightweight insulating system, allowing for easy handling and rapid application. An additional benefit of EPS is its cost, which tends to be lower than that of other insulation boards.

Online images show PIR boards being installed in one street in late 2012[50], while online publicity confirmed EPS was used for at least one part of the project in early 2013[51]. **It should be made clear that, unless stated otherwise, the commentary and images in this section do not relate specifically to either of these systems, but to the project as a whole, which may include other systems.** However, the site visit confirmed widespread use of EPS on later stages of the project (autumn 2013), and the EPS systems seen on site would seem to be broadly similar.

As well as being one of the cheapest wall insulation materials, EPS is also light and fast to apply, which could have been a contributing factor in its selection as projects taking place at the end of the CESP funding programme were subject to considerable time pressures. The composition of EPS also makes it relatively easy to cut and shape around architectural features such as dentil courses and corbelling, and some manufacturers actively promote this aspect. This is undoubtedly a benefit of such a material when considering traditional buildings, which commonly have ornate brickwork and other architectural features: in order to minimise thermal bridging, these features should also be insulated. However, this benefit does not seem to have been made use of, as the insulation stops short of the dentil courses on all properties seen during the site visit. The reasons for this are not clear, however again it may well have been down to a combination of cost and time pressures – insulating the dentil courses would require significant additional time and make associated works such as extending rooflines likely to be required.

In terms of the finish, the main render options for EWI systems tend to be either silicone or mineral based. While both systems are vapour permeable, mineral render generally has a higher level of permeability. Mineral render also sets fast, which is beneficial for winter working (when some of these works took place). Silicone render is also vapour permeable and its flexibility allows for minor movements within the building structure.

It seems that a silicone render was used in most cases. Its setting time is not as quick as that of mineral render, and some specifications state that it should not be applied where the air or wall temperature is at or below 5°C, or where it is likely to be exposed to rain while drying. This may have been a contributing factor in this and other case studies where silicone render was seen or reported to be coming away from the insulation material.

It is not clear who specified the materials for the different stages of the project, or what level of advice was provided by the various manufacturers and contractors. On the basis of the guidance cited in section 2 of this report alternative, permeable materials would seem to be more appropriate for solid brick walls, but the time and cost pressures seem likely to have influenced the specifications and ultimately there is no evidence of permeable materials having been used.

In terms of the finished installations, there are various points of interest; these are illustrated by the images in the following section:

- By and large, whole terraces were treated, providing a more uniform appearance. However, there are exceptions, which create a less uniform appearance and greater potential for thermal bridging where the EWI stops halfway along a terraced elevation
- All properties have some form of ornate brickwork below the eaves: this was generally left exposed, presumably for a combination of reasons including aesthetics, ease of application and avoidance of additional works (e.g. extending rooflines). This presents a thermal bridge. Metal flashings were joined to the brickwork above the insulation line to prevent water ingress behind the insulation – if the seal is incomplete anywhere along the top edge there is a risk of rainwater entering behind the insulation and becoming trapped (as the EPS and PIR materials

are not vapour permeable). Indeed, there were reports from householders of this having happened already – it may be that gaps were left in the seal in the first instance, or that it was applied incorrectly (or when it was too cold or wet). In some cases other architectural features such as ornate window heads and door surrounds were also left untreated.

- Some corner properties have complex forms and EWI was only applied at first floor level, increasing the likelihood of thermal bridging
- The original stone window sills and lintels are no longer visible. The new sills appear to be uPVC and are of much thinner dimensions than the original stone
- Door surrounds were left untreated, presumably on grounds of aesthetics and complexity. This presents a thermal bridge
- Where bay windows exist, these seem to have been replaced in some instances and not in others. There is a mixture of single- and double-glazed windows, and uPVC and timber frames. Where the windows have been replaced everything is new except for the area above the windows, which again presents a thermal bridge. Where the windows were not replaced they remain as before, increasing the area of thermal bridging

Some properties were omitted from the retrofit works. It is likely that these omissions were due to a combination of properties being in poor condition (making EWI inadvisable) and householders not wishing to be involved.

Planning permission does not seem to have been required, no doubt due to the recent relaxation of Permitted Development rights.

During the site visit there were (unconfirmed) householder reports of works being commenced and then left unfinished for some weeks as the workforce was called to other jobs in different locations. This may be due to the time pressures involved in mass-scale EWI projects, but it clearly affects the estimated timescales of c.2 weeks per installation.

As part of this research householders were interviewed during the site visit. As could perhaps be anticipated, there was a clear and inevitable divide between residents who liked the change in appearance (*'I think it's smashing'*) and those who disliked it (*'It doesn't look right … Brick terraces are meant to look like brick terraces'*). Many people noted the improvement in comfort levels, saying they have noticed the difference and their homes heat up more quickly and stay much warmer, reducing their need for heating. People did not seem too concerned about the disruption during the works – indeed, one resident was more than happy to have EWI installed but said no to the offer of a boiler and new windows as he felt they would entail more disruption (presumably because internal access and works would be required). This last point is significant in relation to the predominance of EWI over IWI and suggests that this is likely to continue to be the case in future retrofits – making clear and detailed guidance even more important.

The following quote illustrates the potential benefits of EWI (alongside other measures): *'The house has always been cold but the health problems I've had in recent years have made it even more of an issue. Thanks to the … scheme I can now look forward to spending time at home with my children and grandchildren, without having to have the heating on all day or add extra layers of clothing when moving from room to room … Before the house was insulated I used to put £30 a week on my meter, since it was done two weeks ago I've put £12 on the meter and still have money left'* [52].

Some householders cited instances of damp in neighbouring houses, which is of potential concern. While it was not possible to speak with any occupants of the affected houses, neighbours thought the problem was poor sealing at the top of the EWI which led to rainwater ingress, as workmen returned and re-sealed the perimeters. However, if this is the case it is possible that some moisture is still present behind the insulation as it is impermeable.

In summary, while there may be some technical issues with both the materials used and the extent of application, the overall appearance of the works seems to be viewed positively by many householders. It is important to note that, under the masterplan for the area, not addressing the quality of these buildings may well have resulted in demolition. The EWI project has therefore lent these buildings a new lease of life. The impact of the technical issues covered above remains to be seen; and while some damp issues have been reported during this research it should be noted that some of the possible unintended consequences of SWI on traditionally buildings could take some years to materialise.

Section 3.1.3 Images

In addition to these photographs, a video made by the scheme manager is available online

Figures 7 – 9 The visual impact; note the more uniform appearance where all properties are treated. Also note the thermal bridge at ground level

Figures 10 & 11 Thermal bridges at eaves, lintel, flue, gas box and floor level

Figure 12 Sealing detail

Figure 13 Untreated large window and door

Figure 14 Thermal bridging at eaves

Figure 15 The integrity of seals like this is important

Figure 16 Untreated vs treated window, Note new sill

Figure 17 Note different sill finish to Figure 13

Figure 18 Detailing around downpipes

Figure 19 Note large thermal bridge

Figure 20 Original detailing

Figure 21 Large untreated areas to right-hand property

Figure 22 Gas pipe creating (required) thermal bridge

Figure 23 Exposed brickwork creating thermal bridge risk

Figure 24 Note large areas of exposed building elements

Figure 25 Large thermal bridge created by lamppost

N.B. In both these images, the benefit of the left-hand vertical insulation strip may be open to question

Figure 26 Non-homogenous appearance

Figure 27 Wet EPS boards awaiting installation

Figures 28 & 29 PIR insulation boards being installed[53]

Figure 30 Note cracks in finish around plant holder

Figure 31 Insulation to end wall

Figure 32 More complex thermal bridges

Figure 33 Many exposed areas, & poorly maintained timber

Figures 34 – 37 Several areas of failing render finish; reasons for this are unclear, possibly impact or unsuitable application

Figures 38 & 39 Untreated door surrounds; note different detailing on opposite sides of street[54]

Figures 40 & 41 Alternative CO_2- saving measures adopted on adjacent (more modern) properties (EWI vs PV)[55]

Figures 42 & 43 Properties with bay windows (some new, some not); also note lack of eaves brickwork detailing[56]

Figure 44 Note the many thermal bridges, in particular the corner bridge between the two upper windows

Figures 45 – 48 Traditional homes selected for either refurbishment (newly-rendered dwellings) or demolition & replacement (boarded-up dwellings)

3.2 LIVERPOOL

Project Overview	
Dates:	2012-2013
Dwelling types:	Pre-1919 terraced houses, solid brick walls
Number of dwellings:	c.1,000
Occupancy type:	Private & social housing
Funding:	CESP & social housing landlord
Insulating material:	EPS + silicone render / pebbledash

It should be noted that some of the organisations involved in the different projects in this area did not take part in the research. As such, the information in this case study is sourced mainly from site visits; interviews with social housing providers, local authorities, sustainable design consultants and householders; and research drawn from reports and articles published online.

3.2.1 Background

This project is focused on the Sefton and Bootle areas of Liverpool. The EWI installations are the result of two projects (although more took place historically), covering both social and private housing in adjacent areas and carried out by different organisations. Again the funding route was CESP (with c.£3m for a social housing project and c.£5m for a subsequent private housing project), with the social landlord contributing an additional £1.3m for their project. Further work is planned under ECO.

The maps below show the location of the EWI[57, 58].

The detailed map shows the individual streets targeted for EWI, and was produced as part of a privately-managed project which followed several social housing projects delivered by multiple social housing providers. Only one of the social housing schemes was considered as part of this research. (It should be highlighted that the private scheme manager did not participate in this research to any great extent, and so it is not possible to include their views in the report.) As far as can be ascertained, it seems that the social housing project considered in this report comprises the streets immediately to the North of Peel Road, while the streets immediately to the South of Peel Road are largely private and include the privately managed scheme.

As implied by the CESP eligibility, this is a deprived area where low incomes and poor-quality housing predominate. The housing consists of terraces of traditional solid brick houses, many of which were built as dock workers' housing. One interviewee felt that *'the houses themselves are solid enough',* but the poverty levels in the area mean that occupants can't afford to maintain them properly. As a result, another interviewee confirmed that many of the houses were cold and damp, and felt that the EWI would protect them from further damp (unless of course EWI were to be added to walls while damp was present, in which case the moisture could be trapped). There is a mix of tenure types: the social housing landlord was established in the area over 50 years ago and bought a lot of properties, so there are many streets with 70-80% social rented housing and it seems there are no wholly private streets. The landlord felt that '*anything that supports the customer is a plus and helps social sustainability',* and that upgrades such as EWI also reduce the instances of tenants moving out, which costs social landlords a lot of money.

In the past the area had been identified under the 2002 Housing Market Renewal Initiative (HMRI, also known as Pathfinder), a set of policies in the North of England to address housing market failure – defined as housing which in local markets was priced below the build cost, such that renovations were uneconomic and the sale of property would not generate sufficient funds to move elsewhere[59]. The HMRI came into being due to one of the then Government's policies to improve urban areas that had suffered numerous social problems, originating from the decline of traditional industries such as coal mining, ship yards and the textile industry. These areas did not experience the same house price rises seen in some other areas of England, and experienced '*high vacancy rates, increasing population turnover, low sales values and, in some cases, neighbourhood abandonment and market failure'* [60].

The HMRI was wound up in 2009 due to recession, the collapse of house-building and public spending cuts, but during its existence it led to considerable under investment in the identified areas which inevitably affected the condition of the area and its housing, much of which was demolished or earmarked for demolition. A considerable amount of the housing in these areas comprised traditional solid-brick terraces, and views on the HMRI were mixed. While some householders mourned the loss of their neighbourhoods, and one Minister referred to it as *'bulldozing buildings and knocking down neighbourhoods … demolishing our Victorian heritage'*, others welcomed the potential to live in better-quality housing: '*We lived with rising damp, fungus, ice on the inside of the windows … I brought up four children in these horrible damp conditions. We want the streets to be demolished and modernised'* [61].

Countering this to some degree, the Merseyside area has received additional funding in the past as it falls under the EU's regional policy Objective 1, which aims to '*promote the development and structural adjustment of regions whose development is lagging behind*'[62]. The Liverpool City region was aware of the forthcoming CESP funding and engaged with housing associations so that all parties were ready to proceed with projects when full funding became available through utilities companies.

3.2.2 Project details

The social landlord initiated their EWI project using CESP funding and worked in partnership with a local contractor, while a private company led the private project. The local Council offered the possibility of additional funding through ERDF, but the social landlord felt the CESP funding to be more straightforward and so ERDF funding was not used; consequently the local authority had little involvement in the actual project once it was underway. The contractors who carried out the social housing works were felt by the landlord to have done a good job. As well as EWI, householders in the private scheme were offered loft insulation, heating upgrades and door and window draught proofing[63], with the social housing tenants being offered similar measures but also cavity wall insulation[64]. In total, c.500 properties were treated under each project (although not all of these received EWI).

The social housing project took place in 2012 and finished at the end of that year, with the private works following on between January and March 2013. The landlord had previous experience of EWI installations in the Breckfield area (which they felt had transformed the area), and their reasons for choosing EWI rather than IWI seemed primarily to be on grounds of dwelling size and disruption.

Anecdotal evidence suggests the social housing project went well (the landlord confirmed high customer satisfaction levels), but the subsequent private project reportedly encountered more issues, for different reasons. Its timing close to the end of the CESP funding period meant that it had to be completed quickly, which may have contributed to a reported lack of householder consultation – unlike the social housing project where tenant consultation took place before, during and after the works and they had a regular staff presence on site to identify and resolve any issues immediately. This time pressure may also have been a factor in the planning of the works, which it seems created issues surrounding materials delivery and the constant presence of lorries, complicated by one-way streets and limited access in many cases, and materials being left in the streets. There are also anecdotal reports of poor finishing towards the end of this project, with downpipes not being reinstated and windowsills not being painted, which again could be due to time pressures. In addition, the original project was considering four areas, but one was dropped which led to some disappointment. As the scheme involved private housing, there was no involvement from a social housing provider used to dealing with tenants, conducting resident liaison, pre-empting possible problems and informing householders of likely levels of disruption. This meant that issues such as materials delivery, mortar splashes on walls, noise from workers, scaffolding and general disruption – all issues that could have been expected but were not highlighted through consultation – led to some complaints by residents. It is also possible that a Clerk of Works on the social housing project helped minimise any such issues, although it is not known whether the private project also employed a Clerk of Works.

For the social housing project, suspect properties were subject to structural surveys which identified a few unsound properties (but not many) – these were either repaired or excluded from the project. Initially many tenants refused the EWI, but once the works got underway more and more tenants changed their minds and requested it.

In terms of insulation materials, the social housing provider used a standard EPS-based EWI system, and site inspection showed evidence of EPS material in the private project as well – which seems likely, as these are the most common, economical and easy-to-fit materials for large-scale schemes like this. The social landlord did consider environmental issues in selecting their insulation material: investigations into phenolic foam showed it to be more expensive and harder to dispose of, whereas the EPS, while being thicker than phenolic foam, would be easier to dispose of at the end of its life. The scheme manager was aware to some degree of the potential risks involved in trapping moisture in old properties, and acknowledged they could be storing up a problem for the future, but stressed that no-one seemed to know whether this was an issue and that they would only become aware of any technical problems later on. Thermal bridging was not mentioned, although there are clear instances of this and corbels were intentionally left untreated. However, they felt that it wasn't possible to achieve 100% insulation but that anything is better than nothing and a practical decision was needed – they did not feel that they would over-seal the properties in question, partly as they have suspended wooden floors which they felt effectively cannot be insulated (as there is no access from below). They highlighted that social landlords have an obligation to do whatever they can for their tenants: *'we could do one of two things: do something or do nothing – and we wanted to do something'*. While this approach could create technical risks by proceeding with insulation which could carry unknown risks, it clearly demonstrates one of the main – and powerful – drivers for such projects.

The private project was finished in March 2013 with snagging ongoing to June 2013, so it may be too early to tell whether the EWI system creates any technical problems. However, during the site inspection several private residents reported damp issues, including two in their own houses (both on West-facing walls below ground-floor bay windows and in upstairs rooms) and another who said he knew of many houses in a particular street that were experiencing damp problems following the EWI installation. It should be noted that the two householders who confirmed damp in their properties said their EWI had been installed two years ago, so it seems they were part of a previous scheme; their EWI was installed together with new boilers and double glazing.

Other possible technical issues were noted during the site visit, some of which had also been highlighted during interviews with external parties who had seen the works in progress. These included the following:

- Considerable use of *'squirty foam'* (for example, where the brick surface was uneven expanding foam was just used to fill the gaps rather than cutting the EPS boards to fit)
- Termination of the insulation below the crenelated brickwork at eaves of properties (which creates a thermal bridge and a risk of rainwater ingress behind the insulation if the seal is incomplete or fails)
- Exclusion of bay window sills (and other window sills and lintels)
- Insulating around burglar alarms rather than removing them and insulating behind them
- Not sealing around the gaps left around existing boiler flues, creating a route for rainwater ingress behind the insulation

In terms of appearance, the properties in these projects were finished with render and pebbledash in a variety of colours – unlike the other case studies which used a smooth render finish. This creates a very different finish compared with white render, as illustrated in the images in the following section. One social landlord staff member recognised the considerable visual impact of EWI, but felt this was outweighed by the need to improve the properties and make them more comfortable and affordable for their occupants – indeed, they confirmed that most tenants were keen on the improvement measures as a means to reduce their fuel bill costs. All of the householders interviewed as part of this research liked the appearance of the finished buildings, and many felt it had improved the area as a whole. The only issue one private householder raised was whether they would be able to carry out other energy efficiency measures in the future: *'If*

*I want to replace my windows I'm f***ed, aren't I?'* (this was unclear, as many windows should be replaceable from the inside; however under certain conditions it could prove problematic, and ideally window replacement would be carried out concurrently with EWI). Pebbledash render was chosen for the social housing project on grounds of robustness and longevity: they felt that smooth render may need repainting after only a few years, particularly due to the proximity of the docks which they felt would create films of dirt on the properties. Despite the potential benefits of the pebbledash finish, however, they did confirm some concern over the stereotype of its '1960s image' (a view echoed in the Blackpool case study by the Council, who decided against pebbledash for their own project on the same grounds).

There were no formal conservation constraints on any of the projects, but many of the houses have external masonry features (e.g. dentil brickwork) and are painted, in common with much of the traditional housing in the area.

While there were no conservation constraints, the private project did encounter complications with the planning system: it seems that at the time of the works no permissions were asked for or required, but subsequently the planning department asked for retrospective notification and attached fees, and felt that planning permission may have been required. The scheme manager felt that Permitted Development applied to the works and that early negotiations with the Council had made it clear nothing was required. This situation may have been exacerbated by the current lack of clarity as to when EWI requires Planning Permission (see Section 4). The social housing landlord was also in the process of applying for retrospective consents (with associated costs) at the time of writing this report, which they were informed of after the project was completed. Most of those interviewed for this project felt that the planning policies for SWI can be hard to follow, lack consistency and requirements for planning permission could be driven partly by financial motivations.

It was not possible to make contact with the relevant planning officers and so this element of the project is slightly unclear (at the time of writing this report resolution of these issues is underway), however another department of the Council did highlight the difficulty in interpreting the regulations: for example, EWI may not seem to be a planning requirement, but the 100mm insulation effectively moves properties closer to the highway and it is not clear whether this constitutes encroachment and whether the presence or otherwise of a front yard affects this. This is compounded by the fact that different regional planning bodies adopt different stances in relation to what does and does not require consent. This risks an increasing lack of coherence of property appearance, in terms of insulation depth, finish and colour, and pepper-potting in between untreated properties of varying condition. The result in some areas, according to one interviewee, is *'a dog's dinner of properties'* (although it should be noted that many clusters of traditional properties also lack homogeneity but are felt to be aesthetically pleasing).

The impact of the EWI installations in terms of CO_2 and running cost reductions is not known. The social landlord confirmed that there was no funding requirement to conduct energy modelling (but there had been in the past), and they had carried out enough RdSAP surveys on similar void properties to have a fair idea of the baseline performance. Tenant reports have been favourable, however, and this is echoed in tenant feedback obtained during the site visit.

The Council raised a number of concerns over the general drive for mass-scale EWI installations. It was felt that the funding structure contributed to the problems faced in some cases, and will continue to do so in the future. The potential for thermal bridging was also highlighted, particularly below the eaves where insulation was stopped short to leave the ornate brickwork exposed –

possibly on grounds of time, cost, complexity and knock-on works. The relatively sudden growth of this industry was cited as a further concern, in relation to the likelihood of inexperienced contractors carrying out work very quickly on complex, non-homogenous buildings, and the predominance of detailing being done on site rather than planned in advance.

A further concern was raised in relation to evaluation of EWI projects, namely that there is generally none or very little. Under CESP, the local authority was obliged to sign a declaration confirming they were aware of a scheme; under ECO, they stated that there is no such requirement and so the local authority may not be aware of projects that take place until they receive a householder complaint. The Council's perception was that the utility companies were against consultation as it presented a barrier to projects, but local authorities would rather be involved so they can provide support, have some control over quality and help co-ordinate projects so there aren't too many contractors in one area at the same time.

The funding structure seems to have placed clear stresses on the private project which ran at the end of the funding period. The social landlord felt that EWI and its enabling works should be carried out in the summer months, but this option was not available to the private scheme. The funding also presented complexities by changing what it would cover: in the earlier stages enabling works were not covered so the landlord had to fund these themselves, but in the latter stages of CESP it did cover enabling works as well.

Attempts are being made to mitigate some of these potential issues, through the creation of a local EWI design guide led by Project Viridis[65], a recently-formed consortium in the Merseyside area which includes several local authorities and larger housing associations. This was not available at the time of writing this report, although its publication is anticipated in the near future. It is intended to be a relatively simple guide rather than for a highly technical audience, but it should cover complex aspects like eaves and window detailing. (Project Viridis recently completed a Green Deal pilot project retrofitting 76 properties with measures including EWI and IWI[66], and some partners have many years' experience in EWI projects – although not all on traditional solid-brick properties.)

The social landlord is looking into ECO funding to treat the remainder of their stock which they confirmed is hard to treat. They have identified c.10,000 further properties that may benefit from EWI (including many with hard-to-treat cavity walls).

3.2.3 Images

Figures 49 – 51 Note the different finishes compared with the smooth white render of the other case studies

Figure 52 Note edge detailing

Figure 53 Porch roofs creating a thermal bridge

Figures 54 – 55 The ornate brickwork at eaves has been left exposed

Figures 56 – 57 Note the challenges of insulating bay windows; also upper-right window surrounds untreated. The thermal benefit of the thin section of insulation below the left-hand ground-floor bay window is unclear

Figure 58 Unsealed insulation around flue

Figure 59 Alarm not removed prior to insulation

Figure 60 Burglar alarm not removed; 'squirty foam'[67]

Figure 61 Use of expanding foam rather than cut EPS[68]

Figure 62 Poor insulation jointing[69]

Figure 63 Note uninsulated areas above bay windows[70]

Figure 64 Note the high area of uninsulated wall area in this building; reasons for some of the untreated areas are not clear

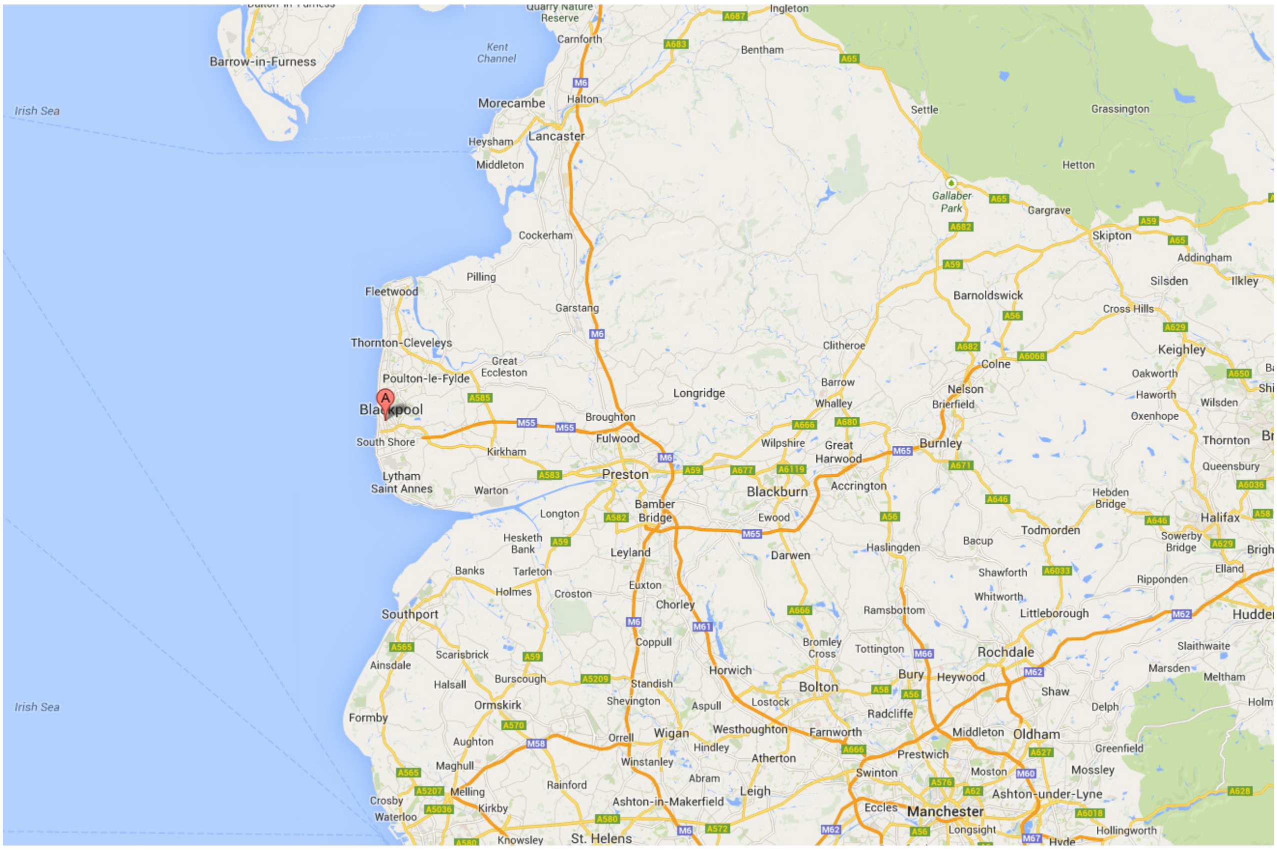
3.3 BLACKPOOL

Project Overview	
Dates:	2012-present
Dwelling types:	Traditional terraced houses, cavity walls with a mix of brick & stone outer leaf
Number of dwellings:	473
Occupancy type:	Mainly private housing (small amount of social housing)
Funding:	CESP (& potential ECO)
Insulating material:	EPS + silicone render (Wetherby)

The information in this section is sourced from site visits, local authority interviews and research drawn from article and reports published online.

3.3.1 Background

This project involved the overcladding of mainly privately-owned[71] houses in central Blackpool. The properties treated to date are in streets close to Central Drive, effectively forming a grid bounded by Central Drive, Ashton Road, Park Road and Ribble Road. These streets are situated in the centre of Blackpool close to the west coast; the map below shows the location.



The location of the houses close to the sea means they are very exposed, and lots of the properties have been subject to damage from both wind and salt[72]. These factors, together with poor maintenance of the properties due to low household incomes, mean that much of the housing in Blackpool is in relatively poor condition.

22% of the housing in Blackpool is pre-1919, and semi-detached and terraced housing predominates (comprising nearly 70% of the dwelling types, significantly more than the English average of 58%)[73]. While terraced and semi-detached houses lose less heat through their walls than detached properties, EWI is logistically simpler in such properties and it is easier to achieve economies of scale. EWI was cited as one of the priority measures in a 2010 study of the region: *'This study shows certain areas as having higher heating demand per home than others, particularly in the older central area of Blackpool … Home improvement measures such as loft, cavity and solid wall insulation, double glazing and boiler replacement should be heavily promoted across the Borough, as these are the least efficient areas on a per home basis'*[74]. This study also proposed CESP as a likely funding route, in recognition of the high levels of deprivation in the area. When funding became available it was therefore seized as a key opportunity for regeneration of the area.

3.3.2 Project details

The first phases of the project were led by the local Council, with several different internal teams involved: Housing Strategy (which drove the project), Planning Policy, Development Control, Heritage, Public Health (which funded works not covered by CESP) and Capital Projects (which seconded the Clerk of Works). Other key partners were a scheme manager and main installer, with whom the Council worked to try and utilise local labour. Funding was provided through the CESP programme.

The project is being delivered in phases of c.200 houses per phase: to date, 473 properties have been treated, however several further phases are planned subject to accessing ECO funding.

Housing was chosen on the basis of the deprived area, the high levels of private rented housing and the simplicity of construction: they are predominantly two-up, two-down terraced houses with outriggers at the back and rear access. In most cases there were minimal architectural features to retain, and the small, contained area made practical delivery easier and more cost-effective.

Due to the poor condition of the housing it was felt that EWI, as well as improving insulation and comfort levels, could help protect properties from further damage. Surveys identified those properties where EWI would have been problematic due to the condition of the external walls. However, funding was not available for structural repairs, and owners were not often able or willing to fund such works themselves, so where there were significant problems with the wall condition these properties were excluded from the refurbishment programme. The Council also drew up an agreed list of streets where they would only consider IWI rather than EWI for heritage reasons.

Unlike the other case studies, the properties in question are of traditional construction but not all have solid walls – some have cavity walls, being either brick- or stone-fronted, but where cavities are present they are all very narrow. In some cases the cavity had been filled in the past, but due to the irregularity of the cavities (some of which the Council believes only exist by accident rather than design) in many cases CWI was not felt to have had any significant impact. EWI was therefore felt to be the best solution – also for its aesthetic properties and ability to contribute to area regeneration.

A standard EPS-based EWI system was used following selection by the contractor, comprising 90mm EPS insulation boards affixed mechanically to the walls and finished with a silicone render. EPS was selected on grounds of cost and ease to work with when applying a thin silicone finish. The project team decided to offer only one choice of finish, in order to achieve a uniformity of appearance; a silicone render was deemed preferable to a pebbledash finish on grounds of aesthetics (it was felt that pebbledash would be negatively perceived due to its stereotypical links with Council estates).

The typical finished make-up of the cavity walls is as follows:

- Silicone render finish (approx. 10mm)
- EPS insulation (90mm)
- Accrington brick / stone outer leaf (100-125mm – varies with stone)
- Cavity (width unknown, and varies with irregular face of stone)
- Common brick inner leaf (100mm)
- Lime plaster (13mm)

The EWI system was installed in conjunction with other measures in some cases, such as boiler replacements, heating installations, loft insulation, draught-proofing and other associated works. It should be noted however that the draught-proofing proved not to be cost-effective and was discontinued – the reasons for this are not clear. Window replacements were also not included as part of the works, and while the contractors use a stop bead up to the existing windows with a silicone sealant which may be broken to allow future window replacement from the inside, it is unclear how straightforward replacement and re-sealing will be in practice.

The early stages of the project were driven by the local Council who co-ordinated efforts and ensured the works got underway successfully. Quality was a priority and funding was secured through CESP for a Clerk of Works: this was felt to be key to the success of the project and was cited as a very important lesson going forward. The presence of an on-site works inspector allows issues to be identified and rectified as much as possible – although not every detail can be seen prior to completion, and the Clerk of Works did identify some details that he felt could have been improved upon. It should also be noted that the funding or this post was only guaranteed for the first year; efforts are ongoing to secure this on a longer-term basis.

This was the first CESP-funded project in Blackpool, and the Council felt it to be a very steep learning curve for all involved, and recognised the challenges of retrofitting terraces of solid brick houses without *'taking away every ounce of character'*. In the first stages, pressures of funding timescales meant that works were done faster than both the Council and the contractors would have liked, and architectural details were lost due to cost and speed requirements and an element of everyone *'learning on their feet'*.

However, at a relatively early stage in the works the Council involved all key delivery stakeholders, including the internal Planning and Heritage teams: this was felt to be another important lesson. Their collaboration included both meetings and site visits, which enabled them to identify the most significant aspects of the buildings and highlight areas where EWI would and would not be deemed acceptable. Walking around the areas before the works started was beneficial, and involving all relevant teams within the Council at this early stage facilitated the adoption of a pragmatic approach wherever possible.

In certain cases properties were left untouched by EWI as they were felt too noteworthy to be covered, but these were in the minority. EWI was largely felt acceptable for this area, as the properties were not felt to be *'packed with character'* (they do not have features such as dentil brickwork that are present in the other case studies, for example, and door surrounds tend to be simpler). However, the Council does have plans to roll out similar works across the town and recognises that in some areas EWI may prove more challenging for aesthetic reasons (hence the previously mentioned list of properties deemed inappropriate for this measure).

Aesthetics have been a big focus for this project, and the Council has taken steps to try and develop sympathetic finishes and detailing where possible that are in keeping with the original appearance of the properties. While the contractor specified the EWI system and the first stages of the project used standard detailing, more detailed specifications have been arrived at for subsequent phases. This was achieved through negotiations between the contractor and the Council's technical and planning staff; the Council noted the support they have received from the contractor on this issue as they are not under any obligation to carry out specialised detailing. The changes in detailing adopted for later phases of the project focus on elements such as window sills and lintels, door surrounds, bay windows and insulation stopping points on sloping streets. In some cases these details have been adopted for a combination of aesthetic and thermal reasons (i.e. to reduce thermal bridging). Details can be seen in the images in the following section.

Methods for this detailing have been refined over time partly through trial and error. Different detailing around windows and doors has been explored, for example, and while this results in some inconsistency of detailing it has allowed the optimum approach to be identified and replicated in later phases.

While the streetscape is, inevitably, dramatically altered, it was felt that a uniform change was more appropriate than a piecemeal approach, and the aim was therefore to treat entire terraces of houses. Inevitably, some properties were excluded, either due to their poor condition or because the owners did not wish to be involved. While not treating properties in poor condition is correct from a technical point of view, it does inevitably lead to some lack of uniformity. There is scope for these properties to be treated at a later date, although this is not guaranteed.

Overall it was felt that this project is being tackled in a realistic manner, and efforts are being made to identify and apply the best solutions with refinements as the works progress and lessons are learned on the ground. This is largely down to the collaborative nature of the delivery team, the involvement of different Council teams (including planning representatives adopting a positive approach to make the most of what is a considerable change in appearance for the area) and the presence of a Clerk of Works on site. It should also be noted that the Council is very aware of some of the possible issues surrounding EWI, particularly in terms of thermal bridging and lack of moisture movement within the walls – although attempts to keep up with developments and research in this area were felt to be largely dependent on officers picking up information as they go along, and the lack of a central resource for this research was highlighted as a barrier to knowledge.

As a result of this heightened awareness, particular efforts have been made to ensure the works are carried out appropriately (e.g. tight jointing of insulation boards, proper sealing around perimeters), and certain areas where only partial insulation is possible have not been treated (e.g. below bay windows and at some door junctions). This improves the aesthetics but increases the areas of untreated wall – however, on the grounds that in any case only partial treatment was possible this may prove to be less of an issue. Again these are detailed in the images in Section

3.1.3.

However, damp has been reported in several properties following the installation of EWI, which has been in place for a maximum of 12 months and in many cases less. The damp is causing mould growth, in all cases (to date) below the large bay windows (in different orientations). There are many possible reasons for this, and further exploration would certainly be beneficial to identify the causes and take steps to prevent this in future rollout of EWI. Possible causes may include rising damp or condensation, cold spots caused by thermal bridging, use of impermeable insulation materials, increased airtightness or inadequate ventilation leading to increased Relative Humidity, poor jointing of insulation boards, incomplete/poor sealing around perimeters, or existing damp in the walls.

Other possible issues that have been identified include the following:

- Staff changes have increased the challenges of maintaining the learning curve on site. The Site Manager has changed 6 times, for example, and an increased requirement to use IT systems takes them away from the works for periods of time. Likewise the teams of contractors have changed, and in some cases teams include foreign workers who may be used to installing EWI elements in different ways (sealing or not sealing along the eaves flashing, for example) – this requires time to ensure a uniform approach and may not always be practically possible, leading to different standards on different buildings.
- Render has fallen off in some instances and had to be re-applied. This is probably due to being applied in the winter when the temperature was too cold for proper application. Preventing this may be difficult in reality, again due to funding time pressures.
- There are significant areas of thermal bridging on many properties, notably at bay windows, porch canopies, ground floors, exposed window heads, door and window surrounds, pre-existing boiler flues and exterior pipework. These are largely unavoidable due to traditional construction details or Building Control requirements, however there are also instances of poor detailing.
- Where the EWI stops short of the eaves, it is capped with metal flashing. Where there is space for the EWI to run all the way up into the eaves, it was reported that the standard procedure used with this system is not to apply any flashing or seal at the top of the EWI, on the grounds that the insulation is protected from the elements by the eaves. However, at corners there may be risk of rain penetration behind the insulation, if indeed it is left unsealed. This cannot be confirmed as these elements were not visible during the site visit.
- Below curved bay windows, use of the standard flashing system was not possible. Insulation was therefore cut into a sympathetic shape, rendered and sealed without any flashing. Flashing below bay windows has also been avoided in later phases of the project on grounds of aesthetics, at the request of the Council. Problems are not anticipated with this approach, although the contractors would appear to have a preference for inclusion of flashing.

No residents were consulted during the site visit, but the Council reports positive feedback from the majority of householders. Press material[75] reflects this positive response, both in terms of comfort and appearance, although some were more ambivalent towards the aesthetics:

- *'It does make a big difference as far as I'm concerned. It's very sore on the eyes when the sun hits it but it's a lovely idea'*
- *'I've felt the difference. It is better and it looks nice'*

- *'It looks better but it'll be like Balamory before long'*

Following this CESP-funded project, further rollout is planned to another c.1,200 properties through ECO funding, but this has not yet happened. The Council note that the funding seemed to work more smoothly and be less limited under the CESP scheme than under ECO, and at the time of writing this report they were finding it harder to access ECO funding. Due to the reduced funding levels under ECO, the Council also felt that this would leave less leeway for the 'nice-to-haves' such as retaining or replicating original features.

It should also be highlighted that following on from this retrofit project the Council secured funding to develop a robust methodology for future SWI installations in their area. Once complete, this methodology will include (among other things) a Code of Practice, a contractor directory and guidance for residents, and a Decision Making Protocol for Development Control (Planning). These good practice measures will be disseminated on a wider basis to enable others to benefit and encourage replication of SWI following sound principles.

3.3.3 Images

The following images highlight specific details noted in section 3.3.2.

Figure 65 Three identical properties at different stages: completed, underway and untreated

Figures 66 & 67 Note the difference in uniformity caused by one untreated property

Figures 68 - 71 Different insulation treatments below bay windows: (clockwise from top left) (i) Conventional flashing; (ii) No flashing, graded insulation, sill uninsulated; (iii) No flashing, insulated to top of sill; (iv) No insulation, render only

Figures 72 & 73 Insulated to top of eaves (left) and stopping short due to lack of space (right)

Figures 74 & 75 Note different approaches to lintels, i.e. leaving exposed or covering: leaving them exposed retains the feature but increases the thermal bridge, covering them creates a cleaner look and increases insulation coverage

Figure 76 Typical rear insulation details

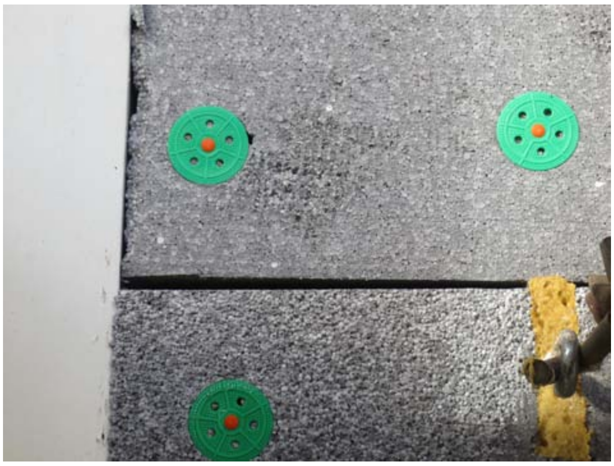


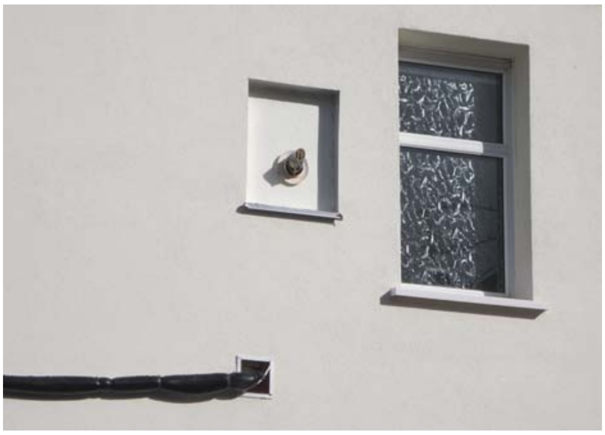
Figure 77 Poor insulation jointing

Figures 78 & 79 Bay windows leave large areas of untreated wall at ground floor level; gable ends are simpler

Figures 80 – 83 Note large uninsulated areas: vennels, gas pipes, porch roofs, window & door surrounds

Figure 84 Uninsuated pipe run

Figure 85 Lamppost obstructing pipework removal



Figures 86 & 87 Uninsulated boiler flue surrounds (note flashing on left vs no flashing on right)

Figures 88 & 89 Uninsulated vs insulated party wall frontage; the difference in thermal impact is unclear

Figures 90 - 91 Possible routes for rainwater ingress behind insulation

Figures 92 & 93 Attempts at sensitive detailing through recreated dimensions and doorway stones

Figures 94 & 95 Conventional EWI window sill (left) vs recreated – and insulated – original stone sill (right)

Figures 96 & 97 The property on the left is untreated; the property on the right is insulated but maintains the original aesthetic through detailing such as painted stone-effect window sills and soft corners at window reveals

3.4 OTHER FEEDBACK

As part of this research, interviews were conducted with individuals either indirectly connected with the case study projects or with experience in similar projects elsewhere. These fed into the sections above, however some additional observations by these individuals are provided below:

- There are many long-standing cases of EWI which seem not to have led to any technical problems – however these are mainly on concrete (No Fines) properties which have a different dynamic to brick or stone walls
- EWI was felt by one individual to be a more 'foolproof' insulation method than either IWI or cavity wall insulation (which in past projects had led to delamination of the outer common brick, possibly because the outer leaf no longer heats up and so becomes colder and wetter). On this basis EWI was felt to provide better protection to the wall
- The lack of consistency in terms of planning requirements was stressed by multiple individuals as a complicating and irritating factor for EWI. It was felt that stances and requirements vary widely within a single region, and even in the same department, to the point that individual planners' whims are perceived to play a large part in some cases. In one area, all seven local planning departments have a different interpretation of Permitted Development for EWI, varying from requiring no planning permission to requiring it for front elevations to requiring it for all elevations
- Householder engagement was highlighted as being fundamental to the long-term success of such projects: *'if you don't spend money and time on tenant behaviour you won't get the full benefit of the insulation'*. One local benefit in this regard was a knowledge transfer arrangement between regional procurement consortium Fusion 21 and Salford University, who had a PhD student investigating tenant engagement – this collaboration enabled the academic research to be translated into a pragmatic work package as part of insulation projects
- Working in partnership with experts and engaging with the supply chain were also felt to be important elements for success, e.g. working with manufacturers to identify the best solutions for different buildings, using experienced contractors, forming a specification with the contractor and supply chain rather than going out to tender with a predefined specification
- The importance of using a Clerk of Works on EWI projects was reiterated
- Monitoring meter readings is showing savings levels of c.30% post-EWI, with relatively short bursts of heating keeping properties warm for longer periods of time
- The procurement method can affect the project manager's ability to specify some details. For example, contractors on a Design & Build EWI project used uPVC trims where the designer would have preferred metal, and towards the end of the project reverted to standard details and phenolic foam rather than the details and materials carefully specified by the designer
- The robustness of BBA certification for EWI materials was questioned, due to the mechanisms of existing moisture measuring conventions [this concern is highlighted in current research being carried out by both SPAB and the STBA[76]]. When reviewing current certified products for a new IWI project in Manchester, the individual in question identified only one product that they would feel comfortable using
- It was suggested that IWI may be more viable and less technically risky at the front of brick properties where the outer leaf is in good condition, and correspondingly that EWI is more likely to be a better solution at the rear where brickwork is often of poorer quality
- The 'In-Use Factor' applied to Green Deal and ECO savings calculations was felt by one

individual to be little more than *'a margin for error for poor installation'*

- EWI was felt to be possible as long as there was careful thought and detailing at design stage – but one of the biggest challenges was controlling this on site
- Developers in some instances are aware of some of the potential issues surrounding EWI, but they do not always have the experience or resources in-house to check on the contractor and have instead to rely on their word
- It was noted that the pepper-potting approach to EWI (i.e. leaving some properties untreated) makes the planning process more laborious, as permission is required for every installation whether the installation is a run of 17 properties or just a single property. Mass-scale installations are therefore more efficient in terms of bureaucracy and planning costs
- In one project, when householders were offered the choice between EWI and IWI, 100% voted for EWI once it was explained to them what IWI would involve. While the properties in question were small – exacerbating any disruption – this is illustrative of one of the strongest drivers for EWI rather than IWI: retrofit of the UK's housing stock will mainly involve occupied properties, and the disruption levels of IWI are likely to be unacceptable in many cases. Coupled with this are the redecoration costs associated with IWI, which are currently not covered by insulation funding
- The need to strike a balance between ideal levels of detailing and quality on the one hand and affordable costs on the other hand, was stressed as being the reality in many cases. Combined with this are concerns to promote bill savings, fears over promoting and installing insulation that could create problems in the future, the fact that *'we don't really know what the answer is for solid walls'* and current funding mechanisms that place an ever-greater emphasis on achieving the lowest possible costs
- There was concern that the above issues risk confusion and market paralysis. In addition, being too prescriptive could lead to liability issues so in most cases advice is general rather than specific which only helps people to a certain point. Suggestions for 'common-sense' approaches include: installing a certain depth of breathable insulation but not too much, so some heat can enter the wall and prevent interstitial condensation; over- rather than under-ventilating properties. But it was also noted that both these approaches risk negating bill savings, and householders can and do elect not to use or to block up ventilation routes, so there is no simple answer
- The time pressures of funding risk excluding some properties: for example, where EWI is the only choice, properties that require planning permission may be excluded from retrofit programmes due to the lack of time needed for preparation and processing of planning applications
- In some instances planners demand that certain architectural features – such as dentil brickwork at eaves – are left exposed. However, it was observed that in many cases, installing 100mm EWI up to this brickwork hides much of it from view in any case, and merely leaves a considerable thermal bridge
- Bristol City Council – which has also undertaken a Green Deal Go Early Pilot[77] – has prepared planning advice on EWI for householders. At the time of writing this report the advice is being refined. It was felt that planning department do not often have the capacity to produce such advice themselves but were keen to see such advice produced, possibly including specifications for complex elements such as bay windows or ornate brickwork.

4.0 ANALYSIS, CONCLUSIONS AND RECOMMENDATIONS

The case studies documented in Section 3 present numerous issues and considerations, from broad holistic aspects to technical details. These are drawn together and summarised in the analysis, prior to conclusions and recommendations being put forward at the end of this section.

4.1 ANALYSIS

4.1.1 Funding

All projects were carried out under the Community Energy Saving Programme (CESP) funding scheme which ran from September 2009 to December 2012. CESP was created as part of the Government's Home Energy Saving Programme, and also contributed to their Fuel Poverty Strategy as it targeted low-income areas of Britain. CESP required UK gas and electricity suppliers to achieve a CO_2 emissions reduction target of 19.25m tonnes by delivering energy-saving measures to domestic consumers, utilising a 'whole-house' approach and addressing as many properties as possible in defined geographic areas.

Many refurbishment projects seem to have taken place in the latter stages of CESP, driven by a need to spend the remaining funding before the programme ended. This time compression is likely to have contributed to some of the issues that arose in some cases, such as lack of appropriate detailing or householder engagement, and application of seals and finishes in weather conditions that may have been inappropriate.

Such funding highlights one of the greatest drivers for EWI in many areas, that of community regeneration and occupant wellbeing. These are in many cases areas where failure to address the housing stock could result in demolition, so a do-nothing approach is not an option.

As CESP is succeeded by ECO, such projects will continue. However, some of those interviewed for this research felt it could become harder accessing funding for some of the related works such as property maintenance and insulation detailing to minimise technical risk and/or retain a traditional feel to the buildings. (At the time of writing this report a number of changes have been announced to ECO, including a reduction on the target number of SWI installations and a reduction in the funding that specifically targets 'hard to treat' properties. In the wake of this there are many reports of traditional building retrofit schemes being cancelled.)

4.1.2 Materials & detailing

For mass-scale projects where time, cost and ease of application are essential, it seems unlikely that the sort of insulation systems (e.g. natural and/or permeable) supported by conservation bodies cited in Section 2 will be used in many instances in the near future. While lack of familiarity with materials can be quickly solved on site, it is likely that this would take time to permeate through the industry and in the meantime contractors may prefer to use systems they are already familiar with and 'risk price' unfamiliar systems.

While such permeable systems could prove most forgiving to imperfect detailing (allowing moisture to escape, for instance), they could also suffer from poor detailing, but attention to detail is equally important where impermeable materials are used. This may prove challenging where insulation and seals are applied in poor weather conditions, budgets do not extend to such detailing or funding pressures push contractors to complete works in a very short space of time.

Careful detailing of EWI works seems to be particularly important to minimise the risk of any problems. The question becomes, to what extent can the risks be 'designed out'? However, following that one of the key challenges is ensuring that such detailing is carried out on site.

4.1.3 Site management

It has been seen that a Clerk of Works is very important on such projects, to ensure works are carried out appropriately and details completed as desired. This is likely to remain a challenge with issues such as a frequently changing workforce – including foreign workers who may be used to different detailing – and changing site managers. This makes it difficult to maintain an education curve on projects, where the project managers may identify optimum solutions over time and their ideal approach therefore evolves, but those carrying out the works change on a periodic basis. A written record may help in keeping track of such evolutions on site.

4.1.4 Coverage & thermal bridging

EWI is often regarded as the less risky option compared with IWI, as it is felt to be easier to avoid thermal bridging. While this may be true in certain instances (e.g. at wall and intermediate floor junctions), in reality where EWI is applied to traditional buildings on an area-wide scale many areas are left uninsulated, due to a combination of complexity, speed, time and in some instances planning requirements (where it is deemed preferable to leave features visible) and building control requirements (e.g. leaving uninsuated areas around boiler flues and gas pipes). In relation to this last point it is important to note the importance of observing these clearances on health & safety grounds; it is also relevant to observe particular care and attention when working around flues, as highlighted in a recent over-cladding Regulatory Advice Note[78] from the Scottish Housing Regulator.

Regardless of the reason, commonly untreated areas include eaves, ground floors, external passageways, window and door surrounds (particularly bay windows), flues, rainwater and drainage pipes, gas pipes and areas where adjacent items make insulation impossible (e.g. lampposts). In combination, these leave considerable areas of wall untreated and present thermal bridges with their risk of moisture build-up and associated complications. In some instances the untreated area is so great that the benefits of applying partial insulation to one side or other of the untreated area may be called into question.

While views on the levels of risk posed by thermal bridging differ, this seems to be to some extent an unknown quantity. At a recent SPAB technical research event[79] views ranged from being *'relaxed about thermal bridging'*[80] to highlighting that insulation does not include window surrounds etc. then their Psi value becomes worse than if no insulation were installed, i.e. the heat loss from thermal bridging increases in those areas, *'concentrating the problem in those areas least able to deal with it'*[81].

Regardless of differing views, however, it seems likely to present a certain level of risk in some instances. One of the particular challenges in trying to minimise thermal bridging is the aesthetic consideration, particularly where planning departments or others deliberately opt to leave traditional details exposed (in particular window/door surrounds and eaves brickwork/boarding) to they may continue to be seen. Even where this is not the case, however, they are generally left untreated due to the additional work involved in covering them adequately. Knock-on works such as roofline extensions are rarely seen – this is contrary to advice outlined in Section 2, but is likely to continue being the reality.

Issues to do with coverage and thermal bridging may be resolved to some degree by adequate detailing at design stage. The key in this respect is for such detailing to become the norm, rather than a 'luxury'. Such a step would also impact positively on the lack of familiarity with such systems and detailing as cited in Section 4.1.2.

4.1.5 Planning & Permitted Development

When does EWI require planning permission? Despite recent legislative changes this is still a contentious issue in many regions of England.

Until recently, many EWI installations would have required planning permission. This changed in January 2013 (partly to align with and facilitate the Green Deal and ECO) when revised Permitted Development (PD) guidance defined EWI as an 'improvement' rather than an 'enlargement' or 'extension', which in some cases removes the requirement for planning permission. However, the situation is not as straightforward as some commentators have proposed: according to the official guidance, this PD only applies where the new materials are similar in appearance to the original building – this is often (commonly) not the case when applying EWI to traditional solid walls. The relevant text is as follows[82]:

- *'Development is not permitted if…the enlarged part of the dwellinghouse would extend beyond a wall which a) fronts a highway and b) forms either the principal elevation or a side elevation of the original dwellinghouse …* ***The installation of solid wall insulation constitutes an improvement rather than an enlargement or extension to the dwellinghouse and is not caught by the provisions [above].'***
- *'Development is permitted…subject to the following conditions:* ***the materials used in any exterior work…shall be of a similar appearance to those used in the construction of the exterior of the existing dwellinghouse.'***

The above is reflected in the current guidance available on the online Planning Portal: *'If you live in a Conservation Area, a National Park, an Area of Outstanding Natural Beauty or the Broads, you will need to apply for planning permission before cladding the outside of your house with stone, artificial stone, pebble dash, render, timber, plastic or tiles.* ***Outside these areas, cladding may be carried out without having to first apply for planning permission provided the materials are of a similar appearance to those used in the construction of the house.'***[83]

In general this seems reasonably clear. However, as with many aspects of the planning system it is open to local interpretation and different local authorities have different stances in this regard, some not requiring planning permission and others requiring it under certain (often differing) circumstances – as highlighted in the case studies.

The caveat requiring materials being of a similar appearance to the original building does not seem to be upheld in many areas, with brick being replaced with render or pebbledash, for example. Even if this requirement were to be upheld, it is likely to present problems for conservation bodies. When applying EWI to an original solid stone or brick wall it is effectively impossible to achieve the same finish, and the only way to achieve this would be through 'imitation' brickwork which is generally deemed a type of mimicry that goes against some conservation principles. In any case it is unlikely to be widely applied due to the extra time and costs incurred: in reality most EWI applications employ a render or pebbledash finish, fundamentally different to that of most solid brick or stone walls.

4.1.6 Aesthetics

In some respects the significance of aesthetics goes without saying, due to the inevitable and fundamental change in appearance (of entire areas, in the case of mass-scale projects). However, even once that is accepted the details of installation methods and project planning remain of great importance, to make sure the change in appearance is as balanced and aesthetically pleasing as possible.

EWI seems to work best where entire streets are treated as this creates a homogenous appearance. Whether the appearance is liked or not remains subjective, and individuals will always differ – although in general, applied in areas such as those in the case studies the general impression is definitely favourable as it helps bring up the look and feel of very deprived areas, lending them a new lease of life. It should also be noted that most householders seem to prefer EWI to IWI – this is a significant point, as most of the housing retrofits in the UK will be on occupied housing, and it seems clear the level of disruption associated with IWI means that EWI will in most cases be the preferred option where walls are treated.

There will always be some properties omitted, however, as this is not a measure than can be forced upon those who do not want it. Some degree of inhomogeneity is therefore inevitable. This is exacerbated by the inevitable changes in detailing, as different projects are carried out alongside each other or preferred styles evolve over time. Learning on the job will remain a feature of such projects.

Depending on the viewpoint, mass-scale EWI could be said to run contrary to the NPPF which advocates that local authorities should *'seek to promote or reinforce local distinctiveness'*[84]. However, this does not preclude change, and in areas such as those targeted by CESP changes in appearance may be strongly favoured by local communities. The visual impact of EWI may therefore be said to be site-specific, and particularly in highly deprived areas with run-down housing stock (traditional or otherwise) that may otherwise be at risk of further decay and/or demolition, it may be broadly viewed as beneficial rather than detrimental.

4.1.7 Moisture-related problems

Time will tell. That seems to be the current situation, as evidence exists both of long-standing installations where no apparent unintended consequences of EWI have materialised, and installations that have been in place only a matter of months before problems occurred. Recent research by bodies such as SPAB and the STBA has explicitly highlighted the potential risks associated with current moisture modelling conventions and insulation methods; a detailed STBA document on the subject is due to be published by DECC for consultation in early 2014.[87]

There could be many reasons for moisture build-up, including poor weatherproofing leading to rainwater ingress behind insulation, insulation being applied to damp walls, insufficient ventilation leading to increased relative humidity, rising damp, thermal bridging from gaps or omitted areas creating cold areas prone to condensation, impermeable materials and so on. However, regardless of the cause it is of some concern that in all three case study projects there have been reports of damp and mould, in installations that have in most cases been in place for less than a year. Should this become the norm rather than the exception it would be a considerable problem for those responsible for maintaining the properties.

Related to this is the issue of ventilation. Additional ventilation does not seem to have been installed in any of the case studies, and again there are varying schools of thought on whether this is necessary, particularly as some householders will block up or not use ventilation systems to prevent heat loss.

The process and extent of pre-installation inspections in the case study projects is unclear. Different parties conducted the surveys in all cases, and the methodology is not known, however in at least one case an individual felt there was likely to be damp in the external walls prior to insulation as this had been a historic issue.

It should also be noted that the long-term effects of EWI in terms of moisture may be very different from short-term issues. In the short term the issues may mainly relate to residual moisture, particularly at low levels or where there are large and clear leaks, and around openings where reveals are not insulated and there is a risk of mould growth. In the longer term some of those involved in traditional building retrofit research have concerns over a) water ingress due to poor detailing and maintenance and b) risk of fabric damage due to accumulation of trapped moisture. Most of these risks may be avoided by appropriate assessment, application and maintenance, and are less likely to be issues if a permeable system is applied.

4.1.8 Property condition

In certain areas EWI could help protect buildings – as long as it is applied correctly and in the right conditions. The level of pre-installation building inspection that is carried out and the assessment of risk from dampness are important factors in the success of projects, and a detailed assessment would seem particularly important before applying EWI.

The use of EWI to protect traditional buildings can be made more difficult by the fact that some product assessment methods can imply that there is little or no risk of moisture accumulation. However, recent research[85] has highlighted the limitations in such modelling methodologies. Further work is needed to refine these to improve the accuracy of predicted risk, so that decisions about the use of EWI in particular situations may be made with greater confidence.

4.1.9 Knowledge, advice and education

The level of awareness of the potential issues involved in applying EWI to traditional buildings varies considerably. Even where scheme managers are familiar with these issues in most cases they proceed with the more conventional (and often partial) approach, due to the pressures upon them to improve housing conditions 'now'. The levels of knowledge seem to be largely piecemeal and dependent on bits and pieces of information being picked up opportunistically. This issue is further complicated by the lack of monitoring of EWI projects, due no doubt to lack of funding.

Advice exists, but is not yet in the mainstream and in many instances gives contrary advice to more widespread advice sources. Significantly, much of the advice for traditional buildings still relies to a certain extent on precautionary principles rather than on evidence – due in large part to the relatively small and recent evidence base from testing and case studies. Staff involved in EWI projects need to be aware of the range of insulation methods available and associated risks. Given the predominance of EWI over IWI, advice specifically on EWI is of particular importance.

Education therefore remains a key priority – the challenge in this respect relates to the fact much of the current research remains indicative rather than absolute fact. Scheme managers are unlikely to put off projects because there 'may be' risks involved – until research and monitoring can show more definitively what is the correct approach and what should definitely not be done, it seems likely projects will continue largely unchanged.

4.2 CONCLUSIONS

For EWI in traditional buildings, there is a clear – and considerable – gap between recommended best practice and actual application. This gap relates not only to finer details but also to many of the fundamental principles promoted by conservation bodies and others involved in traditional building insulation research. Materials, extent of coverage and detailing around complex areas are increasingly felt to be of considerable importance for the long-term wellbeing of both buildings and occupants – but actual installations are carried out in direct opposition to emerging traditional building principles (principally those relating to permeability and moisture movement).

The reasons for this are varied. Many practitioners are not fully aware of these traditional building principles. If they are aware, they are often not in a position to adhere to them. Pressures of time, cost and funding present considerable limitations: traditional building principles would inevitably lead to longer installation periods and higher costs, which are not possible for most mass-scale installation projects. Even where knowledge of traditional building principles is understood by scheme managers, it is doubtful whether this commonly extends to those installing the insulation. This could to some extent be mitigated by an experienced site supervisor, but they may not be present on all projects. All of this is compounded by the fact that many areas of traditional buildings are hard to treat effectively/thoroughly, which in many cases leads to them simply being left untreated. Even where solutions exist, planning decisions have been shown to promote thermal bridging – albeit unintentionally – by requiring architectural details to be left exposed. On a broader scale, the lack of consistency between the requirements of different local planning authorities risks creating a relatively random mix of installation and/or detailing requirements in different streets or areas, exacerbating any lack of uniformity.

The results of this gap between advice and practice are a mixture of positive and potentially negative impacts. The regeneration of social areas is of great social importance and the EWI projects explored in this report seem to have improved the areas in question considerably, both in the eyes of residents and outsiders – and in some instances seem likely to have prolonged the life of the buildings which may otherwise have been at risk of demolition. However, at a more detailed level concerns exist. Reports of damp in all three case study projects are significant, particularly given the relatively short time since installation, and merit further exploration to identify the cause(s). Detailing that leaves large areas exposed, or works around existing elements rather than removing and reinstating them, might also lead to increased risks of condensation, all of which could cause problems over time. Use of impermeable materials could also contribute to moisture-related problems, although such systems have been used in other instances with seemingly no adverse effects to date.

Advice and education will be critical in changing the way mass-scale EWI projects are undertaken. At present, although many of the perceived risks may be very real, little of the advice tailored to traditional buildings can be said to be fully evidence-based. The inevitable result is that a significant amount is both precautionary and advisory rather than dictating an unambiguous 'correct' approach. These factors make it less likely that scheme managers will adopt the principles of such advice in their projects. This is likely to be exacerbated by the not-uncommon view of conservation bodies as being overly cautious and inevitably against such major changes to traditional buildings.

The recent changes in ECO funding and the associated downturn in SWI projects may 'buy time' for conservation bodies and others involved in researching traditional building retrofits, giving them time to produce the detailed and unambiguous advice that is clearly needed before many more traditional properties are insulated without understanding the possible unintended consequences.

4.3 RECOMMENDATIONS FOR FURTHER RESEARCH

If applied correctly, with meticulous attention to detail, EWI could present a relatively low-risk insulation option to many traditional buildings (although problem areas are likely to remain, particularly around challenging details such as bay windows, for example). However, in the near future it seems unlikely that many mass-scale EWI projects will adhere to all of the emerging best practice principles for traditional buildings. For this to change a number of things must happen, as proposed in the following table. (N.B. These recommendations are not presented in any order of priority, and should be considered alongside those from related current and forthcoming research.)

	RECOMMENDATION
1	Workable and affordable solutions should continue to be sought for the 'problem areas' of traditional dwellings such as bay windows, other openings and architectural details such as dentil brickwork. These may include increasing the use of 'hybrid' systems, using IWI on more decorative principal elevations and EWI on side and rear elevations, for example.
2	Comprehensive monitoring of reported damp problems should be carried out to identify the root cause(s), any related unintended consequences, the steps necessary to remove the problem and how to avoid it in future installations. All findings, good and bad, should be documented and published, in order to promote continued learning and established best practice.
3	Testing would also be beneficial on dwellings where no problems have been reported, in order to assess how traditional buildings perform over time where insulation systems have been installed that may run contrary to best practice principles. Such testing may cover such issues as thermal performance, thermal bridging, hygrothermal behaviour of the insulated wall, evidence of damp, internal temperatures and relative humidity, ventilation rates and so on.
4	The way in which moisture in solid walls is dealt with in modelling tools should be addressed, as highlighted in the STBA's Responsible Retrofit of Traditional Buildings. (This is beyond the remit of this report, but is being targeted through other, related research[86].)
5	The impact of EWI on ventilation requirements merits further investigation, to allow scheme managers to build such requirements into projects where necessary.
6	The extent and quality of standard pre-installation moisture risk assessments should be assessed, in order to identify areas that could be refined to take greater account of the permeability and moisture-related issues facing traditional buildings.
7	Education remains paramount, for all those involved in the procurement and delivery of EWI projects. Advice should be produced specifically for EWI on traditional buildings, as it is the predominant form of SWI, and should incorporate new evidence-based research and detailed, costed case studies as and when they become available. Advice and research should be promoted as widely as possible to those involved in schemes to ensure they understand the potential issues and solutions, with widespread and well-known dissemination routes.
8	This report should not be viewed in isolation, but as part of a larger body of work currently underway involving organisations such as BRE, SPAB, the STBA and others. Common and diverging findings should be drawn out, identifying further areas for research and development of new solutions.

9	A wide-ranging review of national and international literature and research would be beneficial in identifying more evidence-based principles for adoption by future UK advice. It should be noted however that the above-mentioned research may cover this recommendation.
10	Future funding schemes should take account of the emerging best practice principles for EWI in traditional buildings, and build in sufficient funding levels and timescales to allow appropriate materials, methods and detailing to be adopted to minimise any risk to buildings and their occupants.

END NOTES

[1]Energy Efficiency and Historic Buildings: Insulating Solid Walls (English Heritage, 2012)

[2]Solid Wall Insulation in Scotland: Exploring Barriers, Solutions and New Approaches (Changeworks, 2012)

[3]Energy Saving Trust, October 2013

[4]Solid Wall Insulation in Scotland: Exploring Barriers, Solutions and New Approaches (Changeworks, 2012)

[5]Advice Series: Energy Efficiency in Traditional Buildings (Government of Ireland, 2010)

[6]Warmer Bath: A Guide to Improving the Energy Efficiency of Traditional Homes in the City of Bath (Bath Preservation Trust & Centre for Sustainable Energy, 2011)

[7]Solid Wall Insulation in Scotland: Exploring Barriers, Solutions and New Approaches (Changeworks, 2012)

[8]Old House Eco Handbook (Suhr, M. & Hunt, R., 2013)

[9]Responsible Retrofit of Traditional Buildings (STBA, 2012)

[10]*Ibid*

[11]*Ibid*

[12]*Ibid*

[13]Old House Eco Handbook (Suhr, M. & Hunt, R., 2013)

[14]Short Guide 1: Fabric Improvements for Energy Efficiency in Traditional Buildings (Historic Scotland, 2012)

[15]Advice Series: Energy Efficiency in Traditional Buildings (Government of Ireland, 2010)

[16]Warmer Bath: A Guide to Improving the Energy Efficiency of Traditional Homes in the City of Bath (Bath Preservation Trust & Centre for Sustainable Energy, 2011)

[17]Energy Efficiency and Historic Buildings: Insulating Solid Walls (English Heritage, 2012)

[18]Old House Eco Handbook (Suhr, M. & Hunt, R., 2013)

[19]Energy Efficiency and Historic Buildings: Insulating Solid Walls (English Heritage, 2012)

[20]*Ibid*

[21]*Ibid*

[22]Warmer Bath: A Guide to Improving the Energy Efficiency of Traditional Homes in the City of Bath (Bath Preservation Trust & Centre for Sustainable Energy, 2011)

[23]Short Guide 1: Fabric Improvements for Energy Efficiency in Traditional Buildings (Historic Scotland, 2012)

[24]Warmer Bath: A Guide to Improving the Energy Efficiency of Traditional Homes in the City of Bath (Bath Preservation Trust & Centre for Sustainable Energy, 2011)

[25]Energy Efficiency and Historic Buildings: Insulating Solid Walls (English Heritage, 2012)

[26]*Ibid*

[27]Old House Eco Handbook (Suhr, M. & Hunt, R., 2013)

[28]*Ibid*

[29]Advice Series: Energy Efficiency in Traditional Buildings (Government of Ireland, 2010)

[30]Energy Efficiency and Historic Buildings: Insulating Solid Walls (English Heritage, 2012)

[31]Old House Eco Handbook (Suhr, M. & Hunt, R., 2013)

[32]*Ibid*

[33]Solid Wall Insulation in Scotland: Exploring Barriers, Solutions and New Approaches (Changeworks, 2012)

[34]Old House Eco Handbook (Suhr, M. & Hunt, R., 2013)

[35]Domestic Green Deal and Energy Company Obligation in Great Britain, Monthly Report (DECC, 2014)

[36]© Google Maps (https://maps.google.co.uk/)

[37]© Met Office (http://www.metoffice.gov.uk/climate/uk/averages/ukmapavge.html)

[38]http://www.panoramio.com/photo/52946826

[39] http://www.thejournal.co.uk/business/business-news/39m-contract-boldon-company-gowarm-4417803

[40]https://bdaily.co.uk/entrepreneurship/26-06-2012/6m-energy-efficiency-scheme-extended-in-stockton/

[41]https://bdaily.co.uk/environment/27-02-2013/8m-fuel-poverty-scheme-celebrates-landmark/

[42]http://www.stockton.gov.uk/news/localnews/year2013/may/gowarm

[43]http://www.ncl.ac.uk/sustainability/assets/documents/CESPPresentation2012-04-23.pdf

[44]Parkfield II Masterplan (DTZ, 2012)

[45]http://www.stockton.gov.uk/environmentandhousing/housingregenerationschemes/parkfieldmilllane/

[46]Parkfield II Masterplan (DTZ, 2012)

[47]*Ibid*

[48]http://www.stockton.gov.uk/environmentandhousing/housingregenerationschemes/parkfieldmilllane/

[49]http://www.celotex.co.uk/applications/wall-insulation/external-solid-walls

[50]https://maps.google.co.uk

[51]http://www.knaufinsulation.co.uk/en-gb/press-releases/all-press-releases/knauf-insulation%E2%80%99s-thermoshell%C2%AE-ewi-warms-up-stockton-on-tees.aspx#axzz2hbCJAEsU

[52]http://www.ncl.ac.uk/sustainability/assets/documents/CESPPresentation2012-04-23.pdf

[53]© Google Maps (https://maps.google.co.uk)

[54]*Ibid*

[55]*Ibid*

[56]*Ibid*

[57]https://maps.google.co.uk

[58]www.seftonsorted.co.uk

[59]http://en.wikipedia.org/wiki/Housing_Market_Renewal_Initiative

[60]The Road to Renewal: The Early Development of the Housing Market Renewal programme in England (Joseph Rowntree Foundation, 2004)

[61]Living in the Ghost Streets (BBC News, 2012)

[62]http://europa.eu/legislation_summaries/regional_policy/provisions_and_instruments/g24203_en.htm

[63]http://www.crosbyherald.co.uk/news/crosby-news/2012/12/31/sefton-homes-sorted-for-energy-efficiency-68459-32521916/

[64]http://www.warmerenergyservices.com/news-detail.php?id=101

[65]http://www.viridisenergysaving.co.uk/

[66]http://www.housingexcellence.co.uk/green-stories/project-viridis-delivers-first-round-green-deal-pilot-projects

[67]Image © Paolo Canfora, JRC European Commission / Marianne Heaslip, URBED.

[68]*Ibid*

[69]*Ibid*

[70]*Ibid*

[71]Some social housing was included but this was very much in the minority.

[72]However, Blackpool is not in a ‘high-risk’ area in terms of extreme wind-driven rain, according to weather data (see

UK rainfall map at Section 3.0).

[73]Climate Change and Renewable Energy Study: Blackpool Borough Council (AECOM, 2010)

[74]*Ibid*

[75]Blackpool Gazette (http://www.blackpoolgazette.co.uk/news/community/environment/barcelona-look-is-all-white-now-1-5693450)

[76]In particular, an STBA moisture conventions document due for consultation publication by DECC in early 2014

[77]Details, case studies, barriers and final reports are available at http://www.cse.org.uk/projects/view/1203

[78]Regulatory Advice Note: Maintaining the Integrity of Gas Flues during Maintenance / Improvement Works (Scottish Housing Regulator, 2014)

[79]York, October 2013

[80]Historic Scotland

[81]BRE, STBA

[82]Permitted Development for Householders: Technical Guidance – Sections A1(d) and A3(a) (DCLG, 2013)

[83]Planning Portal (October 2013)

[84]National Planning Policy Framework (DCLG, 2012)

[85]SPAB, STBA etc.

[86]SPAB, STBA etc.`

[87]The draft document, Moisture Risk Assessment & Guidance, was published in April 2014