energy saving trust

Determining the costs of insulating non-standard cavity walls and lofts

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Background to the project

In 2016 the Energy Saving Trust undertook research for the Department of Energy and Climate Change to quantify the number of non-standard cavity walls and roofs that exist within Great Britain as well as the associated cost and carbons savings that would be incurred by insulating the remaining potential.

Through discussions with stakeholders in the insulation industry our research uncovered a multitude of issues relating to the insulation of non-standard cavity walls and roofs. As well as identifying uncertainty in estimations of the number of non-standard cavity walls, due to limited data collection on the issue, the research identified divergence of opinion amongst installers about the most appropriate ways to insulate various non-standard cavity walls and roofs. Furthermore, the research indicated that the full cost estimates for insulating various non-standard walls and lofts could vary from installer to installer depending upon their approach.

For instance, estimates for the nature of the work required could vary depending on:

- The installer's choice of materials
- Whether guarantees for the work are included
- Finer details regarding construction and location (e.g. assumed level of access, and/or moisture risk).

Our discussions with stakeholders from local authorities and industry revealed evidence of situations where households had encountered moisture problems in their home after insulation being installed. This can occur when an unsuitable material or method is used for insulation. Moisture problems can arise when insulation lowers air infiltration rates to the point where a home's natural ventilation is inadequate to shift internal moisture. This can lead to higher relative humidity and consequent condensation. Additionally, filling cavities in high exposure areas can lead to moisture issues unless a water resistant material is used.

As highlighted in the independent review chaired by Peter Bonfield : Each Home Counts[1] – it is important for ongoing energy efficiency schemes that protection measures are in place to mitigate against unsuitable installations and that guarantees are in place to rectify instances where issues do arise.

This initial research identified a requirement for further data to be gathered on the costs of insulating non-standard cavity walls and roofs to the required standard, encompassing all associated costs for labour, materials, equipment hire, inspection of suitability, and provision of guarantees for the workmanship. This project has been commissioned to gather this data.

As part of this project, specifications for insulation jobs have been sent to installers from across Great Britain. Installers have then been asked to provide quotes for this work,

[1] http://bit.ly/2pfSExE

separating costs out by labour, materials, equipment etc. To ensure consistency across quotes, the specifications are explicit in determining the location, approach to be taken, the materials to be used and the guarantees to be obtained and include drawings of the dwellings requiring insulation.

The results from these quotes have been used to estimate, at a national level, the total costs required to insulate the remaining non-standard uninsulated cavity walls and roofs in Great Britain. The research also provides additional insights about wider issues related to the installation of insulation.

Executive summary of results

This research shows that when provided with a complete list of tasks to undertake as part of insulating a dwelling to a standard of excellence, the costs quoted by installers are far higher than estimated in the previous report: *Quantification of non-standard cavity walls and lofts in Great Britain* (QNSCWL) (see Table 1 and Table 2). This increase is in part due to the inclusion of additional costs not previously considered, for example costs of providing guarantees, equipment hire costs, inspection costs, costs for "making good", margin / profit made by installers and equipment hire.

Table 1 Estimates of insulation costs across GB (roofs), compared to previous estimates from the QNSCWL study

Wall type	Estimated fillable number (000s)	Costs (£M)	Previous QNSCWL estimate (£M)
All Non-Standard Cavities from previous study	3,500-3,800	Not quantified	£5,530 - £5,860
All Non-Standard Cavities from this study (does not include finish and structural faults)	3,110 – 3,310	£21,200-£22,500	Not quantified
Standard Cavity With At Least One Issue:	2,250-2,430	£9,290 – £10,100	£4,890 - £5,270
Issue: Finish Fault	879 - 992	Not included	£1,450 - £1,630
Issue: Too High	478 - 563	£642 - £756	£435 - £512
Issue: Panelling On Exterior	427 - 507	£2,850 - £3,380	£137 - £162
Issue: Conservatory	379 - 455	£1,450- £1,740	£394 - £474
Issue: Mixed Wall Types	334 - 406	£2,520 - £3,070	£125 - £152
Issue: DPC fault	188 - 243	£1,010 - £1,300	£643 - £831
Issue: Structural Fault	121 - 166	Not quantified	£496 - £680
Issue: Exposed Wall	46 - 76	£245 - £399	£121 - £197
Partially Filled Cavity Wall	572 - 664	£6,000 - £6,970	£235 - £273
Narrow Cavity	168 - 220	£468 - £614	£60.2 - £78.9
Timber Frame Solid With Fillable Studwork	127 - 173	Not quantified	£96.7 - £132
Concrete Construction	118 - 162	£358 - £493	£38.0 - £52.3
Timber Frame Cavity With Fillable Studwork	104 - 146	£921 - £1,290	£63.7 - £89.3
Metal Frame	4 - 15	£31 - £128	£2.45 - £10.1
Stone Cavity	58 - 90	£349 - £544	£39.4 - £61.4

Table 2 Estimates of insulation costs across GB (roofs)

Roof Type	Estimated number (000s)	Cost to treat (M)	Previous QNSCWL estimate (M)
Standard pitched with access issues, uninsulated	1,050 - 1,170	£874 - £977	£338 - £432
Flat roof uninsulated	246 - 309	£2,070 - £2,590	£315 - £510
Room-in-roof conversion uninsulated	598 - 693	£2,790 - £3,230	£793 - £1,101
Mansard roof uninsulated	53 - 84	£296 - £469	£64 - £214
Chalet roof uninsulated	121 - 166	£711 - £975	£184 - £292
Mixed roof types uninsulated	77 - 113	Not quantified	Not quantified

The costs estimated in this research have also partly increased due to the selection of slightly costlier materials and processes for each of the wall and roof issues. For instance, in this research we have assumed that the majority of partially filled cavity walls have failed insulation (i.e. insulation boards not secured to the inner leaf) and will therefore require internal wall insulation (IWI), rather than assuming the partially insulated cavities can be simply filled with additional insulation.

This has important implications for government policy and assessments of the costs and benefits of tackling the dual issues of fuel poverty and climate change mitigation in terms of the measures deployed. Whilst the report *Quantification of non-standard cavity walls and lofts in Great Britain* demonstrated that the number of "harder to treat" cavity walls and lofts was higher than formerly quantified in government statistics, this report shows that the costs for insulating these to a sufficient standard are considerably higher too. These costs may not be much less than the costs of using other types of insulation, such as internal wall insulation (IWI) or external wall insulation (EWI). Whereas previously cavity wall insulation had played a significant role as a relatively cheap and cost effective measure in many energy efficiency programmes. This research suggests that for many of the remaining walls with uninsulated cavities, cavity wall insulation may not be the most cost effective option compared to EWI or IWI.

Furthermore, the research identified that Polyurethane (PUR) foam, specified as an insulation material in at least two cases, can be provided only by a limited number of UK installers. The British Urethane Foam Contractors Association (BUFCA) only lists 15 UK based installers as members[2]. This impacted on the projects ability to recruit installers to provide quotes, and also indicates limitations in the supply chain for non-standard cavity wall insulation.

[2] http://www.bufca.co.uk/members-lists

Contents

Research structure and methodology

The structure of this report reflects the sequence in which the project was executed. The first stage of the report deals with how specifications for each issue were developed and why certain approaches were chosen (see Choices of insulation method), The second section focuses on how installers were recruited and details how data was gathered (see Recruitment of installers). The third deals with how the data collected from installers was checked an analysed (see Analysis methodology and Results: Quotes and costs for each issue. Finally the last section deals with the methodology and results for scaling up costs to a national level (see Analysis methodology and Results: Estimates of costs at a national level)

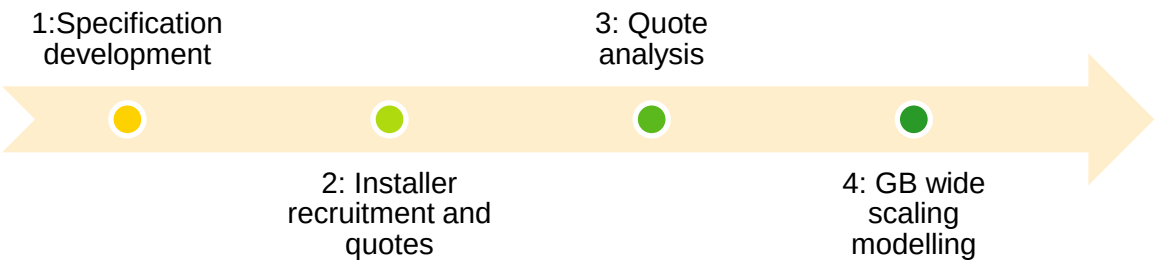

Figure 1 GB wide cost modelling methodology

Choices of insulation method

The project brief from BEIS specified the gathering of quotes to insulate 12 types of non-standard cavity walls and 4 types of non-standard roofs (See Table 3 Non-standard cavity walls and roofs specified). The brief specified that costs should be gathered for archetypal flats and semi-detached houses, where possible. In some cases, there are variations to these – for instance flat roof insulation, which was specified for an extension to a Victorian terrace and for a low rise block of flats, as well as room in roof insulation which was applied to an end terrace.

Table 3 Non-standard cavity walls and roofs specified

Wall or roof type	Flat	House
Narrow masonry cavity	X	X
Concrete construction	X	X
Timber frame construction		X
Wall or roof with uneven stone cavity		X
Partially filled cavity	X	X
Mixed wall construction	X	X
Cavity walls with external tile hanging	X	X
Cavity walls with access issues	X	X
Cavity walls with defects	X	X
Walls in exposed locations	X	X
Walls in flood risk areas	X	X

Walls extending above 3 storeys		X
Flat roofs	X	X
Room-in-roof and mansard roofs		X
Chalet roof		X
Roof with access issues		X

For each type of wall or roof to be insulated (referred to for short here as 'issue') an appropriate specification or method of approach has been devised. This sets out in detail the steps that an installer must go through in order to sufficiently insulate the home to an appropriate standard. The full specifications are appended to the end of this document (see Details of approach and Core specifications). The specifications set out:

- The pre-installation assessments required
- Submissions to buildings control
- The method, equipment and materials to be used when insulating the walls
- Necessary guarantees for the work

The purpose of including these requirements is to ensure that when obtaining quotes from installers it is explicitly clear that the work quoted for is:

- To the best standard in terms of thermal performance,
- Will assess any risks relating to moisture, structural or other problems before insulating the dwelling and,
- guarantees the householder against any unforeseen adverse effects that may arise following the work taking place.

The specifications for this project have been drawn up by Peter Rickaby, of Rickaby Thomson Associates. Peter is a current member of the Each Home Counts Implementation Board, partly facilitated by BEIS, where he is the co-lead for retrofit standards as well as chair of the BSI Retrofit Standards Task Group. The approaches chosen were presented and consulted on with members of the National Insulation Association (NIA) and modified in accordance.

Despite trying to the best of our abilities to find suitable insulation solutions to the issues set out in this task, when quotes were sent to installers, a number raised some issues which had not previously been identified. These are discussed below. Nonetheless data was gathered from installers for each of the issues.

A brief summary of the assumptions used and approach specified is detailed for each of the issues below. (Full details of the approaches specified are given in the appendix section: Details of approach)

Narrow Masonry Cavity:

For this we asked contractors to quote the costs for insulating a home that has a masonry cavity that is only 25mm wide. A standard cavity is considered to be at least 50mm. The narrowness of the void within the walls presents two issues for insulation, which is why these

walls are considered “non-standard”. Firstly, the material filling the void forms a bridge between the inner and outer leafs of brickwork, this means that if the insulant used is not water resistant, moisture could be wicked from the outer leaf to the inner leaf of brickwork leading to damp problems. Greater attention needs to be paid to this issue in narrow cavities as there is less distance for the moisture to bridge than in standard cavities. Secondly, the smaller void width can lead to insulation not distributing evenly throughout the wall when pumped/blown/injected into the walls.

For these reasons, we chose to specify using closed cell PUR foam insulation. This is because it is water resistant, yet vapour permeable, meaning that it should prevent moisture from crossing into the dwelling from the outer leaf, whilst allowing any vapour to escape. Closed cell PUR foam has a slightly better thermal performance than EPS (Expanded Poly-Styrene) beads and other loose fill insulation. Secondly, as the material is injected into the walls as a liquid, that evenly expands to form a rigid foam, there is minimal risk of the insulant clumping in patches and causing cold spots in the wall. Additionally, the insulant is BBA certified.

Concrete constructions:

The construction of concrete dwellings across the country takes on a number of forms as illustrated in the extensive cataloguing of building types in the BRE book: Non-traditional houses: Identifying non-traditional houses in the UK[3]. Some of these constructions have walls made of two leaves with a void between that is fillable. For the purposes of this work we have asked for quotes for two different types of concreate constructions, one for a flat and one for a house:

Concrete Houses

For concrete houses, the specifications describe a house with a Wimpey No-Fines precast inner leaf and a masonry outer leaf with a cavity void of 50mm between the leaves. For these dwellings we have chosen to specify using EPS bead insulation. EPS beads are unlikely to cause risks for homes of this construction as beads are likely to distribute evenly within a two storey dwelling where the cavity void is more than 50mm. This means there is little risk of cold spots. EPS bead insulation is generally cheaper than PUR foam, and like PUR foam is vapour permeable and water resistant. EPS bead solutions have BBA certificates and installations made with EPS bead come with CIGA (Cavity wall Insulation Guarantee Agency) guarantees.

Concrete Flats

For concrete flats we assume that the dwelling to be insulated has precast concrete panels. For these dwellings filling the cavity can lead to a number of issues. Firstly, if the block of flats has a large number of storeys then filling the void with a loose fill material or EPS beads is likely to lead to the material being unevenly distributed throughout the cavity, with the material collapsing under its own weight. Secondly, many concrete flat constructions have

[3] Harrison HW, Mullin S, Reeves B and Stevens A (2004) Non-traditional houses: Identifying non-traditional houses in the UK 1918-75, BREPress.

structural floors at each storey that protrude through the cavity to the exterior. Even after voids are insulated these floors can act as thermal bridges into the dwellings.

For the reasons stated above we concluded the most suitable approach for these dwellings is to apply external (polyurethane) solid board insulation. This is suitable for tall structures (up to 18metres high) and mitigates against thermal bridging from the exterior. This works provided the remaining cavity is unventilated; otherwise a thermal by-pass can arise behind the EWI.

Partially filled cavities

Some dwellings built toward the end of the 20th Century were constructed with cavity walls where the inner leaf has insulation boards attached, but still leaving a remaining gap between the boards and the external leaf. This remaining partially filled cavity can be filled, however a thorough inspection of the interior of the cavity must be undertaken to ensure that the cavity is clear and free from obstructions so that insulation can be evenly distributed within the cavity. It is not uncommon in these constructions for insulation boards to fall away from the internal leaf as a result of not being securely fixed to the wall in the first place – causing an obstruction in this wall. This also causes thermal by-pass because cold air from the cavity can get behind the insulation boards, i.e. to the warm side of the insulation. Under these circumstances the insulation is effectively useless.

In choosing the appropriate approach to this wall type, the project team investigated the suitability of using PUR foam insulation to fill the wall. Some PUR foam manufacturers claim that the product is suitable for this application, claiming that as the foam expands it could help to push loose boards onto the inner leaf. However, we could not find an approach such as this that was endorsed by any appropriate 3rd parties. Therefore, we have specified using IWI. We have chosen this as opposed to EWI, as there is a possibility that if the cavity is vented (i.e. opens into a cold space in the roof or the exterior) this would diminish the effectiveness of EWI due to convection within the cavity.

Mixed wall construction

Mixed wall constructions may be common in older dwellings that have been extended or renovated – with parts of the wall being solid and others cavity construction. For these walls we have specified that the cavity walls can be insulated as standard with EPS bead insulation, and that the solid walls should be insulated using EWI. Where the two types of wall meet it is important to ensure that the EWI is carried across these junctions to minimize thermal bridging and to prevent cold spots. For this reason, we have specified that it is carried across a minimum horizontal distance of 450 mm.

Standard cavity walls with external cladding

Cavity walls with external cladding can be insulated in the same fashion as a standard cavity, with the exception that the cladding must be removed and, ideally, replaced after the work is completed to maintain the wall's appearance. As part of the specifications contractors have been asked to provide additional costs for the removal and replacement of

external tiles, and a weather proof membrane beneath the tiles. In this instance we have specified using mineral fibre, so that we could collect costs for using this material within the project. Mineral fibre is generally a cheaper material than EPS beads and is suitable in this instance.

Standard cavity walls with access issues (boundary)

In this scenario we have specified a flat with cavity walls that cannot be insulated by accessing the cavity externally due to space constraints around the periphery of the building. In this instance we have specified that the standard cavity wall insulation procedure can be followed, except that insulation (EPS bead) should be blown in from the dwellings interior. This assumes that the height of the flat will not lead to any issues with the insulation and asks installers to provide additional costs for 'making good' on the dwelling's internal walls.

Standard cavity walls with access issues (due to conservatory)

A common access issue for houses as opposed to flats is the presence of a conservatory. This causes complications because machinery often needs to be brought inside the conservatory and requires some means of accessing the wall above where the conservatory joins the house. Initially the project team proposed specifications whereby installers build scaffolding around the conservatory in order to access the walls above. On presenting this to the National Insulation Association (NIA), it was raised that in some instances conservatories can be insulated around using specially designed ladders. For this reason, we asked a selection of installers to provide costs with a procedure using ladders and the remainder using scaffolding.

Standard cavity walls with defective DPC (Damp Proof Course)

The project brief asked for costs to be collected on structural defects, finish defects or DPCs. Structural defects can be wide ranging in nature and therefore in costs, similarly with finish defects to walls. It was therefore agreed early on in the project that we should only ask installers to quote for the repair of a dwelling's damp proof course under this issue. It should also be noted that whilst it is necessary for structural, finish and DPC defects to be dealt with prior to insulating cavities, these defects must be repaired in all situations regardless of whether a dwelling is to be insulated or not. This is because not dealing with structural issues may lead on to further issues, including the building becoming structurally unsound and potentially collapse. Untreated finish faults and DPC defects can lead to damp problems in a dwelling.

The approach specified is for the installation of EPS bead insulation after the DPC is repaired. It requires the specifier to assess the DPC, assumes that around 30% of the existing DPC has failed and instructs the installer as to how to repair the DPC, replacing any faulty bricks before the insulation takes place.

Standard cavity walls in exposed locations / flood risk areas / with uneven stone cavities

This specification covers three types of issues – walls in exposed locations, in flood risk areas or with uneven stone cavities.

An exposed location means somewhere that the exposure level is greater than that recommended in Table 1 of the BRE guide *Thermal insulation: avoiding risks* . It also includes walls that are very exposed to driving rain because they are close to the coast, at high elevation, on the edge of an urban or suburban area adjacent to open land, or elevated above the surrounding townscape (irrespective of the exposure zone identified in *Thermal Insulation: avoiding risks*).

For homes in both exposed and flood risk areas it is important to choose an insulation material that is water resistant, but that is also vapour permeable (to allow for drying action to take place). Closed cell PUR foam was chosen as the most dependable solution for this issue. As mentioned above (see section *Narrow Masonry Cavity*:) the solution is guaranteed for these instances. Furthermore, as the insulation forms a solid water-resistant barrier in the cavity, it has the added benefit of helping to reduce the risk of flood water entering into the dwelling through walls.

In uneven stone cavity walls, uneven distribution of insulation can occur if using a loose fill or bead material, which may in-turn lead to cold spots. Therefore, the approach chosen for these walls was to apply PUR foam which has the advantage of expanding into uneven surfaces, therefore providing a continuous layer of insulations between the inner and outer leaves.

To note the original project brief asked to find costs for homes with “smooth stone” cavities. However, during early stage discussions, it was confirmed that smooth stone cavities present no significantly different challenges to standard masonry cavities (assuming there is sufficient space in the mortar between stones to bore through to the cavity). Therefore, it was decided to look at solutions to stone cavity walls with uneven internal cavities.

Standard cavity walls with more than three stories

There are two issues of concern when insulating cavity walls above a certain height. Firstly, if walls are significantly higher than the other structures around them, then they are more likely to be exposed to moisture, such as wind driven rain. Secondly, extra height requires extra insulation, leading to certain materials compressing under their own weight, thus losing their effectiveness as an insulant. For this reason, loose fill insulation on its own would not be suitable.

BBA guarantees are available for EPS bead insulation to be installed above 3 storeys provided that approval is obtained from the insulation manufacturer before the material is installed. To overcome the issue of insulation compressing, these specifications require the installation of “Carbon Cut[4]” cavity trays in between storeys that help to support the weight of the insulation to prevent it from compressing. It should be noted that this method was considered suitable by the project team but does not come with external guarantees. This means that this method would be applied with liability being with the dwelling owner.

[4] Carbon Cut is the trading name of the company that produces this technology

Therefore, if anything untoward happened after insulation was installed (such as damp or structural issues) these would not be covered by a guarantee.

Metal framed / Timber framed cavity walls

In the report *Quantification of non-standard cavity walls and lofts in Great Britain*[5], putting insulation in the voids of buildings with metal and timber frames had been considered viable. However, advice from Rickaby Thompson and other installers were cautious about this approach. It was noted that the contact of certain insulation materials with structural metal frames can cause corrosion of the frames, causing the buildings to become structurally unsound. There was concern that with timber frames it is necessary for the frames to be clear from any substances that may cause moisture to collect or condense around the frame that could lead to timber rotting. However, others believe that these risks may be minimal. Nonetheless for the purposes of choosing the option with the least risks and guaranteed performance, IWI was seen as the best solution in these instances. This was suggested as opposed to external wall insulation, as this might not be as effective on walls with a cavity, especially if the cavity is vented.

Flat roof insulation

The original project brief asked only to provide costs for insulating the roofs of houses with "flat roofs". As these roofs were commonly used during the mid to late 20th century – often on blocks of flats or on extensions to existing buildings we asked installers to provide quotes for insulating building forms which are more likely to have flat roofs. For this issue installers were asked to provide quotes for insulating the entire roof of a low rise flat and the lean-to extension of a period terrace.

There are two ways of insulating flat roofs known as either cold deck or warm deck. Cold deck flat roof insulation involves placing insulation beneath the roof deck. This can cause problems as a result of the deck being cooler after insulation, which then may lead to interstitial condensation. This issue can only be mitigated with a sufficient ventilation gap (generally 50mm) between the top of the insulation and the underside of the roof surface. Although cold deck insulation may be a cheaper option, the approach specified here was warm deck insulation where insulation is applied above the roof surface. This is considered a safer option as it protects the building fabric from the weather. It also mitigates against interstitial condensation, and can be carried out during the replacement of the roof covering – a process that needs to take place frequently with flat roofs.

Room in roof / Mansard / Chalet roof insulation (from above and below)

Dwellings without a standard loft space, such as room in roofs, mansard roofs and chalet roofs can all be insulated using one of two methods – insulation either above or below rafter level. *Core Specification F: Pitched Roof Insulation (from below)* and *Core Specification G: Pitched Roof Insulation (from above)* both set out safe procedures for insulating these roofs.

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[5] Shreeve, G. Payne, J., (2016) Quantification of non-standard cavity walls and lofts in Great Britain, Energy Saving Trust Ltd. [available from http://bit.ly/2DC36Sx]

The approach to take will depend largely on the occupier or owner of the dwelling's preference in terms of cost and disruption caused by the work.

Loft without access

The specification for this issue involves insulating a loft, as per a standard loft, with mineral wool as per *Core Specification D: Loft Insulation in Roofs with Access Issues,* which requires installers to quote for the cost of creating an access hatch to the roof space. Mineral wool has been specified as this is an affordable, incombustible material and is used as standard for this application.

Recruitment of installers

Over 40 candidate organisations were initially invited to offer quotes. These were recruited from lists of accredited installers registered as members of the British Board of Agrément's (BBA's) Approved Installer Scheme and the Cavity Insulation Guarantee Agency's (CIGA's) list of Registered Installers. These were chosen as they are well established organisations that assure insulation installation.

However, several of the jobs specified for quotes required the installation of closed-cell polyurethane (PUR) foam. We found that unlike expanded polystyrene (EPS) bead and mineral wool insulation only a comparatively small number of installers could do jobs involving PUR foam. To recruit installers who could do these types of jobs, we contacted installers who were registered with the British Urethane Foam Contractors Association (BUFCA).

In total 43 installers were contacted via this method, initially by email and followed up with several attempts to speak to installers over the phone. Many of the installers contacted did not respond to calls to participate. Some installers responded to our request but did not provide quotes, owing to the amount of work required in providing fully costed quotes for 23 issues. For some installers the timescales were inconvenient as there were other priorities occupying their time, such as responding to the Energy Company Obligation 2 transition (ECO2t) consultation.

To increase the sample size of installers, all 125 installers from the Energy Saving Trust's Installer network were emailed to take part in the work (13 of whom were part of the initial 43). This is a network of installers who are qualified to install energy efficiency measures under the ECO scheme. The grand total number of installers contacted was 157 (for a complete list of contacts see Appendix section: Installers contacted:).

From our initial 43 contacts, 10 told us outright that they could not participate, 21 said that they would participate. But, despite frequent engagement attempts many of these did not provide responses. In total only 9 installers out of 157 responded with quotes. Installers were told there would be no work resulting from this quote therefore, the response rate is not comparable with what householders could expect when requesting quotes for real work.

Form of quotes

For each issue, installers were asked to provide a total quote per job with a detailed breakdown of the costs. The breakdown separated material, labour and other costs (e.g. hire of specific equipment, VAT, overheads and profit and submission of building control notices) and specified detail pertaining to which parts of the costs were fixed and which were variable according to either time required or the area of wall or roof to be treated.

For all issues, where relevant, installers were asked to quote separately for insulating a semi-detached house or a mid-floor flat (see Table 3). Installers were also asked to indicate discounts that could be applied (as a percentage of the total costs) when installations took place at scale – for 10, 50 and 100 homes separately. Furthermore, installers were asked to

provide a % increase in cost for insulating in a rural area. A location for each installation (both rural and urban) was provided in the specification guide for each installer. Table 4 provides an example template for part of a quote.

Table 4 Example quote template

Semi-Detached House: Closed Cell PU insulation

	Variable costs					Fixed costs	Total cost
	Time required (hrs)	Rate (£ / hr)	Area covered (m^2)	Cost per unit area (£ / m2)	Total Variable cost		
Material costs							
Closed cell polyurethane (PU) foam			*81.8*		£0.00		£0.00
Labour costs							
Pre-install assessment					£0.00		£0.00
Installation					£0.00		£0.00
Post-installation checks and making good					£0.00		£0.00
Other costs							
Equipment costs					£0.00		£0.00
Scaffolding costs					£0.00		£0.00
Submission of Building Control Notices Supply of certificate of compliance					£0.00		£0.00
Provision of guarantee					£0.00		£0.00
Other costs (describe below)							£0.00
Overheads and profit							
VAT							
						Total Cost	£0.00

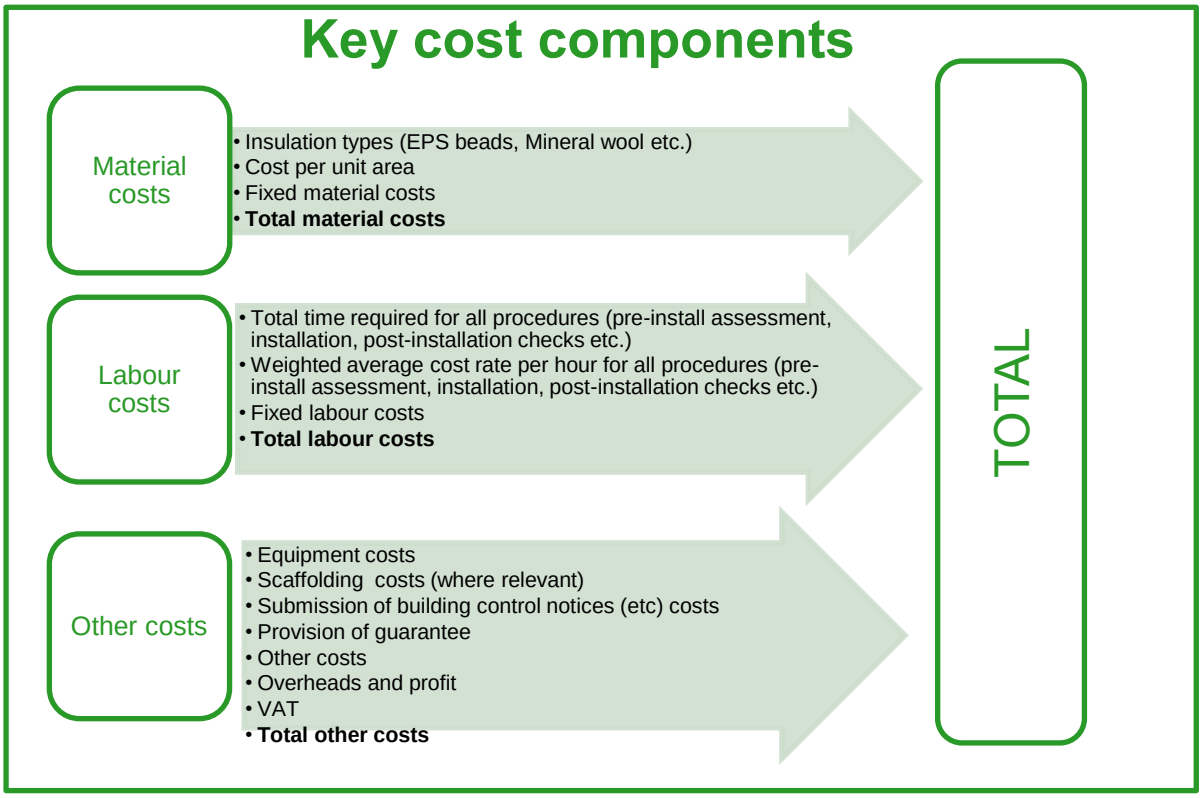
Analysis methodology

Individual quote analysis

All data from the quotes provided by installers has been compiled into a large table for analysis (data table available separately). Summary data for the costs from these tables are provided at the end of this document (See: Summary tables).

The purpose of these tables is to compare costs across the range of quotes provided by installers. These tables each give an indication of the average, minimum and maximum figures for each detail on each quote, as well as the sample size (N) detailing the number of quotes received. These summaries give material, labour and other costs split by dwelling type (e.g. for flat or house) and for all dwelling types.

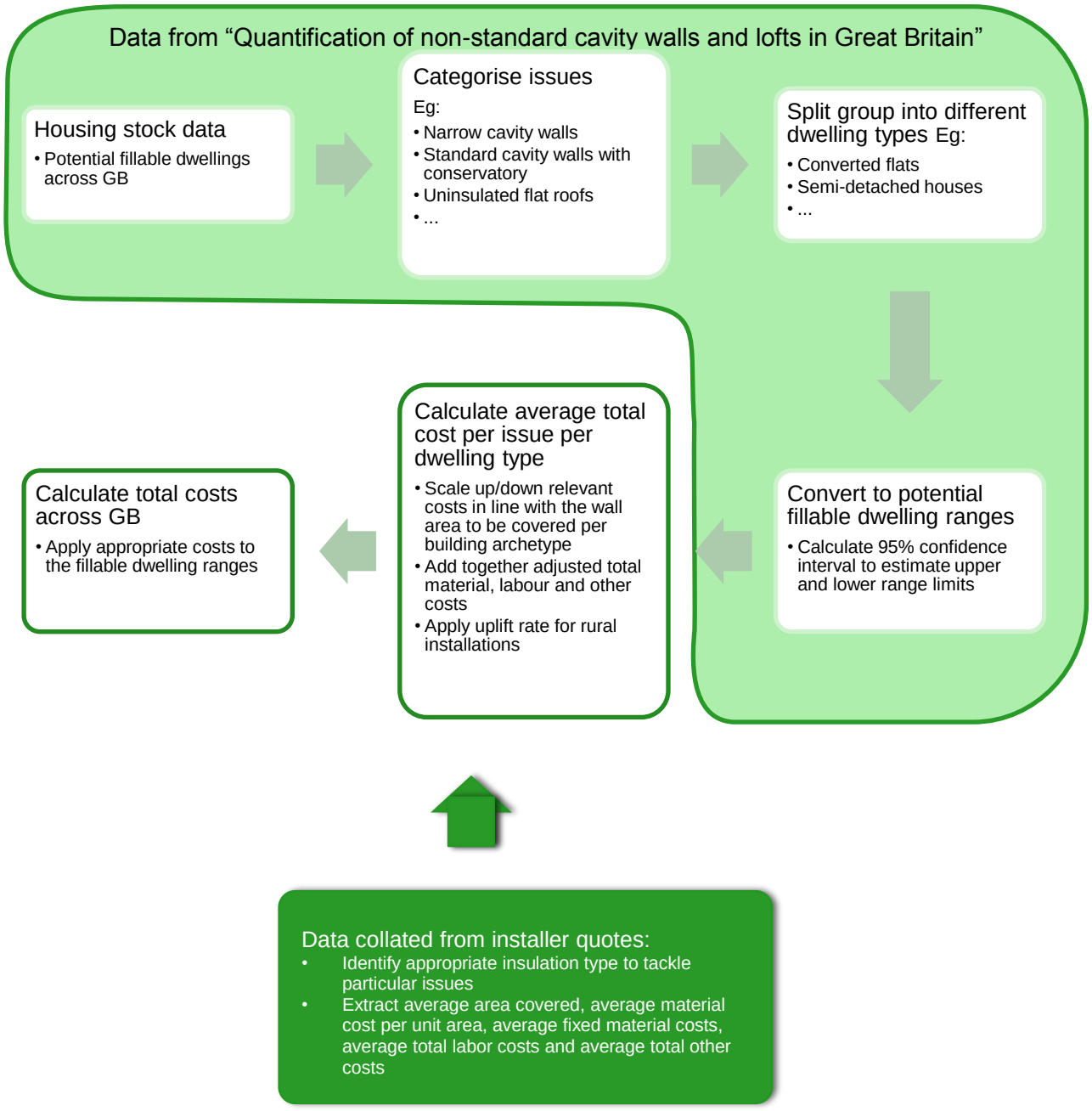
When analysing the data that installers provided, we found differences in approaches to how quotes were provided. In some cases installers avoided giving cost breakdowns of variable costs, opting instead to merely quote a fixed price for a certain aspects of a job. A characteristic example was insulating the loft hatch. Some installers provided a variable cost per square meter of hatch insulated while others gave a fixed cost for this job. This is possibly because certain installers will not always price jobs on a basis proportional to the time required or space covered. This meant that some details within the quotes are not directly comparable between quotes. Nonetheless the overall data provides a good basis on which to estimate the total costs of installing insulation across different types of home. All of the cost components are kept in the summary table as this a very useful approach to identify the most influential cost component and also to assess the cost ranges in the market.



Scaling up to a national level

The next phase of the analysis was to determine the total costs for insulating the remaining fillable non-standard cavities and roofs. This estimate is based upon combining data from the quotes received from installers with data from the previous report previous report: *Quantification of non-standard cavity walls and lofts in Great Britain* (QNSCWL) [6]. The overall process of calculating the costs at a national level is shown in Figure 2

Figure 2 Process for scaling costs to a national level



[6] Shreeve, G. Payne, J., (2016) Quantification of non-standard cavity walls and lofts in Great Britain, Energy Saving Trust Ltd. [available from http://bit.ly/2DC36Sx]

These total numbers of walls and roofs in the report are given in Table 5 and Table 6 below.

Table 5 Number of fillable non-standard cavity walls

Wall type	Fillable (000s)
Non Standard Cavity	**3,500-3,800**
Standard Cavity With At Least One Issue:	2,250-2,430
Issue: Finish Fault	879 - 992
Issue: Too High	478 - 563
Issue: Panelling On Exterior	427 - 507
Issue: Conservatory	379 - 455
Issue: Mixed Wall Types	334 - 406
Issue: DPC fault	188 - 243
Issue: Structural Fault	121 - 166
Issue: Exposed Wall	46 - 76
Partially Filled Cavity Wall	572 - 664
Narrow Cavity	168 - 220
Timber Frame Solid With Fillable Studwork	127 - 173
Concrete Construction	118 - 162
Timber Frame Cavity With Fillable Studwork	104 - 146
Metal Frame	4 - 15
Stone Cavity	58 - 90

Table 6 Number of insufficiently insulated non-standard roofs

Type of roof	Estimated number (000s)
Standard lofts with access issues, uninsulated	**1,046 - 1,168**
Flat roof uninsulated	**247 - 308**
Room-in-roof uninsulated	**599 - 692**
Mansard roof uninsulated	**53 - 84**
Chalet roof uninsulated	**121 - 166**
Mixed roof types uninsulated	**76 - 113**

QNSCWL gave a dwelling type breakdown (converted flat, detached house, end terrace, mid terrace, purpose built flat and semi-detached house) of the total number of suitable homes in Great Britain. To estimate costs at a national level, the average cost for each job has been scaled from the quotes installers provided for houses and flats to reflect these six dwelling types. These were scaled based on the wall and roof dimensions of these archetypal properties.

All costs (material, labour and other) are scaled up or down in proportion to the area to be covered per dwelling type. When a particular type of insulation is applicable to both flats and semi-detached houses and installers have provided us with two quotes for both dwelling type,

the average values of the area covered of those two dwelling types based on the given quotes are calculated and a linear regression is applied to estimate the costs for any other wall area. Whenever a linear regression is not applicable because there is only one value available, for example installers provided just one quote for EWI which can be used for both flats and houses, it is assumed that the costs are proportional of the wall area.

For wall insulation the average wall area of the six building archetypes is used to estimate the material, labour and other costs. The average cost per unit area is used to calculate the variable material costs and on top of this any additional fixed costs which are added to calculate the total material costs. Results were sense checked in order to make sure that fixed and variable costs were not double-counted. This total cost calculated is applied to urban installations and an uplift is applied for installations in rural areas.

Accordingly, the potential number of fillable dwelling roofs was grouped into five main categories: dwellings with standard pitched roofs with access issues, uninsulated mansard roofs, uninsulated room-in-roof conversions, uninsulated chalet roofs and uninsulated flat roofs. The average total cost to tackle the specific issue is calculated per dwelling type and is applied respectively. Each of the above mentioned categories and subcategories, i.e. narrow cavity walls, partial filled calls, mixed walls, uninsulated mansard roofs, etc., requires the implementation of a different measure. Not only that, any relevant costs per issue also need to be adjusted to the corresponding dwelling type as the quotes received are based on either a semi-detached house or a flat.

The dimensions of the archetype dwellings are provided in Table 7. These dimensions are based on archetype analysis carried out in *Quantification of nonstandard cavity walls and lofts in Great Britain.* This original analysis comes from data from the English Housing Condition Survey (2007 – 2013); the Living In Wales Survey (2008) and the Scottish Housing Condition Survey (2007 – 2009).

Table 7 Archetype dwelling dimensions: wall and roof area

Dwelling	Wall Area Covered (m^2)	Flat roof area (m^2)[8]	Loft area (m^2)	Room in roof (m^2)	Chalet roof (m^2)	Mansard roof area (m^2)
Large detached	172	5	73	101	105	141
End terrace	77	3	39	47	48	66
Mid terrace	43	3	39	47	48	54
Semi detached	82	4	49	56	57	76
Flat converted	29	23	61	70	74	81
Flat purpose built	29	108	61	70	74	81

[8] To note many dwellings with flat roofs have these only on parts of the dwelling (e.g. extensions) hence why in this instance we see large detached houses having considerably smaller “flat roof” area than for purpose built flats.

Having calculated the average cost to tackle a specific issue in both urban and rural areas, the total cost to insulate all potential dwellings across GB is estimated by multiplying these average total costs by the respective range for the number of potential fillable dwellings.

Some of the specifications we received quotes for are suitable to be applied to more than one of the issues quantified at a national level. For instance, IWI is suitable for both timber-frame and metal-frame cavity walls. The table below provides a summary of the specification used for each issue:

Table 8 Assumed specifications applied to issues at GB level

Issue	Specification
Too high: Having more than three storeys	Houses: EPS bead insulation with cavity wall trays Flats: EWI
Walls with panelling, tiles or weatherboarding (this again impedes access to the cavity)	Tile Removal And Mineral Wool Insulation
Walls with conservatories (this causes access issues)	Houses: EPS Beads Flats: EPS Bead Insulation Through Internal Wall
Dwelling with mixed wall types	Hybrid Cavity And EWI
Walls with faulty damp proof courses (insulation may cause damp problems)	EPS Beads and DPC repair
Walls in high exposure zones (these require careful treatment)	PUR Insulation
Partially Filled Cavity Wall	Inspection of partial fill cavity followed by IWI
Narrow Cavity	Closed cell polyurethane (PU) insulation
Concrete Construction	Houses: EPS Insulation Flats: EWI
Timber Frame Cavity With Fillable Studwork	IWI
Metal Frame	IWI
Stone Cavity	PUR Insulation
Standard lofts with access issues, uninsulated	Create loft hatch and install mineral wool insulation
Flat roof uninsulated	Flat roof insulation
Room-in-roof uninsulated	Pitched Roof Insulation From Above or Below
Mansard roof uninsulated	Pitched Roof Insulation From Above or Below
Chalet roof uninsulated	Pitched Roof Insulation From Above or Below

Results: Quotes and costs for each issue

The section below presents summary tables for the cost quotes for individual dwellings as well as estimates at a national level. Table 9 provides the range of quotes for each of the jobs including the average total cost and the number of quotes received.

Table 9 Summary of costs for individual dwelling types

Dwelling type	Flat				Semi-Detached House			
	N	Min	Avg	Max	N	Min	Avg	Max
Narrow Masonry Cavity	6	£812	**£1,613**	£2,944	8	£1,012	**£2,783**	£4,990
Concrete Dwelling	8	£2,906	**£4,178**	£6,443	8	£540	**£1,465**	£3,356
Partially Filled Cavity	7	£2,018	**£4,453**	£9,970	7	£6,191	**£8,434**	£12,028
Mixed Wall Construction	7	£2,985	**£5,441**	£10,615	7	£5,056	**£7,429**	£10,740
Walls with External Cladding	6	£1,350	**£4,901**	£7,049	7	£1,266	**£7,009**	£10,249
Walls with boundary access issues	7	£411	**£1,810**	£6,180	N/A			
Homes with conservatory	N/A				7	£912	**£2,380**	£7,291
Standard cavity wall with defect	6	£1,445	**£3,406**	£6,960	6	£1,392	**£3,097**	£4,446
Walls in exposed locations etc.	7	£812	**£3,217**	£7,400	8	£1,094	**£4,799**	£16,307
Wall above three stories	N/A				6	£1,538	**£3,709**	£8,001
Metal / Timber Framed Cavity walls					7	£3,058	**£7,976**	£13,931
RIR / Pitched roof (from above)					5	£3,538	**£4,942**	£6,599
RIR / Pitched roof (from below)					5	£1,885	**£3,111**	£4720
Loft with access issue					8	£452	**£757**	£1,354
	Low rise block of flats				Mid terrace extension			
Flat roof	5	£4,880	**£24,319**	£49,085	5	£1,435	**£2,468**	£3,538

As can be seen, the costs for treating each issue according to the specifications provided range considerably between installers. For most jobs, the minimum quote can be significantly less than the maximum quote.

To some degree this variation will be related to the location of the installer, although quotes received do not consistently suggest this to be the main reason.

Table 10, Table 11 and Table 12 show the average cost of quotes given for installations by region. As highlighted, the average cost installations taking place in the South of England are higher than in the rest of Great Britain for 12 out of 20 quotes. The average of quotes from Scotland were cheapest 13 out of 20 times. Quotes for the North of England tended to be nearest the mean value. Quotes from the North of England had the least expensive average quotes only 3 times and were never the most expensive. This suggests that other factors beyond geography will also affect the quotes given by a qualified installer.

Table 10 Average cost of non-standard insulation installation by region: Flats

	Average costs Flats									
	North England		South England		Scotland		Wales		Total	
	N	£	N	£	N	£	N	£	N	£
Narrow Masonry Cavity	2	£1,623	2	£2,204	2	£1,014	0	£0	6	£1,613
Concrete Dwelling	2	£3,522	2	£5,002	2	£3,431	2	£4,756	8	£4,178
Partially Filled Cavity	2	£2,985	2	£4,701	1	£2,793	2	£6,503	7	£4,453
Mixed Wall Construction	2	£4,624	2	£4,244	2	£4,867	1	£10,615	7	£5,441
Walls with External Cladding	2	£5,151	2	£5,352	1	£1,350	1	£7,049	6	£4,901
Walls with boundary access issues	2	£1,217	2	£4,024	2	£887	1	£411	7	£1,810
Homes with conservatory	N/A									
Standard cavity wall with defect	2	£3,259	2	£2,732	1	£1,491	1	£6,960	6	£3,406
Walls in exposed locations etc.	2	£1,629	2	£4,785	2	£1,144	1	£7,400	7	£3,217
Wall above three stories	N/A									
Metal / Timber Framed Cavity walls										
Flat Roof										
Room in roof / Mansard / Chalet roof										
Loft with access issue										

Table 11 Average cost b non-standard insulation installation by region: Semi-detached homes

	Average costs Semi-detached homes									
	North England		South England		Scotland		Wales		Total	
	N	£	N	£	N	£	N	£	N	£
Narrow Masonry Cavity	2	£1,644	2	£4,065	2	£2,867	2	£2,557	8	£2,783
Concrete Dwelling	2	£832	2	£2,267	2	£813	2	£1,948	8	£1,465
Partially Filled Cavity	2	£8,363	2	£9,110	1	£7,057	2	£8,518	7	£8,434
Mixed Wall Construction	2	£7,093	2	£7,898	2	£6,896	1	£8,232	7	£7,429
Walls with External Cladding	2	£8,672	2	£9,920	1	£2,729	2	£4,575	7	£7,009
Walls with boundary access issues	N/A									
Homes with conservatory	2	£1,103	2	£5,425	2	£1,347	1	£912	7	£2,380
Standard cavity wall with defect	2	£3,050	2	£3,422	1	£4,245	1	£1,392	6	£3,097
Walls in exposed locations etc.	2	£1,685	2	£10,649	2	£3,520	2	£3,344	8	£4,799
Wall above three stories	2	£2,558	2	£6,124	1	£2,963	1	£1,925	6	£3,709
Metal / Timber Framed Cavity walls	1	£9,177	2	£10,167	1	£6,991	3	£6,444	7	£7,976
Flat Roof	N/A									
Room in roof / Mansard / Chalet roof	3	£3,402	2	£2,911	2	£4,663	3	£4,972	10	£4,027
Loft with access issue	2	£560	2	£1,195	2	£629	2	£646	8	£757

Table 12 Average cost by region: flat roof insulation

	Average costs flat roof insulation									
	North England		South England		Scotland		Wales		Total	
	N	£	N	£	N	£	N	£	N	£
Low rise block of flats	1	£28,371	2	£30,694	1	£26,955	1	£4,880	5	£24,319
Period terrace extension	1	£1,805	2	£3,225	1	£2,648	1	£1,435	5	£2,468

Costs included and commentary on suitability of approach

Installers were asked to provide details about what other costs, additional to labour and materials, they had included in their quote. They were also asked to comment on the suitability of each approach. These responses are summarised below.

In general, each installer gave the same comments for each issue. In general, some installers noted that in their quotes had not made allowances for:

- Remedial works
- Marketing costs
- ECO assessment
- Asbestos surveys
- Structural repairs
- Moving utility meters
- Extension of roof eaves (generally only applicable for EWI)

For insulation of several dwellings, such as blocks of flats, one installer noted they had included costs for site compounds and worker welfare, whereas another did not. Other costs generally included by installers included:

- Removal and re-affixing of external fittings (such as TV aerials and satellite dishes)
- Potential work to extend waste pipes and boiler flues
- Re location of lighting
- Waste removal costs
- Travel to and from the location.
- Scaffolding
- Structural engineer report
- Architect fee.
- Height waver from the system designer (this is a certificate say that the insulation is suitable to be used in a situation above a certain height)

The section below looks at what additional costs were included on an issue by issue basis.

Narrow masonry cavity

The costs for insulating a flat with a narrow masonry cavity ranged from just £812 to as much as £2,944. For a semi-detached house, this ranged from just £1,012 to £4,990. This is based on using closed cell PUR foam insulation.

An installer with a midrange quote for the cost (£1,464) stated that flats require no scaffolding (that towers could be used instead). One installer assumed that a cherry picker could be used (subject to a ground assessment)

One installer commented that they were not sure of the extent to which PUR foam is suitable in a cavity as narrow as 25mm, as the limited thickness of insulation would provide a limited thermal improvement. They also didn't believe a BBA certificate could be given for use of the material on a narrow cavity, and said that internal or EWI would be preferable as it would provide a greater saving. Another installer commented explicitly to say that this approach was suitable.

Concrete constructions

The costs for insulating a concrete construction flat with EWI ranged from between £2,906 to £6,443.

No installers made any comments to indicate that they thought that EWI would be unsuitable for concrete construction flats. One installer included the costs of site compounds and welfare whereas another did not.

To insulate a semi-detached concrete construction flat with EPS bead insulation the quoted costs ranged from £540 to £3,356. Installers mentioned the same included and excluded additional costs as noted for flats. One installer included the costs of site compounds and welfare whereas another did not.

The installer with the most expensive quote (£3,356) for a semi-detached house said their costs were based upon using open cell PUR foam instead of EPS beads. They said that although EPS bead material may be suitable the PU foam is better as it partially penetrates into the no-fines structure of the concrete leaf (reducing heat loss). One installer raised doubts about whether EPS beads were a suitable solution in concrete dwellings, saying they would require further information. Another installer was adamant that EPS bead insulation should not be used for any concrete property regardless of construction.

Partially filled cavities

The costs for insulating a flat with a partially filled cavity with IWI ranged from between £2,018 to £9,970. For semi-detached homes the costs ranged from £6,191 to £12,028.

IWI can be particularly difficult to provide generic costs for as it can involve a lot of internal disruption for the home, and it is questionable how much of the disruption, and redecorating etc. to include in cost estimates.

One installer gave a good indication of the scope of what was included in their costs as follows:

> *An allowance has been made for removing and re-fixing existing fittings/fixtures only, [but] no allowance has been made for replacements. Making good consists of minor redecoration to disturbed walls only. No*

allowance has been made for removing resident's furniture, adjusting bath or showers, or removing/adjusting any mains services.

No installers questioned the suitability of the use of IWI for this issue. One installer included the costs of site compounds and welfare whereas another did not

Mixed wall construction

The costs for hybrid cavity wall and EWI ranged from £2985 to £10,615 for flats and £5056 to £10,740 for semi-detached houses. No installers questioned the suitability of this method for mixed wall construction insulation.

Standard cavity walls with external cladding

The costs for insulating these walls ranged from £1,350 to £7,049 for flats and £1,266 to £10,249 to for semi-detached houses. In the approach, one installer stated that they assumed the following:

We have assumed that existing tiles on vertical walls are removed, set aside and refitted with 5-10% being replaced with new tiles.

No installer stated that the process was not suitable.

Standard cavity walls with access issues (boundary)

The costs for insulating a flat of this type with EPS beads through the internal walls ranged from to £411 to £6,180. However, judging by the commentary for the most expensive quote (£6,180) it was not clear whether the installer had provided a quote for the correct process, as they provided a cost for using scaffolding and talked about doing works on the exterior of the dwelling. The next highest quote for this process was considerably less (£1,868)

Standard cavity walls with access issues (due to conservatory)

The costs for insulating a semi-detached house of this type with EPS beads ranged from just £912 to £7,291. The most expensive quote, largely consisted of costs related to labour time (totalling 89 hours at £31 an hour). The average labour time quoted for this job was 22 hours. As noted, some of these quotes made use of scaffolding, whereas others used conservatory ladders.

None of the installers mentioned any issues with the suitability of this measure for this type of dwelling.

Standard cavity walls with defective DPC (Damp Proof Course)

The costs for insulating this type of dwelling with EPS beads and DPC repair ranged from to £1,445 to £6,960 for flats and from £1,392 to £4,446 for semi-detached homes. The highest quote for flats (£6,960) was largely made up of a cost of £6,000 for scaffolding.

No issues were mentioned by any installers who responded about the suitability of this method for treating dwellings of this type. However, an installer who was unable to provide quotes mentioned that they had some concerns about whether a DPC that had failed along 30% of the walls perimeter could be treated in this manner without causing structural issues for a block of flats.

Standard cavity walls in exposed locations / flood risk areas / with uneven stone cavities

Costs for closed cell PUR foam insulation on these dwellings ranged from £812 to £7,400 for flats and from £1,094 to £16,307 for semi-detached homes. The interquartile range for the cost of flats was £1,473 to £4,785 and £2,288 to £4,543 for semi-detached homes. The most expensive quote for a semi-detached home appears to be an outlier in terms of total cost, although no specific item on the cost breakdown appears to be problematic.

No installer raised any concerns about using PU foam for this issue, however one installer said that they did not provide a quote for flats because:

> *No rates have been provided for the flatted dwelling as the PU foam materials must be injected to the full height of the cavity wall to prevent the possibility of water ingress via penetration from above.*

As part of this analysis we assume that the quotes provided assume for flats give quotes for one flat insulated as part of an entire block being insulated,

Standard cavity walls with more than three stories

The costs for undertaking this work on a dwelling were quoted as ranging from £1,538 to £8,001. No issues were mentioned by any installers who responded about the suitability of this method for treating dwellings of this type.

Metal framed / Timber framed cavity walls

The costs for insulating these types of semi-detached homes with IWI, ranged from £6,402 to £13,931. None of the installers mentioned any concerns or issues related to using this approach. However, the least expensive quote for this type of dwelling provided was £3,058 but using a different form of insulation (injected open cell PU foam):

> *The process and method specified is slow and requires the property to be unoccupied. Injection using a breathable open cell PU foam enables a faster turn round time without the need to decant occupants. The foam also encapsulates steel framing reducing the likelihood of continuing corrosion. Our figures are therefore based on injecting a breathable open cell PU foam.*

Flat roof insulation

The costs for flat roof insulation on low rise blocks ranged from £4,880 to £49,085. The most expensive quote gave considerable details about why costs are so high. These costs included:

> *Preparation of existing deck, underlay, cap sheet, perimeter detailing, lead coverings, rainwater outlets, details to protrusions through roof, grp trims, rainwater goods. Extra over cost for tapered insulation board approximately £25 per m2. No allowance for Asbestos or structural engineers survey or remedial works. No allowance for Preliminary items such as site compound or welfare - dependant on scheme size or location.*

It was noted that the length of time for the guarantee for flat roofs can significantly affect the cost of the job. No length of time was given in the specifications given to installers. One installer said:

> *Unable to give guarantee cost due to the high not knowing the length required. The difference between a 10 year and a 25 year is vast. Also hugely dependant on what system is used,*

The most expensive quote assumed a 20-year insurance backed guarantee.

Room in roof / Mansard / Chalet roof insulation (from above and below)

The costs quoted for providing pitched roof insulation in a semi-detached house, from above, ranged from £3,538 to £6,599 and ranged from £1,885 to £4,720. The only comments made about the costs for this work was made by the lowest quote for roof insulation from below:

> *We have assumed the installation of [insulated plasterboard] laminate board to sloping ceilings only (front and rear elevation) no other works, to install the board, tape and joint, coat of emulsion and 2 final coats with trims to go around roof-lights.*

Loft without access

The costs quoted for providing pitched roof insulation in a semi-detached house, from above, ranged from £452 to £1,354. No additional comments were made about the suitability of specification for this issue.

Discounts and uplifts

Installers were asked to provide details of any discounts that could be applied for jobs where a group of dwellings could be insulated at once. Specifically, they were asked to quote a % discount for insulating either 10, 50 and 100 dwellings in one go. The average discount given for each measure is given in Table 13. We also asked installers to offer a comment as to why they might offer a discount for doing several jobs together. Six of the installers provided reasons for discounts – these were usually similar for each job.

Generally, discounts could be offered where jobs are at the same location – as this can reduce the costs from travelling to new locations and “set up times”. Where assessments need to be carried out before insulating dwellings (particularly for internal and EWI) these costs can be reduced when a series of similar dwellings in the same location can be assessed at the same time. Discounts could also be made specifically for the fact that a series of jobs have been identified. For installers, a large proportion of their operating costs is related to find suitable work, therefore having pre-identified properties to insulate saves these costs and means a discount can be applied.

Some of the reasons for given a discount are as follows:

> *Economies of scale, reduced travel and organisational costs*
> *Reduced travelling costs and set up times per property.*

Looking for work has costs, this allows those costs to be reallocated to the job in hand

Access costs reductions/bulk reports/survey available

Bulk material cost savings

Reduced transport costs

Similarly, we asked installers to provide us with the total uplift in costs for undertaking jobs in rural areas. We did not ask installers to detail why there would be an increase in costs – assuming that this is generally to do with working in rural areas therefore incurring longer travel times. Result are presented in Table 13.

Table 13 Average quoted discount for insulating at scale and uplift for insulating homes in rural areas

Measure	Average % discounting for insulating:			Average uplift for Rural areas
	10 homes	50 homes	100 homes	
Narrow Masonry Cavity – Closed Cell PUR foam insulation	2.72%	5.33%	6.89%	4.17%
Concrete construction house: EPS Insulation	3.00%	5.67%	7.33%	5.22%
Concrete construction flat: External wall insulation	2.22%	5.11%	7.33%	4.83%
Partially Filled Cavity: Inspection of partial fill cavity followed by internal wall insulation	2.17%	4.39%	6.17%	3.94%
Mixed Wall Construction Hybrid Cavity and External Wall Insulation	2.50%	4.83%	6.11%	4.28%
Walls with External Cladding Tile Removal and Mineral Wool Insulation	2.17%	4.28%	5.72%	3.61%
Walls with boundary access issues EPS Bead Insulation Through Internal Wall	2.39%	4.78%	5.94%	3.22%
Walls with access issues due to conservatory EPS Beads	2.61%	5.11%	6.50%	3.22%
Standard cavity wall with defect: EPS beads and DPC repair	1.83%	3.67%	5.06%	2.78%
Standard Cavity Walls in exposed locations / Walls in flood risk areas / Walls with uneven stone cavity: PUR Foam Insulation	2.72%	5.11%	6.50%	4.56%
Standard cavity wall with more than three stories: EPS bead insulation with cavity wall trays	2.06%	4.00%	5.39%	2.78%
Metal framed / timber framed cavity walls: internal wall insulation	2.22%	4.33%	5.83%	4.44%
Room in roof / Mansard / Chalet roof Pitched Roof Insulation from Above	1.56%	3.00%	3.89%	3.11%
Room in roof / Mansard / Chalet roof Pitched Roof Insulation from Below	1.61%	3.11%	4.06%	2.00%
Loft with access issue: Create loft hatch and install mineral wool insulation	3.17%	5.56%	7.72%	5.22%
Flat Roof Insulation board and vapour control membrane	1.78%	3.44%	4.56%	3.22%

Results: Estimates of costs at a national level

Table 14 and Table 15 give a summary of the estimated costs for insulating the remaining potential of non-standard cavity walls and roofs. The table also includes a comparison of these updated comprehensive costs against those used in the previous non-standard cavity wall and roofs report.

Table 14 Estimates of insulation costs across GB (walls)

Wall type	Estimated fillable (000s)	Costs (£M)	Previous report cost estimate (£M):
All Non-Standard Cavities from previous study	3,500-3,800	Not quantified	£5,530 - £5,860
All Non-Standard Cavities from this study (does not include finish and structural faults)	3,110 - 3310	**£21,200 - £22,500**	Not quantified
Standard Cavity With At Least One Issue:	2,250-2,430	£9,290 – £10,100	£4,890 - £5,270
Issue: Finish Fault	879 - 992	Not quantified	£1,450 - £1,630
Issue: Too High	478 - 563	£642 - £756	£435 - £512
Issue: Panelling On Exterior	427 - 507	£2,850 - £3,380	£137 - £162
Issue: Conservatory	379 - 455	£1,450- £1,740	£394 - £474
Issue: Mixed Wall Types	334 - 406	£2,520 - £3,070	£125 - £152
Issue: DPC fault	188 - 243	£1,010 - £1,300	£643 - £831
Issue: Structural Fault	121 - 166	Not quantified	£496 - £680
Issue: Exposed Wall	46 - 76	£245 - £399	£121 - £197
Partially Filled Cavity Wall	572 - 664	£6,000 - £6,970	£235 - £273
Narrow Cavity	168 - 220	£468 - £614	£60.2 - £78.9
Timber Frame Solid With Fillable Studwork	127 - 173	Not quantified	£96.7 - £132
Concrete Construction	118 - 162	£358 - £493	£38.0 - £52.3
Timber Frame Cavity With Fillable Studwork	104 - 146	£921 - £1,290	£63.7 - £89.3
Metal Frame	4 - 15	£31 - £128	£2.45 - £10.1
Stone Cavity	58 - 90	£349 - £544	£39.4 - £61.4

Table 15 Estimates of insulation costs across GB (roofs)

Roof type	Estimated number - range (000s)	Cost to treat (£M)	Previous report cost estimate (£M):
Standard pitched with access issues, uninsulated	1,050 - 1,170	£874 - £977	£338 - £432
Flat roof uninsulated	246 - 309	£2,070 - £2,590	£315 - £510
Room-in-roof conversion uninsulated	598 - 693	£2,790 - £3,230	£793 - £1,100
Mansard roof uninsulated	52.8 - 83.8	£296 - £469	£63.5 - £214
Chalet roof uninsulated	121 - 166	£711 - £975	£184 - £292
Mixed roof types uninsulated	76.5 - 113	Not quantified	Not quantified

Conclusions and recommendations

The report *Quantification of non-standard cavity walls and lofts in Great Britain* provided estimates of the number of non-standard cavities and roofs remaining in Great Britain requiring insulation (results presented above in Table 14 and Table 15). The report identified some uncertainty as to the precise number owing to limitations regarding the extent to which national level data is collected relating to the specificities of wall and roof construction types. The report also attempted to estimate the costs associated with treating non-standard cavity walls and roofs by applying identified generic material and labour costs to undertake certain types of insulation job and scaling these according to the size of dwelling to be treated.

This research has gathered more detailed data about the actual costs arising from insulating non-standard cavity walls and roofs. We asked installers to quote for jobs based on actual specificationsproviding them dwelling drawings and descriptions of the nature of the issue to be tackled. Furthermore, these specifications have been drawn up with guidance from buildings professionals to ensure that the process guarantees sufficient thermal performance. The specifications have been designed to mitigate damage risk to the dwelling arising from problems with moisture.

The results of this research have shown that when provided with a complete list of tasks to undertake as part of insulating a dwelling to a standard of excellence, the costs quoted by installers are far higher than previously estimated (see Table 16). The increase is in part due to the inclusion of additional costs not previously considered, for example costs of providing guarantees, equipment hire-costs, inspection costs, costs for “making good”, margin / profit made by installers and equipment hire.

The costs in this research have also partly increased due to the selection of slightly costlier materials and processes for each of the wall and roof issues. For instance, in this research we have assumed that the majority of partially filled cavity walls have failed insulation (i.e. insulation boards not secured to the inner leaf) and will therefore require IWI rather than assuming the partially insulated cavities can be simply filled with additional insulation.

This has important implications for government policy and assessments of the costs and benefits of tackling the dual issues of fuel poverty and climate change mitigation. Whilst the report *Quantification of non-standard cavity walls and lofts in Great Britain* demonstrated that the number of “harder to treat” cavity walls and lofts was higher than formerly quantified in government statistics, this report demonstrates that the costs for insulating these to a sufficient standard are considerably higher too. As the costs for “filling” these dwellings cavities may not be significantly less than the costs of using other types of insulation, such as internal or EWI, the research also lends itself towards the question of the extent to which cavity wall insulation will continue to be used on dwellings with cavities, as opposed to external or IWI in future energy efficiency programmes.

Table 16 Comparison of average quotes by property type in this research against the report: *Quantification of Non-standard cavity walls and lofts in Great Britain*

Dwelling type	Flat		Semi	
	Average quote	QNSCWL	Average quote	QNSCWL
Narrow Masonry Cavity	£1,613	£145	£2,783	£409
Concrete Dwelling	£4,178	£244	£1,465	£691
Partially Filled Cavity	£4,453	£116	£8,434	£327
Mixed Wall Construction	£5,441	£145	£7,429	£409
Walls with External Cladding	£4,901	£145	£7,009	£409
Walls with boundary access issues	£1,810	-	-	-
Homes with conservatory	-	-	£2,380	£809
Standard cavity wall with defect	£3,406	£3145	£3,097	£3409
Walls in exposed locations etc.	£3,217	£795	£4,799	£2250
Wall above three stories	-	£885	£3,709	£2506
Metal / Timber Framed Cavity walls	-	£225	£7,976	£638
RIR / Pitched roof (from above)	-	-	£4,942	-
RIR / Pitched roof (from below)	-	-	£3111	£1250
Loft with access issue	-	-	£757	£340
	Block of flats		Mid terrace	
Flat roof	£24,319	£1640 (per flat)	£2,468	£1320

Appendix

Installers contacted:

A&M Energy Solutions Ltd	DMS Installations Ltd
Acrobat Carbon Services T/A Energy Alliance	Dyson Energy Services Limited
Actavo	Ececo Ltd
AE Energy Solutions	Eco Energy Solutions (NW) Ltd
Agility Eco Services Ltd	ECO Green World Ltd
Alba Insulation	Eco Insulate Ltd
Alternate Energy UK Ltd	Ecogee Ltd
Anesco Limited	Ecosave Installations Ltd
Apex Green Ltd	Eco-Tek Scotland
Apple Energy Carbon Services Ltd	Effective Energy Solutions Ltd
Aran Services Limited	Elite Ecotec Ltd
Arktek Group Ltd	Energy North East Insulation Limited
ARP Energy Services / Avalon solutions Ltd	Energy Saviour Ltd
BCA Insulation Ltd	EnergyCare
Berks Insulation Ltd	Energywise Scotland
Billsave UK Limited	ENVO Energy Solutions Ltd
Boilerhut Ltd	Eversmart Limited
Breyer Renew	Everwarm Limited
British Gas (previously ECL Contracts)	FS Energy Solutions Ltd
Broad Oak Properties Ltd	FSG Property Services
Build-Therm Services Ltd	Fusion Energy Limited
C12 Ltd	Gas Tech (Wales) Ltd
Cambridge Sales and Marketing Ltd	GHE Solar Ltd
Cenergist Limited	Gilpin Energy Limited
Certas Energy	Go Brit Green
City Energy South Wales Limited	Golden Globe Merchants Limited
City Technical Services (UK) Ltd	Gorilla Energies Ltd
Climate Insulation Limited	Green Deal Advice Bureau Ltd
Consumer Energy Solutions	Green Deal Centre
Contract services group	Green Deal Consortia
Cosyhome	Green Deal Eco Boilers & Insulation Ltd
DHL (Energy) Services Ltd	Green Deal Shop.com
Direct Savings (Scotland)	Green Eco Company NW Limited
Distinction Energy Ltd	Green Home Systems Limited
DK Hughes Plumbing & Heating	

Green Hut Energy	NCS Property Maintenance
Green Key Installations	NEST
Green Leads UK Ltd	Network Energy Limited
Green Team UK Ltd	New Elite Ltd
H&M UK Enterprises Ltd	North West Energy Solutions Ltd
Happy Energy Solutions Ltd	Northern Gas Heating Limited
Heatwave Energy Solutions Ltd	One Stop Facilities Ltd (prev One Stop Energy Ltd)
Imminent Group Limited	Origin (UK) Energy Services
Impact Energy Limited	Osborne Energy Ltd
Improveasy Ltd	Pacifica Home Services Ltd
Industria Systems UK Ltd	Pink Innovations
Infinity Energy Organisation Ltd	Prestige Energy
Instagroup Limited	Professional Plumbing & Heating t/a Borthwick Heating
Insul8 Energy Ltd	QERB Energy Ltd
ITS	R & S Insulation Ltd
J&J Crump & Son Ltd	Renew Partnership Ltd
J4 Consultancy	Renewable Solutions Team
JNR contracting LTD	Retrofit UK Limited
Joyner Group	Richard Irvin Energy Solutions
Karnheath Ltd	Ridge Retail t/a Warm & Secure
Keepmoat Regeneration Limited	Saliis Ltd
Kershaw Contracting Services Ltd	SERS Energy Solutions (Scotland) Ltd
Kier group energy solutions	Short Bros Homes Ltd
Knowle Engineering Limited	Simply Eco Ltd
Lakehouse energy services	SM4U Ltd
Lawtech Group	Smart Energy Insulation Northwest Ltd
Leicestershire Gas and Insulation	Sun Spirit Ltd
Live Manage Facilitate Limited	Sustain Energy (UK) Ltd
Logical Insulation Solutions	Sustain Ltd
M13 Services T/A Go Sustainable	Team 42 Ltd
Mears group	Thermabead Ltd
Merinal Limited	Think Energy Ltd
Miller Pattison Ltd	Thrift Energy Limited
MPC Energy Ltd	Tighean Innse Gall
National Energy Services	TK Murray Limited

Travis Perkins / Sustainable Building Solutions
Union Technical
Upgrade and Save Ltd
Valley Heating Services Limited
Vantage Global Management Limited
Viridian Energy Solutions
Viva Gas Ltd
Wallcoatings Ltd
Warm Care Insulation
Warm Zones CIC
Warmer Energy Services Limited
Warmhomes Insulation
Websters Insulation Ltd
Westville Ltd
Willmott Dixon Energy Services
Work Ltd
YES Energy Solutions (prev Yorkshire Energy Solutions CIC)

Summary tables

1: Narrow Masonry Cavity – Closed Cell PUR foam insulation

	Dwelling	N	Min	Max	Average
Material costs:					
Closed cell polyurethane (PU) foam					
Cost per unit area (£/m2)	Flat	6	£4.25	£27.50	£17.65
	Semi-Detached House	8	£4.25	£27.50	£15.32
	All quotes	14	£4.25	£27.50	£16.32
Fixed costs	Flat	1	£42.79	£42.79	£42.79
	Semi-Detached House	1	£175.87	£175.87	£175.87
	All quotes	2	£42.79	£175.87	£109.33
Total material costs	Flat	6	£84.58	£547.25	£358.86
	Semi-Detached House	8	£347.65	£2,249.50	£1,335.76
	All quotes	14	£84.58	£2,249.50	£917.09
Labour costs:					
Pre-install assessment, Installation and Post-installation checks and making good					
Time required (hrs)	Flat	6	3.75	12.00	6.74
	Semi-Detached House	8	4.00	24.50	11.56
	All quotes	14	3.75	24.50	9.50
Cost rate (£ / hr)	Flat	6	£17.33	£54.98	£33.64
	Semi-Detached House	8	£16.63	£62.22	£36.32
	All quotes	14	£16.63	£62.22	£35.17
Fixed costs	Flat	1	£12.00	£12.00	£12.00
	Semi-Detached House	1	£12.00	£12.00	£12.00
	All quotes	2	£12.00	£12.00	£12.00
Total labour costs	Flat	6	£104.00	£350.00	£206.80
	Semi-Detached House	8	£80.00	£1,524.50	£439.95
	All quotes	14	£80.00	£1,524.50	£340.03

Other costs:					
Equipment costs	Flat	3	£12.00	£250.00	£92.33
	Semi-Detached House	4	£11.00	£250.00	£79.95
	All quotes	7	£11.00	£250.00	£85.26
Scaffolding costs total (where relevant)	Flat	5	£100.00	£1,000.00	£548.66
	Semi-Detached House	3	£200.00	£1,000.00	£550.00
	All quotes	8	£100.00	£1,000.00	£549.16
Submission to building control etc.	Flat	5	£6.75	£120.00	£47.55
	Semi-Detached House	5	£6.75	£120.00	£47.44
	All quotes	10	£6.75	£120.00	£47.49
Provision of guarantee	Flat	6	£23.50	£80.00	£53.33
	Semi-Detached House	7	£23.50	£80.00	£50.55
	All quotes	13	£23.50	£80.00	£51.84
Other costs	Flat	2	£72.50	£125.00	£98.75
	Semi-Detached House	3	£50.00	£848.00	£323.50
	All quotes	5	£50.00	£848.00	£233.60
Overheads and profit	Flat	6	£181.86	£528.62	£299.40
	Semi-Detached House	7	£249.78	£672.73	£459.01
	All quotes	13	£181.86	£672.73	£385.34
VAT	Flat	4	£69.42	£490.60	£178.73
	Semi-Detached House	5	£48.17	£831.60	£263.10
	All quotes	9	£48.17	£831.60	£225.60
Total other costs	Flat	6	£346.48	£2,093.60	£1,047.81
	Semi-Detached House	7	£398.50	£2,589.60	£1,151.42
	All quotes	13	£346.48	£2,589.60	£1,103.60
Total cost:					
Grand Total	Flat	6	£811.67	£2,943.60	£1,613.47
	Semi-Detached House	8	£1,011.60	£4,989.60	£2,783.20
	All quotes	**14**	**£811.67**	**£4,989.60**	**£2,281.89**
Discount & uplift (all dwellings)					
% discount for insulating 10 homes		18	0.00%	10.00%	2.72%
% discount for insulating 50 homes		18	0.00%	20.00%	5.33%
% discount for insulating 100 homes		18	0.00%	25.00%	6.89%
% increase in total costs for insulating rural homes		18	0.00%	11.00%	4.17%

2 a: Concrete construction house: EPS Insulation

	N	Min	Max	Average
Material costs:				
EPS Beads and bonding agent				
Cost per unit area (£/m2)	7	£2.07	£8.00	£4.37
Fixed costs	1	£30.00	£30.00	£30.00
Total material costs	7	£169.33	£656.00	£362.33
Labour costs:				
Pre-install assessment, Installation and Post-installation checks and making good				
Time required (hrs)	8	4.25	21.50	12.22
Cost rate (£ / hr)	8	£16.63	£61.98	£34.26
Fixed costs	0	£0.00	£0.00	£0.00
Total labour costs	8	£168.00	£1,332.50	£422.68
Other costs:				
Equipment costs	3	£11.00	£50.00	£24.33
Scaffolding costs total (where relevant)	2	£450.00	£1,000.00	£725.00
Submission of building control notices (etc.)	6	£6.75	£120.00	£46.20
Provision of guarantee	8	£16.00	£80.00	£35.30
Other costs	2	£195.00	£648.00	£421.50
Overheads and profit	8	£50.00	£1,115.17	£282.39
VAT	5	£11.11	£469.92	£123.36
Total other costs	8	£110.00	£1,853.93	£725.19
Total cost:				
Grand Total	**8**	**£540.00**	**£3,355.76**	**£1,464.91**
Discount & uplift (all dwellings)				
% discount for insulating 10 homes	9	0.00%	10.00%	3.00%
% discount for insulating 50 homes	9	0.00%	20.00%	5.67%
% discount for insulating 100 homes	9	0.00%	25.00%	7.33%
% increase in total costs for insulating rural homes	9	0.00%	11.00%	5.22%

2 b Concrete construction flat: External wall insulation

		N	Min	Max	Average
Material costs:					
Insulation boards / adhesive/ render					
Cost per unit area (£/m2)		8	£24.00	£50.00	£32.19
Fixed costs		1	£60.00	£60.00	£60.00
Total material costs		8	£477.60	£2,562.50	£906.75
Labour costs:					
Pre-install assessment and design specifications, Installation and Post-installation checks and making good					
Time required (hrs)		7	2.00	107.00	43.00
Cost rate (£ / hr)		7	£19.76	£35.45	£26.77
Fixed costs		3	£617.50	£1,600.00	£1,039.17
Total labour costs		8	£221.00	£2,160.00	£1,268.88
Other costs:					
Equipment costs		2	£50.00	£100.00	£75.00
Scaffolding costs total (where relevant)		8	£200.00	£1,500.00	£629.01
Submission of building control notices (etc.)		8	£10.44	£250.00	£97.55
Provision of guarantee		8	£25.88	£225.00	£117.48
Other costs		3	£125.00	£1,795.00	£1,006.67
Overheads and profit		7	£200.00	£1,223.26	£704.07
VAT		4	£33.81	£797.50	£291.69
Total other costs		8	£475.00	£3,035.00	£2,002.20
Total cost:					
Grand total		**8**	**£2,905.60**	**£6,442.50**	**£4,177.83**
Discount & uplift (all dwellings)					
% discount for insulating 10 homes		9	0.00%	10.00%	2.22%
% discount for insulating 50 homes		9	0.00%	20.00%	5.11%
% discount for insulating 100 homes		9	0.00%	25.00%	7.33%
% increase in total costs for insulating rural homes		9	0.00%	10.00%	4.83%

3: Partially Filled Cavity: Inspection of partial fill cavity followed by internal wall insulation

	Dwelling	N	Min	Max	Average
Material costs:					
Insulation boards / adhesive/ render					
Cost per unit area (£/m2)	Flat	7	£18.00	£54.00	£36.71
	Semi-Detached House	6	£18.00	£54.00	£34.50
	All quotes	13	£18.00	£54.00	£35.69
Fixed costs	Flat	1	£60.00	£60.00	£60.00
	Semi-Detached House	1	£120.00	£120.00	£120.00
	All quotes	2	£60.00	£120.00	£90.00
Total material costs	Flat	7	£358.20	£1,074.60	£740.04
	Semi-Detached House	6	£1,472.40	£4,417.20	£2,844.10
	All quotes	13	£358.20	£4,417.20	£1,711.15
Labour costs:					
Pre-install assessment (of cavity), Pre-install assessment and design for internal wall insulation, Preparatory work (i.e. removal of fixtures and fittings, wallpaper and flooring), Installation and Post-installation checks and making good					
Time required (hrs)	Flat	6	11.00	130.50	65.92
	Semi-Detached House	6	21.00	234.50	113.08
	All quotes	12	11.00	234.50	89.50
Cost rate (£ / hr)	Flat	6	£19.86	£41.03	£27.56
	Semi-Detached House	6	£19.70	£40.19	£26.18
	All quotes	12	£19.70	£41.03	£26.87
Fixed costs	Flat	4	£300.00	£7,900.00	£2,328.60
	Semi-Detached House	4	£300.00	£9,325.00	£3,162.95
	All quotes	8	£300.00	£9,325.00	£2,745.78
Total labour costs	Flat	7	£894.40	£7,900.00	£2,668.56
	Semi-Detached House	7	£2,000.00	£9,325.00	£4,103.26
	All quotes	14	£894.40	£9,325.00	£3,385.91

Other costs:					
Equipment costs	Flat	1	£100.00	£100.00	£100.00
	Semi-Detached House	2	£75.00	£100.00	£87.50
	All quotes	3	£75.00	£100.00	£91.67
Scaffolding costs total (where relevant)	Flat	2	£250.00	£800.00	£525.00
	Semi-Detached House	1	£800.00	£800.00	£800.00
	All quotes	3	£250.00	£800.00	£616.67
Submission to building control etc.	Flat	6	£50.00	£200.00	£115.91
	Semi-Detached House	6	£50.00	£185.00	£90.91
	All quotes	12	£50.00	£200.00	£103.41
Provision of guarantee	Flat	7	£80.00	£225.00	£122.27
	Semi-Detached House	7	£80.00	£225.00	£122.27
	All quotes	14	£80.00	£225.00	£122.27
Other costs	Flat	1	£125.00	£125.00	£125.00
	Semi-Detached House	1	£500.00	£500.00	£500.00
	All quotes	2	£125.00	£500.00	£312.50
Overheads and profit	Flat	6	£300.00	£1,168.09	£564.44
	Semi-Detached House	6	£469.00	£3,208.86	£1,374.11
	All quotes	12	£300.00	£3,208.86	£969.28
VAT	Flat	4	£96.08	£677.60	£274.39
	Semi-Detached House	4	£292.54	£1,031.80	£532.09
	All quotes	8	£96.08	£1,031.80	£403.24
Total other costs	Flat	7	£625.00	£1,651.28	£1,044.36
	Semi-Detached House	7	£775.00	£4,452.08	£1,892.77
	All quotes	14	£625.00	£4,452.08	£1,468.56
Total cost:					
Grand total	Flat	7	£2,017.72	£9,970.00	£4,452.96
	Semi-Detached House	7	£6,190.80	£12,028.34	£8,433.82
	All quotes	**14**	**£2,017.72**	**£12,028.34**	**£6,443.39**
Discount & uplift (all dwellings)					
% discount for insulating 10 homes		18	0.00%	10.00%	2.17%
% discount for insulating 50 homes		18	0.00%	20.00%	4.39%
% discount for insulating 100 homes		18	0.00%	25.00%	6.17%
% increase in total costs for insulating rural homes		18	0.00%	10.00%	3.94%

4: Mixed Wall Construction Hybrid Cavity and External Wall Insulation

	Dwelling	N	Min	Max	Average
Material costs:					
EPS Beads and bonding agent					
Cost per unit area (£/m2)	Flat	0	£0.00	£0.00	£0.00
	Semi-Detached House	7	£3.00	£8.00	£4.79
	All quotes	7	£3.00	£8.00	£4.79
Fixed costs	Flat	0	£0.00	£0.00	£0.00
	Semi-Detached House	0	£0.00	£0.00	£0.00
	All quotes	0	£0.00	£0.00	£0.00
Total material costs (EPS)	Flat	0	£0.00	£0.00	£0.00
	Semi-Detached House	7	£134.97	£656.00	£369.87
	All quotes	7	£134.97	£656.00	£369.87
Insulation boards / adhesive/ render					
Cost per unit area (£/m2)	Flat	7	£24.00	£45.00	£30.68
	Semi-Detached House	7	£24.00	£45.00	£30.68
	All quotes	14	£24.00	£45.00	£30.68
Fixed costs	Flat	1	£60.00	£60.00	£60.00
	Semi-Detached House	1	£120.00	£120.00	£120.00
	All quotes	2	£60.00	£120.00	£90.00
Total material costs	Flat	7	£314.52	£3,243.37	£1,133.13
	Semi-Detached House	7	£467.50	£3,690.00	£2,270.40
	All quotes	14	£314.52	£3,690.00	£1,701.76
Labour costs:					
Pre-install assessment and design specifications, Installation and Post-installation checks and making good					
Time required (hrs)	Flat	7	3.00	97.00	34.71
	Semi-Detached House	7	3.00	140.00	49.57
	All quotes	14	3.00	140.00	42.14
Cost rate (£ / hr)	Flat	7	£19.56	£63.33	£32.51
	Semi-Detached House	7	£19.56	£63.33	£32.53
	All quotes	14	£19.56	£63.33	£32.52
Fixed costs	Flat	3	£50.00	£1,500.00	£816.67
	Semi-Detached House	3	£50.00	£2,460.00	£1,336.67
	All quotes	6	£50.00	£2,460.00	£1,076.67
Total labour costs	Flat	7	£406.00	£2,425.00	£1,235.21
	Semi-Detached House	7	£687.00	£3,500.00	£1,878.39
	All quotes	14	£406.00	£3,500.00	£1,556.80

Other costs:					
Equipment costs	Flat	2	£50.00	£100.00	£75.00
	Semi-Detached House	3	£11.00	£100.00	£58.67
	All quotes	5	£11.00	£100.00	£65.20
Scaffolding costs total (where relevant)	Flat	7	£250.00	£6,500.00	£1,540.97
	Semi-Detached House	7	£650.00	£1,250.00	£924.29
	All quotes	14	£250.00	£6,500.00	£1,232.63
Submission to building control etc.	Flat	7	£50.00	£250.00	£105.31
	Semi-Detached House	7	£50.00	£250.00	£112.46
	All quotes	14	£50.00	£250.00	£108.88
Provision of guarantee	Flat	7	£100.00	£225.00	£160.20
	Semi-Detached House	7	£80.00	£225.00	£139.48
	All quotes	14	£80.00	£225.00	£149.84
Other costs	Flat	0	£0.00	£0.00	£0.00
	Semi-Detached House	3	£350.00	£1,100.00	£633.33
	All quotes	3	£350.00	£1,100.00	£633.33
Overheads and profit	Flat	7	£352.83	£1,704.20	£812.99
	Semi-Detached House	6	£549.51	£2,371.05	£1,121.40
	All quotes	13	£352.83	£2,371.05	£955.34
VAT	Flat	4	£142.16	£865.70	£463.76
	Semi-Detached House	4	£335.23	£1,789.92	£833.97
	All quotes	8	£142.16	£1,789.92	£648.86
Total other costs	Flat	7	£1,027.83	£7,590.00	£2,905.91
	Semi-Detached House	7	£1,760.00	£4,618.44	£2,910.55
	All quotes	14	£1,027.83	£7,590.00	£2,908.23
Total cost:					
Total	Flat	7	£2,985.49	£10,615.00	£5,440.73
	Semi-Detached House	7	£5,055.51	£10,739.52	£7,429.22
	All quotes	**14**	**£2,985.49**	**£10,739.52**	**£6,434.97**
Discount & uplift (all dwellings)					
% discount for insulating 10 homes		18	0.00%	10.00%	2.50%
% discount for insulating 50 homes		18	0.00%	20.00%	4.83%
% discount for insulating 100 homes		18	0.00%	25.00%	6.11%
% increase in total costs for insulating rural homes		18	0.00%	10.00%	4.28%

5: Walls with External Cladding Tile Removal and Mineral Wool Insulation

	Dwelling	N	Min	Max	Average
Material costs:					
Mineral wool					
Cost per unit area (£/m2)	Flat	5	£5.00	£30.00	£16.10
	Semi-Detached House	7	£5.00	£40.00	£18.05
	All quotes	12	£5.00	£40.00	£17.24
Fixed costs	Flat	1	£60.00	£60.00	£60.00
	Semi-Detached House	1	£120.00	£120.00	£120.00
	All quotes	2	£60.00	£120.00	£90.00
Total material costs	Flat	5	£100.00	£1,500.00	£513.09
	Semi-Detached House	7	£410.00	£3,400.00	£1,512.06
	All quotes	12	£100.00	£3,400.00	£1,095.82
Labour costs:					
Pre-install assessment, Removal of tile hanging cladding, Installation and Post-installation checks and restoration of tiles					
Time required (hrs)	Flat	6	2.00	86.50	35.25
	Semi-Detached House	6	2.00	248.00	80.42
	All quotes	12	2.00	248.00	57.83
Cost rate (£ / hr)	Flat	6	£19.63	£50.00	£30.34
	Semi-Detached House	6	£19.63	£50.00	£30.05
	All quotes	12	£19.63	£50.00	£30.19
Fixed costs	Flat	2	£550.00	£1,905.50	£1,227.75
	Semi-Detached House	3	£550.00	£3,400.00	£2,216.83
	All quotes	5	£550.00	£3,400.00	£1,821.20
Total labour costs	Flat	6	£360.00	£2,248.00	£1,259.33
	Semi-Detached House	7	£550.00	£5,626.00	£2,610.29
	All quotes	13	£360.00	£5,626.00	£1,986.77

Other costs:					
Equipment costs	Flat	2	£25.00	£100.00	£62.50
	Semi-Detached House	2	£50.00	£100.00	£75.00
	All quotes	4	£25.00	£100.00	£68.75
Scaffolding costs total (where relevant)	Flat	5	£300.00	£6,000.00	£1,862.36
	Semi-Detached House	6	£600.00	£1,800.00	£1,013.33
	All quotes	11	£300.00	£6,000.00	£1,399.26
Submission to building control etc.	Flat	6	£50.00	£280.00	£117.57
	Semi-Detached House	7	£50.00	£280.00	£135.78
	All quotes	13	£50.00	£280.00	£127.38
Provision of guarantee	Flat	6	£7.50	£100.88	£53.06
	Semi-Detached House	7	£7.50	£100.88	£59.05
	All quotes	13	£7.50	£100.88	£56.29
Other costs	Flat	2	£95.00	£1,795.00	£945.00
	Semi-Detached House	2	£95.00	£3,450.00	£1,772.50
	All quotes	4	£95.00	£3,450.00	£1,358.75
Overheads and profit	Flat	6	£250.00	£1,842.20	£776.45
	Semi-Detached House	6	£100.00	£2,708.41	£1,165.20
	All quotes	12	£100.00	£2,708.41	£970.82
VAT	Flat	4	£168.17	£1,071.23	£568.65
	Semi-Detached House	4	£403.91	£2,122.14	£1,140.23
	All quotes	8	£168.17	£2,122.14	£854.44
Total other costs	Flat	6	£650.00	£6,570.00	£3,213.98
	Semi-Detached House	7	£225.00	£9,012.46	£3,241.57
	All quotes	13	£225.00	£9,012.46	£3,228.84
Total cost:					
Grand total	Flat	6	£1,350.00	£7,049.40	£4,900.89
	Semi-Detached House	7	£1,265.80	£10,248.86	£7,009.06
	All quotes	**13**	**£1,265.80**	**£10,248.86**	**£6,036.06**
Discount & uplift (all dwellings)					
% discount for insulating 10 homes		18	0.00%	10.00%	2.17%
% discount for insulating 50 homes		18	0.00%	20.00%	4.28%
% discount for insulating 100 homes		18	0.00%	25.00%	5.72%
% increase in total costs for insulating rural homes		18	0.00%	10.00%	3.61%

6: Walls with boundary access issues EPS Bead Insulation Through Internal Wall

		N	Min	Max	Average
Material costs:					
EPS bead and bonding agent					
Cost per unit area (£/m2)		7	£3.00	£8.00	£4.65
Fixed costs		1	£30.00	£30.00	£30.00
Total material costs		7	£64.68	£330.00	£165.59
Labour costs:					
Pre-install assessment, Removal and protection of occupants belongings etc., Installation and Post-installation checks and making good					
Time required (hrs)		7	2.50	74.50	21.07
Cost rate (£ / hr)		7	£17.45	£50.00	£34.73
Fixed costs		4	£25.00	£750.00	£341.25
Total labour costs		7	£180.00	£2,214.00	£712.54
Other costs:					
Equipment costs		2	£65.00	£100.00	£82.50
Scaffolding costs total (where relevant)		2	£250.00	£450.00	£350.00
Submission to building control etc.		5	£5.44	£50.00	£32.44
Provision of guarantee		6	£15.00	£80.00	£43.56
Other costs		1	£195.00	£195.00	£195.00
Overheads and profit		7	£50.00	£3,014.86	£636.82
VAT		4	£44.64	£311.30	£145.00
Total other costs		7	£115.00	£3,876.92	£931.62
Total cost:					
Grand Total		**7**	**£410.60**	**£6,180.47**	**£1,809.75**
Discount & uplift (all dwellings)					
% discount for insulating 10 homes		9	0.00%	10.00%	2.39%
% discount for insulating 50 homes		9	0.00%	20.00%	4.78%
% discount for insulating 100 homes		9	0.00%	25.00%	5.94%
% increase in total costs for insulating rural homes		9	0.00%	10.00%	3.22%

7: Walls with access issues due to conservatory EPS Beads

		N	Min	Max	Average
Material costs:					
EPS bead and bonding agent					
Cost per unit area (£/m2)		7	£3.00	£8.00	£4.70
Fixed costs		1	£30.00	£30.00	£30.00
Total material costs		7	£162.50	£712.00	£390.01
Labour costs:					
Pre-install assessment, Installation and Post-installation checks and making good					
Time required (hrs)		7	4.5	91	22.14
Cost rate (£ / hr)		7	£16.63	£50.00	£30.16
Fixed costs		1	£250.00	£250.00	£250.00
Total labour costs		7	£175.28	£3,081.25	£671.86
Other costs:					
Equipment costs		2	£20.00	£100.00	£60.00
Conservatory ladder / Scaffolding costs total (where relevant)		0	£0.00	£0.00	£0.00
Submission to building control etc.		6	£5.44	£120.00	£47.03
Provision of guarantee		7	£15.00	£80.00	£42.34
Other costs		1	£195.00	£195.00	£195.00
Overheads and profit		7	£75.00	£552.33	£294.95
VAT		4	£44.30	£1,215.12	£372.41
Total other costs		7	£290.00	£3,497.44	£1,318.49
Total cost:					
Grand total		7	£912.20	£7,290.69	£2,380.36
Discount & uplift (all dwellings)					
% discount for insulating 10 homes		9	0.00%	10.00%	2.61%
% discount for insulating 50 homes		9	0.00%	20.00%	5.11%
% discount for insulating 100 homes		9	0.00%	25.00%	6.50%
% increase in total costs for insulating rural homes		9	0.00%	10.00%	3.22%

8: Standard cavity wall with defect: EPS beads and DPC repair

	Dwelling	N	Min	Max	Average
Material costs:					
EPS Bead Insulation and bonding agent					
Cost per unit area (£/m2)	Flat	6	£3.25	£8.00	£4.98
	Semi-Detached House	6	£3.25	£8.00	£4.98
	All quotes	12	£3.25	£8.00	£4.98
Fixed costs	Flat	0	£0.00	£0.00	£0.00
	Semi-Detached House	0	£0.00	£0.00	£0.00
	All quotes	0	£0.00	£0.00	£0.00
Total material costs	Flat	6	£65.67	£265.85	£132.90
	Semi-Detached House	6	£265.85	£712.00	£417.28
	All quotes	12	£65.67	£712.00	£275.09
Replacement DPC / Bricks / Mortar					
Cost per unit area (£/m2)	Flat	3	£16.00	£50.00	£30.37
	Semi-Detached House	4	£9.00	£50.00	£25.03
	All quotes	7	£9.00	£50.00	£27.32
Fixed costs	Flat	2	£60.00	£775.00	£417.50
	Semi-Detached House	2	£100.00	£890.45	£495.23
	All quotes	4	£60.00	£890.45	£456.36
Total material costs	Flat	5	£60.00	£775.00	£336.18
	Semi-Detached House	6	£96.00	£2,054.82	£611.88
	All quotes	11	£60.00	£2,054.82	£486.56
Labour costs:					
Pre-install assessment and design specifications, DPC repair work, Installation and Post-installation checks and making good					
Time required (hrs)	Flat	6	9.00	46.50	17.75
	Semi-Detached House	6	13.25	54.50	21.71
	All quotes	12	9.00	54.50	19.73
Cost rate (£ / hr)	Flat	6	£18.67	£55.00	£32.08
	Semi-Detached House	6	£18.67	£53.33	£32.61
	All quotes	12	£18.67	£55.00	£32.35
Fixed costs	Flat	1	£910.00	£910.00	£910.00
	Semi-Detached House	1	£1,100.00	£1,100.00	£1,100.00
	All quotes	2	£910.00	£1,100.00	£1,005.00
Total labour costs	Flat	6	£320.00	£1,162.00	£614.39
	Semi-Detached House	6	£432.90	£1,352.00	£789.69
	All quotes	12	£320.00	£1,352.00	£702.04

Other costs:					
Equipment costs	Flat	2	£40.00	£100.00	£70.00
	Semi-Detached House	2	£100.00	£120.00	£110.00
	All quotes	4	£40.00	£120.00	£90.00
Scaffolding costs total (where relevant)	Flat	5	£225.00	£6,000.00	£1,812.37
	Semi-Detached House	3	£450.00	£1,000.00	£683.33
	All quotes	8	£225.00	£6,000.00	£1,388.98
Submission to building control etc.	Flat	6	£5.44	£120.00	£47.03
	Semi-Detached House	6	£5.44	£120.00	£52.03
	All quotes	12	£5.44	£120.00	£49.53
Provision of guarantee	Flat	6	£10.00	£80.00	£43.90
	Semi-Detached House	6	£10.00	£80.00	£36.90
	All quotes	12	£10.00	£80.00	£40.40
Other costs	Flat	1	£195.00	£195.00	£195.00
	Semi-Detached House	2	£100.00	£195.00	£147.50
	All quotes	3	£100.00	£195.00	£163.33
Overheads and profit	Flat	6	£200.00	£1,499.78	£517.60
	Semi-Detached House	6	£120.00	£1,587.78	£528.94
	All quotes	12	£120.00	£1,587.78	£523.27
VAT	Flat	4	£68.79	£582.18	£305.25
	Semi-Detached House	4	£78.81	£615.62	£359.49
	All quotes	8	£68.79	£615.62	£332.37
Total other costs	Flat	6	£505.00	£6,560.00	£2,378.17
	Semi-Detached House	6	£210.00	£2,125.44	£1,285.03
	All quotes	12	£210.00	£6,560.00	£1,831.60
Total cost:					
Grand total	Flat	6	£1,444.66	£6,960.00	£3,405.60
	Semi-Detached House	6	£1,392.48	£4,445.78	£3,096.99
	All quotes	**12**	**£1,392.48**	**£6,960.00**	**£3,251.29**
Discount & uplift (all dwellings)					
% discount for insulating 10 homes		18	0.00%	10.00%	1.83%
% discount for insulating 50 homes		18	0.00%	20.00%	3.67%
% discount for insulating 100 homes		18	0.00%	25.00%	5.06%
% increase in total costs for insulating rural homes		18	0.00%	10.00%	2.78%

9: Standard Cavity Walls in exposed locations / Walls in flood risk areas / Walls with uneven stone cavity: PUR Foam Insulation

	Dwelling	N	Min	Max	Average
Material costs:					
Closed cell polyurethane (PU) foam					
Cost per unit area (£/m2)	Flat	7	£4.25	£29.50	£19.11
	Semi-Detached House	8	£4.25	£29.50	£17.96
	All quotes	15	£4.25	£29.50	£18.50
Fixed costs	Flat	1	£42.79	£42.79	£42.79
	Semi-Detached House	1	£215.00	£215.00	£215.00
	All quotes	2	£42.79	£215.00	£128.90
Total material costs	Flat	7	£84.58	£587.05	£387.07
	Semi-Detached House	8	£347.65	£2,413.10	£1,533.23
	All quotes	15	£84.58	£2,413.10	£998.36
Labour costs:					
Pre-install assessment, Installation and Post-installation checks and making good					
Time required (hrs)	Flat	7	3.75	86.40	18.80
	Semi-Detached House	8	6.00	198.40	37.98
	All quotes	15	3.75	198.40	29.03
Cost rate (£ / hr)	Flat	7	£17.33	£50.00	£29.67
	Semi-Detached House	8	£16.73	£61.10	£34.13
	All quotes	15	£16.73	£61.10	£32.05
Fixed costs	Flat	1	£12.00	£12.00	£12.00
	Semi-Detached House	1	£12.00	£12.00	£12.00
	All quotes	2	£12.00	£12.00	£12.00
Total labour costs	Flat	7	£104.00	£1,713.60	£439.44
	Semi-Detached House	8	£186.30	£3,897.60	£999.26
	All quotes	15	£104.00	£3,897.60	£738.01

Other costs:					
Equipment costs	Flat	2	£12.00	£250.00	£131.00
	Semi-Detached House	2	£24.00	£250.00	£137.00
	All quotes	4	£12.00	£250.00	£134.00
Scaffolding costs total (where relevant)	Flat	7	£100.00	£6,000.00	£1,291.90
	Semi-Detached House	4	£200.00	£1,800.00	£900.00
	All quotes	11	£100.00	£6,000.00	£1,149.39
Submission to building control etc.	Flat	6	£6.75	£250.00	£105.36
	Semi-Detached House	6	£6.75	£155.44	£80.36
	All quotes	12	£6.75	£250.00	£92.86
Provision of guarantee	Flat	7	£10.00	£100.88	£51.20
	Semi-Detached House	8	£10.00	£100.88	£49.17
	All quotes	15	£10.00	£100.88	£50.12
Other costs	Flat	2	£125.00	£1,795.00	£960.00
	Semi-Detached House	3	£50.00	£3,450.00	£1,449.33
	All quotes	5	£50.00	£3,450.00	£1,253.60
Overheads and profit	Flat	7	£184.48	£720.29	£395.19
	Semi-Detached House	8	£200.00	£1,772.55	£638.43
	All quotes	15	£184.48	£1,772.55	£524.92
VAT	Flat	4	£70.02	£1,104.45	£437.56
	Semi-Detached House	5	£62.26	£2,717.91	£785.89
	All quotes	9	£62.26	£2,717.91	£631.08
Total other costs	Flat	7	£346.48	£6,760.00	£2,390.35
	Semi-Detached House	8	£310.00	£9,996.78	£2,266.81
	All quotes	15	£310.00	£9,996.78	£2,324.46
Total cost:					
Grand total	Flat	7	£811.67	£7,400.00	£3,216.87
	Semi-Detached House	8	£1,094.14	£16,307.48	£4,799.30
	All quotes	**15**	**£811.67**	**£16,307.48**	**£4,060.83**
Discount & uplift (all dwellings)					
% discount for insulating 10 homes		18	0.00%	10.00%	2.72%
% discount for insulating 50 homes		18	0.00%	20.00%	5.11%
% discount for insulating 100 homes		18	0.00%	25.00%	6.50%
% increase in total costs for insulating rural homes		18	0.00%	11.00%	4.56%

10: Standard cavity wall with more than three stories: EPS bead insulation with cavity wall trays

		N	Min	Max	Average
Material costs:					
EPS Bead Insulation and bonding agent					
Cost per unit area (£/m2)		6	£3.25	£8.00	£4.98
Fixed costs		0	£0.00	£0.00	£0.00
Total material costs		6	£265.85	£840.50	£486.80
Cavity support trays					
Cost per unit area (£/m2)		4	£4.25	£12.85	£8.53
Fixed costs		2	£125.00	£140.00	£132.50
Total material costs		6	£125.00	£300.00	£184.63
Labour costs:					
Pre-install assessment, Installation of cavity wall trays, Insulation installation and Post-installation checks and make good					
Time required (hrs)		6	12.00	46.50	23.13
Cost rate (£ / hr)		6	£17.36	£50.00	£30.30
Fixed costs		2	£50.00	£120.00	£85.00
Total labour costs		6	£337.00	£972.10	£650.35
Other costs:					
Equipment costs		2	£100.00	£150.00	£125.00
Scaffolding costs total (where relevant)		5	£600.00	£2,974.00	£1,348.55
Submission of building control notices (etc.) total costs		6	£6.00	£352.00	£85.79
Provision of guarantee		6	£10.00	£87.00	£47.08
Other costs		1	£195.00	£195.00	£195.00
Overheads and profit		6	£175.00	£1,057.52	£483.97
VAT		4	£73.00	£2,481.13	£858.06
Total other costs		6	£795.34	£6,390.38	£2,386.84
Total cost:					
All quotes		**6**	**£1,538.19**	**£8,000.88**	**£3,708.62**
Discount & uplift (all dwellings)					
% discount for insulating 10 homes		9	0.00%	10.00%	2.06%
% discount for insulating 50 homes		9	0.00%	20.00%	4.00%
% discount for insulating 100 homes		9	0.00%	25.00%	5.39%
% increase in total costs for insulating rural homes		9	0.00%	10.00%	2.78%

11: Metal framed / timber framed cavity walls: internal wall insulation

	Dwelling	N	Min	Max	Average
Material costs:					
Insulation boards / adhesive					
Cost per unit area (£/m2)	Flat	7	£18.00	£54.00	£36.71
	Semi-Detached House	7	£4.14	£54.00	£33.59
	All quotes	14	£4.14	£54.00	£35.15
Fixed costs	Flat	1	£60.00	£60.00	£60.00
	Semi-Detached House	1	£120.00	£120.00	£120.00
	All quotes	2	£60.00	£120.00	£90.00
Total material costs	Flat	7	£358.20	£1,074.60	£740.04
	Semi-Detached House	7	£338.65	£4,417.20	£2,725.21
	All quotes	14	£338.65	£4,417.20	£1,732.63
Labour costs:					
Pre-install assessment, Installation and Post-installation checks and making good					
Time required (hrs)	Flat	6	9.00	128.00	64.17
	Semi-Detached House	6	22.50	232.00	108.58
	All quotes	12	9.00	232.00	86.38
Cost rate (£ / hr)	Flat	6	£19.78	£40.71	£27.49
	Semi-Detached House	6	£19.66	£62.07	£36.19
	All quotes	12	£19.66	£62.07	£31.84
Fixed costs	Flat	1	£60.00	£60.00	£60.00
	Semi-Detached House	1	£120.00	£120.00	£120.00
	All quotes	2	£60.00	£120.00	£90.00
Total labour costs	Flat	7	£894.40	£7,900.00	£2,668.56
	Semi-Detached House	7	£1,396.50	£5,460.00	£3,410.57
	All quotes	14	£894.40	£7,900.00	£3,039.56

Other costs:					
Equipment costs	Flat	1	£100.00	£100.00	£100.00
	Semi-Detached House	2	£75.00	£100.00	£87.50
	All quotes	3	£75.00	£100.00	£91.67
Scaffolding costs total (where relevant)	Flat	2	£250.00	£800.00	£525.00
	Semi-Detached House	1	£800.00	£800.00	£800.00
	All quotes	3	£250.00	£800.00	£616.67
Submission of building control notices (etc.) total costs	Flat	6	£50.00	£200.00	£115.91
	Semi-Detached House	6	£50.00	£195.00	£92.67
	All quotes	12	£50.00	£200.00	£104.29
Provision of guarantee	Flat	7	£80.00	£225.00	£122.27
	Semi-Detached House	7	£30.00	£140.00	£78.86
	All quotes	14	£30.00	£225.00	£100.56
Other costs	Flat	1	£125.00	£125.00	£125.00
	Semi-Detached House	1	£848.00	£848.00	£848.00
	All quotes	2	£125.00	£848.00	£486.50
Overheads and profit	Flat	6	£300.00	£1,168.09	£564.44
	Semi-Detached House	6	£293.85	£2,804.40	£1,046.26
	All quotes	12	£293.85	£2,804.40	£805.35
VAT	Flat	4	£96.08	£677.60	£274.39
	Semi-Detached House	4	£140.22	£2,321.90	£918.68
	All quotes	8	£96.08	£2,321.90	£596.53
Total other costs	Flat	7	£625.00	£1,651.28	£1,044.36
	Semi-Detached House	7	£690.00	£4,054.18	£1,840.46
	All quotes	14	£625.00	£4,054.18	£1,442.41
Total cost:					
Grand total	Flat	7	£2,017.72	£9,970.00	£4,452.96
	Semi-Detached House	7	£3,057.60	£13,931.38	£7,976.24
	All quotes	**14**	**£2,017.72**	**£13,931.38**	**£6,214.60**
Discount & uplift (all dwellings)					
% discount for insulating 10 homes		18	0.00%	10.00%	2.22%
% discount for insulating 50 homes		18	0.00%	20.00%	4.33%
% discount for insulating 100 homes		18	0.00%	25.00%	5.83%
% increase in total costs for insulating rural homes		18	0.00%	11.00%	4.44%

12: Flat Roof Insulation board and vapour control membrane

	Dwelling	N	Min	Max	Average
Material costs:					
Insulation board and vapour control membrane					
Cost per unit area (£/m2)	Low rise block	5	£15.00	£59.50	£36.67
	Mid terrace extension	5	£34.00	£120.00	£57.67
	All quotes	10	£15.00	£120.00	£47.17
Fixed costs	Low rise block	0	£0.00	£0.00	£0.00
	Mid terrace extension	0	£0.00	£0.00	£0.00
	All quotes	0	£0.00	£0.00	£0.00
Total material costs	Low rise block	5	£2,440.00	£15,423.00	£7,922.44
	Mid terrace extension	5	£200.00	£720.00	£418.13
	All quotes	10	£200.00	£15,423.00	£4,170.28
Labour costs:					
Pre-install assessment, Creation of loft access, Installation of insulation and Post-installation checks and making goods					
Time required (hrs)	Low rise block	5	2.00	113.00	48.60
	Mid terrace extension	5	2.00	24.00	10.80
	All quotes	10	2.00	113.00	29.70
Cost rate (£ / hr)	Low rise block	5	£22.09	£50.00	£33.17
	Mid terrace extension	5	£22.48	£53.00	£37.10
	All quotes	10	£22.09	£53.00	£35.13
Fixed costs	Low rise block	3	£145.00	£6,480.25	£3,908.42
	Mid terrace extension	3	£145.00	£700.00	£388.07
	All quotes	6	£145.00	£6,480.25	£2,148.24
Total labour costs	Low rise block	5	£405.00	£6,620.25	£4,083.25
	Mid terrace extension	5	£265.00	£1,200.00	£644.24
	All quotes	10	£265.00	£6,620.25	£2,363.75

Other costs:					
Equipment costs	Low rise block	1	£100.00	£100.00	£100.00
	Mid terrace extension	1	£100.00	£100.00	£100.00
	All quotes	2	£100.00	£100.00	£100.00
Scaffolding costs total (where relevant)	Low rise block	4	£1,500.00	£17,078.80	£6,454.70
	Mid terrace extension	5	£340.00	£1,500.00	£680.00
	All quotes	9	£340.00	£17,078.80	£3,246.53
Submission to building control etc.	Low rise block	4	£50.00	£256.00	£114.00
	Mid terrace extension	4	£50.00	£81.00	£57.75
	All quotes	8	£50.00	£256.00	£85.88
Provision of guarantee	Low rise block	4	£30.00	£80.00	£65.50
	Mid terrace extension	4	£30.00	£80.00	£54.25
	All quotes	8	£30.00	£80.00	£59.88
Other costs	Low rise block	2	£1,200.00	£6,480.25	£3,840.13
	Mid terrace extension	2	£220.00	£228.00	£224.00
	All quotes	4	£220.00	£6,480.25	£2,032.06
Overheads and profit	Low rise block	5	£400.00	£6,746.91	£3,133.26
	Mid terrace extension	4	£268.00	£460.00	£367.41
	All quotes	9	£268.00	£6,746.91	£1,903.99
VAT	Low rise block	3	£1,351.02	£8,180.90	£3,860.77
	Mid terrace extension	3	£85.96	£589.60	£387.02
	All quotes	6	£85.96	£8,180.90	£2,123.90
Total other costs	Low rise block	5	£575.00	£37,408.31	£12,313.13
	Mid terrace extension	5	£450.00	£2,587.60	£1,405.34
	All quotes	10	£450.00	£37,408.31	£6,859.24
Total cost:					
Grand total	Low rise block	5	£4,880.00	£49,085.37	£24,318.82
	Mid terrace extension	5	£1,435.00	£3,537.60	£2,467.71
	All quotes	**10**	**£1,435.00**	**£49,085.37**	**£13,393.26**
Discount & uplift (all dwellings)					
% discount for insulating 10 homes		18	0.00%	10.00%	1.78%
% discount for insulating 50 homes		18	0.00%	20.00%	3.44%
% discount for insulating 100 homes		18	0.00%	25.00%	4.56%
% increase in total costs for insulating rural homes		18	0.00%	10.00%	3.22%

13: Room in roof / Mansard / Chalet roof Pitched Roof Insulation from Above

	N	Min	Max	Average
Material costs:				
Insulation board and vapour control membrane				
Cost per unit area (£/m2)	5	£ 10.00	£ 50.00	£ 29.30
Fixed costs	0	£ -	£ -	£ -
Total material costs	5	£ 450.00	£ 3,231.10	£ 1,836.22
Labour costs:				
Pre-install assessment, Installation and Post-installation checks and making good				
Time required (hrs)	4	3	40	23.75
Cost rate (£ / hr)	4	£ 45.29	£ 63.33	£ 51.46
Fixed costs	3	£ 150.00	£ 1,450.00	£ 986.66
Total labour costs	5	£ 1,000.00	£ 2,000.00	£ 1,508.00
Other costs:				
Equipment costs	1	£ 100.00	£ 100.00	£ 100.00
Scaffolding costs total (where relevant)	4	£ 600.00	£ 1,250.00	£ 912.50
Submission of building control notices (etc.)	5	£ 50.00	£ 195.00	£ 93.00
Provision of guarantee	5	£ 50.00	£ 120.00	£ 85.00
Other costs	0	£ -	£ -	£ -
Overheads and profit	4	£ 268.00	£ 1,192.00	£ 638.25
VAT	2	£ 208.60	£ 589.60	£ 399.10
Total other costs	5	£ 1,085.00	£ 2,087.60	£ 1,598.24
Total cost:				
Grand total	**5**	**£ 3,537.60**	**£ 6,599.10**	**£ 4,942.46**
Discount & uplift (all dwellings)				
% discount for insulating 10 homes	9	0.00%	10.00%	1.56%
% discount for insulating 50 homes	9	0.00%	20.00%	3.00%
% discount for insulating 100 homes	9	0.00%	25.00%	3.89%
% increase in total costs for insulating rural homes	9	0.00%	10.00%	3.11%

14: Room in roof / Mansard / Chalet roof Pitched Roof Insulation from Below

	N	Min	Max	Average
Material costs:				
Insulation board and vapour control membrane				
Cost per unit area (£/m2)	5	£18.9	£55	£27.36
Fixed costs	0	0	0	0
Total material costs	5	££549.93	£3080	£1405.19
Labour costs:				
Pre-install assessment, Installation and Post-installation checks and making good				
Time required (hrs)	5	3.00	28.00	16.50
Cost rate (£ / hr)	5	£ 24.34	£ 63.33	£ 44.68
Fixed costs	2	£ 150.00	£ 1,300.00	£ 725.00
Total labour costs	5	£ 600.00	£ 1,490.00	£ 925.00
Other costs:				
Equipment costs	2	£ 25.00	£ 100.00	£ 62.50
Scaffolding costs total (where relevant)	0	£ -	£ -	£ -
Submission to building control etc.	5	£ 18.00	£ 120.00	£ 58.60
Provision of guarantee	4	£ 30.00	£ 120.00	£ 68.75
Other costs	0	£ -	£ -	£ -
Overheads and profit	5	£ 173.00	£ 1,072.00	£ 510.41
VAT	3	£ 89.74	£ 380.60	£ 219.31
Total	5	£ 430.00	£ 1,499.60	£ 780.60
Total cost:				
Grand total	**5**	**£ 1,884.73**	**£ 4,720.00**	**£ 3,110.79**
Discount & uplift (all dwellings)				
% discount for insulating 10 homes	9	0.00%	10.00%	1.61%
% discount for insulating 50 homes	9	0.00%	20.00%	3.11%
% discount for insulating 100 homes	9	0.00%	25.00%	4.06%
% increase in total costs for insulating rural homes	9	0.00%	10.00%	2.00%

15: Loft with access issue: Create loft hatch and install mineral wool insulation

	N	Min	Max	Average
Material costs:				
Mineral wool insulation				
Cost per unit area (£/m2)	8	£ 1.70	£ 5.50	£ 3.22
Fixed costs	2	£ 25.00	£ 25.00	£ 25.00
Total material costs	8	£ 72.00	£ 325.00	£ 169.81
Loft Hatch				
Cost per unit area (£/m2)	3	£ 32.50	£ 165.00	£ 82.50
Fixed costs	6	£ 5.00	£ 165.00	£ 80.00
Total material costs	8	£ 37.50	£ 165.00	£ 90.94
Labour costs:				
Pre-install assessment, Creation of loft access, Installation of insulation and Post-installation checks and making good				
Time required (hrs)	7	5	16	9
Cost rate (£ / hr)	7	£ 20.00	£ 40.00	£ 26.24
Fixed costs	2	£ 75.00	£ 430.00	£ 252.50
Total labour costs	8	£ 160.00	£ 430.00	£ 254.00
Other costs:				
Equipment costs	3	£ 5.00	£ 100.00	£ 51.67
Scaffolding costs total (where relevant)	0	£ -	£ -	£ -
Submission to building control etc.	4	£ 5.44	£ 50.00	£ 28.86
Provision of guarantee	3	£ 25.88	£ 80.00	£ 45.29
Other costs	1	£ 195.00	£ 195.00	£ 195.00
Overheads and profit	7	£ 45.00	£ 240.00	£ 126.92
VAT	4	£ 22.84	£ 225.70	£ 112.94
Total other costs	7	£ 55.00	£ 599.21	£ 277.36
Total cost:				
Grand total	8	**£ 452.00**	**£1,354.21**	**£ 757.43**
Discount & uplift (all dwellings)				
% discount for insulating 10 homes	9	0.00%	10.00%	3.17%
% discount for insulating 50 homes	9	0.00%	20.00%	5.56%
% discount for insulating 100 homes	9	0.00%	25.00%	7.72%
% increase in total costs for insulating rural homes	9	0.00%	10.00%	5.22%

National cost estimates:

Uninsulated non-standard cavity walls

	Converted	Detached	End terrace	Mid terrace	Purpose built flat	Semi detached	Total
Number of dwellings (000s)	41.2 - 69.1	3,010.0 - 3,210.0	715.0 - 818.0	1,060.0 - 1,190.0	2,280.0 - 2,450.0	2,680.0 - 2,870.0	10,000.0 - 10,300.0
Number of fillable dwellings (000s)	24.7 - 47.2	733.0 - 837.0	194.0 - 250.0	448.0 - 531.0	1,020.0 - 1,140.0	554.0 - 645.0	3,110.0 - 3,310.0
Cost to insulate (£M)	£70 - £134	£7690 - £8780	£1360 - £1760	£2050 - £2430	£3110 - £3480	£3160 - £3670	£21,200 - £22,500
Average cost per home	£2,840	£10,500	£7,030	£4,570	£3,050	£5,700	£6,810

Narrow Cavity

	Converted	Detached	End terrace	Mid terrace	Purpose built flat	Semi detached	Total
Number of dwellings (000s)	8.4 - 23.4	90.2 - 130.0	40.9 - 68.7	96.5 - 137.0	34.2 - 59.9	167.0 - 219.0	494.0 - 580.0
Number of fillable dwellings (000s)	6.8 - 20.7	15.4 - 34.1	7.7 - 22.2	52.1 - 83.0	7.6 - 22.1	43.6 - 72.1	168.0 - 220.0
Cost to insulate (£M)	12.6 - 38.4	75.1 - 166.0	22.3 - 64.6	116.0 - 184.0	14.1 - 41.0	131.0 - 217.0	468.0 - 614.0
Average cost per home	£1,850	£4,880	£2,910	£2,220	£1,850	£3,010	£2,790

Uneven Stone Cavities

	Converted	Detached	End terrace	Mid terrace	Purpose built flat	Semi detached	Total
Number of dwellings (000s)	0 - 1.5	114.0 - 157.0	13.7 - 31.6	12.1 - 29.2	3.8 - 15.4	91.0 - 130.0	267.0 - 332.0
Number of fillable dwellings (000s)	0 - 1.5	25.4 - 48.2	0 - 6.2	0 - 5.5	0 - 4.4	19.3 - 39.7	57.9 - 90.2
Cost to insulate (£M)	0.0 - 5.3	185.0 - 351.0	0.0 - 30.2	0.0 - 22.1	0.0 - 15.4	95.8 - 197.0	349.0 - 544.0
Average cost per home	£3,490	£7,270	£4,850	£4,000	£3,490	£4,970	£6,030

Metal Frame dwellings

	Converted	Detached	End terrace	Mid terrace	Purpose built flat	Semi detached	Total
Number of dwellings (000s)	0 - 2.0	37.1 - 63.8	3.2 - 14.4	1.5 - 10.9	16.9 - 36.2	35.6 - 61.9	119.0 - 164.0
Number of fillable dwellings (000s)	0 - 0.0	0 - 3.8	0 - 1.4	0 - 2.0	0 - 4.1	1.1 - 9.9	3.7 - 15.3
Cost to insulate (£M)	0.0 - 0.0	0.0 - 51.9	0.0 - 11.1	0.0 - 11.5	0.0 - 20.1	8.9 - 80.8	31.0 - 128.0
Average cost per home	-	£13,700	£7,930	£5,900	£4,960	£8,180	£8,340

Concrete dwellings

	Converted	Detached	End terrace	Mid terrace	Purpose built flat	Semi detached	Total
Number of dwellings (000s)	0 - 0.0	6.1 - 19.5	17.4 - 37.0	37.4 - 64.1	388.0 - 465.0	82.3 - 120.0	572.0 - 665.0
Number of fillable dwellings (000s)	0 - 0.0	0 - 0.4	0 - 2.2	0 - 8.2	92.4 - 132.0	13.7 - 31.6	118.0 - 162.0
Cost to insulate (£M)	0.0 - 0.0	0.0 - 0.9	0.0 - 2.6	0.3 - 5.4	325.0 - 464.0	16.7 - 38.5	358.0 - 493.0
Average cost per home	-	£2,550	£1,150	£658	£3,510	£1,220	£3,040

Timber frame with unfilled cavities

	Converted	Detached	End terrace	Mid terrace	Purpose built flat	Semi detached	Total
Number of dwellings (000s)	0 - 3.1	23.7 - 45.9	14.5 - 32.8	12.6 - 30.0	5.7 - 18.9	21.5 - 42.8	104.0 - 146.0
Number of fillable dwellings (000s)[9]	0 - 3.1	23.7 - 45.9	14.5 - 32.8	12.6 - 30.0	5.7 - 18.9	21.5 - 42.8	104.0 - 146.0
Cost to insulate (£M)	0.0 - 15.6	318.0 - 616.0	114.0 - 257.0	74.1 - 176.0	28.8 - 95.4	174.0 - 347.0	921.0 - 1,290.0
Average cost per home	£5,050	£13,400	£7,840	£5,870	£5,050	£8,100	£8,820

Partial Filled cavity

	Converted	Detached	End terrace	Mid terrace	Purpose built flat	Semi detached	Total
Number of dwellings (000s)	0 - 0.7	223.0 - 282.0	46.5 - 75.9	40.3 - 67.9	121.0 - 166.0	87.3 - 126.0	572.0 - 664.0
Number of fillable dwellings (000s)	0 - 0.7	223.0 - 282.0	46.5 - 75.9	40.3 - 67.9	121.0 - 166.0	87.3 - 126.0	572.0 - 664.0
Cost to insulate (£M)	0.0 - 3.5	3,460.0 - 4,390.0	402.0 - 656.0	250.0 - 422.0	625.0 - 857.0	783.0 - 1,130.0	6,000.0 - 6,970.0
Average cost per home	£5,170	£15,500	£8,650	£6,210	£5,170	£8,980	£10,500

Standard cavity with issues

	Converted	Detached	End terrace	Mid terrace	Purpose built flat	Semi detached	Total
Number of dwellings (000s)	26.6 - 49.9	2,460.0 - 2,640.0	547.0 - 637.0	822.0 - 932.0	1,640.0 - 1,790.0	2,130.0 - 2,300.0	7,840.0 - 8,120.0
Number of fillable dwellings (000s)	12.1 - 29.1	396.0 - 474.0	97.7 - 138.0	305.0 - 373.0	741.0 - 845.0	311.0 - 380.0	1,970.0 - 2,130.0
Cost to insulate (£M)	40.4 - 97.4	3,080.0 - 3,680.0	646.0 - 915.0	1,450.0 - 1,770.0	1,910.0 - 2,180.0	1,620.0 - 1,980.0	9,290.0 - 10,100.0
Average cost per home	£3,340	£7,770	£6,610	£4,740	£2,580	£5,200	£4,720

Uninsulated Cavity too high

	Converted	Detached	End terrace	Mid terrace	Purpose built flat	Semi detached	Total
Number of dwellings (000s)	2.4 - 12.7	0 - 2.3	0 - 5.2	3.5 - 14.9	724.0 - 828.0	0 - 5.6	746.0 - 851.0
Number of fillable dwellings (000s)	1.0 - 9.7	0 - 2.3	0 - 5.2	1.0 - 9.6	462.0 - 546.0	0 - 5.6	478.0 - 563.0
Cost to insulate (£M)	1.3 - 12.7	0.0 - 16.4	0.0 - 16.8	1.8 - 18.0	606.0 - 715.0	0.0 - 19.1	642.0 - 756.0
Average cost per home	£1,310	£7,040	£3,220	£1,860	£1,310	£3,400	£1,340

Standard cavity with conservatory

	Converted	Detached	End terrace	Mid terrace	Purpose built flat	Semi detached	Total
Number of dwellings (000s)	0 - 2.6	1,190.0 - 1,320.0	146.0 - 195.0	159.0 - 209.0	6.7 - 20.6	893.0 - 1,010.0	2,480.0 - 2,660.0
Number of fillable dwellings (000s)	0 - 2.5	209.0 - 267.0	0 - 0.5	33.6 - 59.2	1.7 - 11.3	105.0 - 147.0	379.0 - 455.0
Cost to insulate (£M)	0.0 - 3.8	1,070.0 - 1,370.0	0.0 - 1.1	43.8 - 77.2	2.6 - 17.2	254.0 - 356.0	1,450.0 - 1,740.0
Average cost per home	£1,530	£5,120	£2,300	£1,300	£1,530	£2,430	£3,820

[9] Modelling assumed that all of these buildings had cavities that were fillable

Standard cavity with external cladding

	Converted	Detached	End terrace	Mid terrace	Purpose built flat	Semi detached	Total
Number of dwellings (000s)	0.7 - 9.1	447.0 - 529.0	155.0 - 205.0	282.0 - 349.0	369.0 - 444.0	418.0 - 498.0	1,770.0 - 1,930.0
Number of fillable dwellings (000s)	0 - 7.9	51.7 - 82.5	36.1 - 62.4	129.0 - 176.0	130.0 - 176.0	29.0 - 53.1	427.0 - 507.0
Cost to insulate (£M)	1.4 - 40.0	587.0 - 936.0	262.0 - 454.0	754.0 - 1,020.0	662.0 - 898.0	217.0 - 396.0	2,850.0 - 3,380.0
Average cost per home	£5,100	£11,300	£7,270	£5,830	£5,100	£7,470	£6,670

Mixed Wall construction

	Converted	Detached	End terrace	Mid terrace	Purpose built flat	Semi detached	Total
Number of dwellings (000s)	5.7 - 18.9	186.0 - 241.0	89.0 - 128.0	155.0 - 205.0	161.0 - 212.0	296.0 - 364.0	971.0 - 1,090.0
Number of fillable dwellings (000s)	0 - 6.1	46.3 - 75.6	22.0 - 43.5	64.5 - 98.4	70.7 - 106.0	84.4 - 123.0	334.0 - 406.0
Cost to insulate (£M)	0.0 - 31.8	585.0 - 955.0	169.0 - 335.0	384.0 - 586.0	370.0 - 554.0	662.0 - 962.0	2,520.0 - 3,070.0
Average cost per home	£5,230	£12,600	£7,700	£5,960	£5,230	£7,850	£7,560

Cavity Walls in exposed locations

	Converted	Detached	End terrace	Mid terrace	Purpose built flat	Semi detached	Total
Number of dwellings (000s)	0 - 7.7	283.0 - 349.0	20.2 - 41.0	28.9 - 52.9	148.0 - 197.0	75.9 - 112.0	610.0 - 706.0
Number of fillable dwellings (000s)	0 - 4.2	8.6 - 23.7	8.6 - 23.6	0 - 6.4	2.3 - 12.6	9.0 - 24.4	46.5 - 75.8
Cost to insulate (£M)	0.0 - 14.3	62.3 - 172.0	41.4 - 114.0	0.0 - 25.5	7.9 - 42.9	44.9 - 121.0	245.0 - 399.0
Average cost per home	£3,410	£7,260	£4,840	£3,990	£3,410	£4,980	£5,260

DPC Fault Uninsulated

	Converted	Detached	End terrace	Mid terrace	Purpose built flat	Semi detached	Total
Number of dwellings (000s)	3.2 - 14.3	245.0 - 307.0	81.7 - 119.0	125.0 - 170.0	133.0 - 180.0	342.0 - 415.0	1,010.0 - 1,130.0
Number of fillable dwellings (000s)	1.3 - 10.3	38.5 - 65.5	9.7 - 25.5	37.0 - 63.7	22.8 - 44.6	41.9 - 69.9	188.0 - 243.0
Cost to insulate (£M)	4.2 - 33.8	376.0 - 641.0	46.5 - 122.0	111.0 - 191.0	74.5 - 146.0	210.0 - 351.0	1,010.0 - 1,300.0
Average cost per home	£3,270	£9,780	£4,780	£3,000	£3,270	£5,020	£5,360

Standard pitched with access issues, uninsulated

	Converted	Detached	End terrace	Mid terrace	Purpose built flat	Semi detached	Total
No potential (000s)	0 - 5.9	135.0 - 182.0	38.7 - 65.9	86.4 - 125.0	36.6 - 63.1	166.0 - 217.0	517.0 - 605.0
Potential (000s)	7.6 - 22.1	243.0 - 305.0	95.3 - 136.0	219.0 - 278.0	16.4 - 35.5	390.0 - 467.0	1,050.0 - 1,170.0
Cost to insulate (£M)	7.0 - 20.4	314.0 - 393.0	58.2 - 82.9	134.0 - 170.0	15.1 - 32.8	287.0 - 344.0	874.0 - 977.0
Average cost per home	£924	£1,290	£611	£611	£924	£738	£836

Mansard roof uninsulated

	Converted	Detached	End terrace	Mid terrace	Purpose built flat	Semi detached	Total
No potential (000s)	0 - 3.3	3.1 - 14.1	1.4 - 10.6	2.4 - 12.6	7.0 - 21.0	8.7 - 23.9	39.9 - 67.3
Potential (000s)	9.6 - 25.2	2.4 - 12.8	0 - 6.7	4.5 - 16.8	7.0 - 21.1	8.0 - 22.7	52.8 - 83.8
Cost to insulate (£M)	53.7 - 142.0	22.7 - 120.0	0.0 - 28.9	17.0 - 63.0	39.5 - 119.0	40.1 - 114.0	296.0 - 469.0
Average cost per home	£5,620	£9,360	£4,330	£3,750	£5,620	£5,030	£5,600

Room-in-roof

	Converted	Detached	End terrace	Mid terrace	Purpose built flat	Semi detached	Total
No potential (000s)	8.7 - 23.9	156.0 - 207.0	48.3 - 78.2	150.0 - 199.0	7.4 - 21.7	183.0 - 237.0	612.0 - 708.0
Potential (000s)	12.8 - 30.2	143.0 - 192.0	32.3 - 57.4	145.0 - 193.0	7.5 - 21.9	200.0 - 257.0	598.0 - 693.0
Cost to insulate (£M)	64.0 - 151.0	1,000.0 - 1,340.0	113.0 - 200.0	504.0 - 674.0	37.3 - 109.0	809.0 - 1,040.0	2,790.0 - 3,230.0
Average cost per home	£4,990	£7,010	£3,490	£3,490	£4,990	£4,040	£4,660

Chalet roof uninsulated

	Converted	Detached	End terrace	Mid terrace	Purpose built flat	Semi detached	Total
No potential (000s)	0 - 3.3	50.9 - 81.5	0 - 6.8	1.3 - 10.4	0 - 2.9	53.0 - 84.1	123.0 - 169.0
Potential (000s)	0 - 0.0	60.5 - 93.4	0 - 0.0	0 - 5.5	0 - 0.0	49.1 - 79.2	121.0 - 166.0
Cost to insulate (£M)	0.0 - 0.0	458.0 - 708.0	0.0 - 0.0	0.0 - 18.8	0.0 - 0.0	201.0 - 324.0	711.0 - 975.0
Average cost per home	-	£7,580	-	£3,450	-	£4,090	£5,870

Flat roof uninsulated

	Converted	Detached	End terrace	Mid terrace	Purpose built flat	Semi detached	Total
No potential (000s)	0 - 3.3	14.1 - 32.1	1.1 - 9.9	15.4 - 34.1	34.0 - 59.7	5.5 - 18.5	93.5 - 133.0
Potential (000s)	6.2 - 19.8	6.1 - 19.5	16.2 - 35.3	31.8 - 56.8	137.0 - 185.0	12.3 - 29.4	246.0 - 309.0
Cost to insulate (£M)	36.6 - 116.0	39.8 - 128.0	62.4 - 136.0	122.0 - 218.0	1,390.0 - 1,880.0	52.9 - 127.0	1,890.0 - 2,370.0
Average cost per home	£5,890	£6,560	£3,840	£3,840	£10,200	£4,310	£7,670

1: Narrow Masonry Cavity

Dwellings: Semi-detached house and flat
Drawings: A & B
Description: Masonry cavity that is 25mm wide.
Approach: Closed Cell PU Insulation
Apply Core Specification A with the following changes:
- The insulation material is to be closed-cell polyurethane (PU) foam, injected into the cavities strictly in accordance with the manufacturer's instructions and recommendation. The chosen product is to be the subject of a British Board of Agrément (BBA) certificate confirming its suitability for use as cavity wall insulation, a copy of which is to be supplied. The insulation material is to be delivered to sites in packaging that carries the BBA identification mark and the number of the BBA certificate.
- In all other respects, Core Specification A: Cavity Wall Insulation applies.

2: Concrete constructions

Dwelling: Semi-detached house
Drawings: A
Description: Wimpey No-Fines precast Inner leaf with masonry outer leaf. Cavity is 50mm
Approach: EPS Bead Insulation
Apply Core Specification A

Dwelling: Flat
Drawings: B
Description: Precast panels with 50mm cavity
Approach: External Wall Insulation
Apply Core Specification B

3: Partially Filled Cavity

Dwelling: Semi-detached house and Flat
Drawings: A & B
Description: This specification applies to improving the insulation of walls with cavities that have been partially filled with rigid insulation boards at the time of construction, leaving an approximately 25 mm wide cavity. This process includes inspection which identifies that insulation boards inside the cavity have fallen from the inner leaf and therefore requires internal wall insulation.
Approach: Inspection of Partial Fill Cavity Followed by Internal Wall Insulation
Conduct a pre-install assessment to establish whether the partial-fill insulation is in good condition:
- Carry out a thorough inspection of all the wall cavities, using a borescope to examine the condition of the partial-fill cavity insulation in at least three places at each level in each wall. Observe whether the insulation boards have been fixed against the inner leave, with no gaps or movement into the cavity, and no possibility of cold outside air moving behind the insulation. Record the results of the inspection and make the walls good.
For this dwelling, please assume the insulation is not in good condition i.e. all the insulation boards are not firmly fixed against the inner leaves, there are gaps between the boards or movement into the cavity, and there is a possibility of cold outside air moving behind the insulation. Cavity wall insulation therefore cannot be applied.

Instead, apply Core Specification C (Internal Wall Insulation)

4: Mixed Wall Construction

Dwelling: Semi-detached house & Flat
Drawings: A & B
Description: This supplementary specification applies to buildings that have more than one wall type.
For the semi-detached house dwelling, please assume that the front wall is solid and the side and rear walls are uninsulated masonry cavity walls with a 50mm gap.
For the flat assume that front wall is solid and the rear wall is an uninsulated masonry cavity wall with a 50mm gap.
Approach: EPS Bead and External wall insulation
Insulate the cavity walls in accordance with Core Specification A.
Insulate to sold walls in accordance with Core Specification B.
Where the two types of wall meet, ensure that the external wall insulation (EWI) is carried across the junction between the two wall types for a minimum horizontal distance of 450 mm, in order to minimise thermal bridging. If the existing construction includes movement joints between wall types, incorporate movement joints in the EWI, as appropriate.

5: Walls with External Cladding

Dwelling: Semi-detached house & Flat
Drawings: A
Description: This specification applies to masonry cavity walls with a 50mm cavity and that have external cladding consisting of tile-hanging, weatherboarding or panels.

Approach: Tile Removal and Mineral Wool Insulation
•Apply Core Specification A: Cavity Wall Insulation, but with the following changes.
• The insulation material injected into the wall cavities is to be mineral fibre, not expanded polystyrene (EPS) beads.
• Before proceeding, carefully remove the tiles, weatherboarding or panels, and the supporting timber battens, remove all nails and inspect all components for rot and damage. Remove any weatherproof membrane fixed to the wall behind the battens. Discard the timber battens, and any damaged tiles, boards or panels, and supply replacements.
• After the insulation has been installed, fix a new weatherproof membrane to the wall, fix new timber battens, re-fix the tiles, weatherboarding or panels in the original positions, including all flashings, etc., and make good

6: Walls with boundary access issues

Dwelling: Flat
Drawings: B
Description: This specification applies to walls with access issues due to boundary constraints, which means that insulation must be installed from the inside of the dwelling. The external walls are standard masonry cavity walls with a 50mm gap.
Approach: EPS Bead Insulation through Internal Wall
Apply Core Specification A with the following changes:
- Clear and/or protect the occupants' belongings inside the dwelling, including floor finishes, furniture and fittings, appliances, etc., to allow access for the installation of cavity wall insulation; protect the whole of the property from dust and dirt associated with the work.
- Fill the external wall cavities by injecting insulation through holes drilled in the inner leaves of the walls, from inside the dwelling.
- After the insulation has been installed, fill the holes drilled in the walls and make the linings and decorations good; redecorate the whole of each affected wall, rather than patching the decorations.

- Return the cleared or protected floor finishes, furniture, fittings, appliances, etc., to their original fittings, and reconnect appliances as appropriate; clear away all rubbish, debris and dirt.
In all other respects, Core Specification A: Cavity Wall Insulation applies.

7: Walls with access issues due to conservatory

Dwelling: Semi-detached house
Drawings: C
Description: This supplementary specification applies to cavity walls to which conservatories are attached, obstructing access for the installation of cavity wall insulation. The external walls are standard masonry cavity walls with a 50mm gap.
Approach: EPS Insulation with construction of scaffolding around conservatory
Apply Core Specification A with the following changes:
If possible, construct scaffolding across the conservatory in order to provide access to the exposed wall above the conservatory and to protect the conservatory from damage during the installation of cavity wall insulation.
Insulate the cavity wall in accordance with Core Specification A
Ensure that injection holes drilled within or above the conservatory are at least 200 mm away from the walls and roof of the conservatory, to reduce the risk of damage to the conservatory or to abutment flashings, etc.

8: Standard cavity wall with defect

Dwelling: Semi-detached house & Flat
Drawings: A & B
Description: This specification applies to the insulation of cavity walls with defective damp proof courses (DPCs), which must be repaired before insulation is installed. For costing purposes assume that 30% of the existing DPC has failed. The external walls are standard masonry cavity walls with a 50mm gap.
Approach: EPS Beads and DPC repair
Before installing CWI, the DPCs must be inspected and repaired:
- Inspect the walls to identify the sections of the DPC that have failed.
- Pin and prop the wall as necessary, then cut out brickwork adjacent to each section of defective DPC, and extending at least 200 mm beyond each defective section, at each end. Cut out and remove the defective DPC material.
- Replace the defective DPC material with new material or equivalent or better specification, and ensure that it is lapped at least 150mm and fully bonded to the existing DPC at the ends of each section and all other edges. Check that the repaired DPC is watertight.
- Replace the bricks, using new bricks where the existing bricks have been damaged, repoint the wall using mortar to match the existing in specification and colour, and make good generally.
- Allow the new mortar to go off completely, then install cavity wall insulation in accordance with Core Specification A.

9: Standard cavity wall in exposed location / Walls in flood risk areas / Walls with uneven stone cavity

Dwelling: Semi-detached house & Flat
Drawings: A & B
Description: This specification applies to homes in exposed locations. This means that either:
- the location is more exposed than recommended in Table 1 of the BRE guide Thermal insulation: avoiding risks, because of the combination of cavity width, external finish or (in walls with externally exposed masonry) the type of mortar joints

- the walls are very exposed to driving rain because they are close to the coast, at high elevation, on the edge of an urban or suburban area adjacent to open land, or elevated above the surrounding townscape (irrespective of the exposure zone identified in Thermal Insulation: avoiding risks).
The external walls are standard masonry cavity walls with a 50mm gap.
Approach: PUR Insulation
Apply Core Specification A with the following changes:
- The insulation material is to be closed-cell polyurethane (PU) foam, injected into the cavities strictly in accordance with the manufacturer's instructions and recommendation. The chosen product is to be the subject of a British Board of Agrément (BBA) certificate confirming its suitability for use as cavity wall insulation, a copy of which is to be supplied. The insulation material is to be delivered to sites in packaging that carries the BBA identification mark and the number of the BBA certificate.
- In all other respects, Core Specification A: Cavity Wall Insulation applies.

10: Standard Cavity Wall with More Than Three Stories

Dwelling: Semi-detached house & Flat
Drawings: A & B
Description: This specification applies to the insulation of standard cavity walls of buildings that are more than 12 m (or three storeys) high. The external walls are standard masonry cavity walls with a 50mm gap.
Approach: EPS bead insulation with cavity wall trays
Apply Core Specification A with the following changes:
- Before installing the cavity wall insulation, remove bricks at each end of each straight section of wall, and at each floor level, and insert proprietary flexible cavity trays that unfold when inserted and will support insulation within the wall cavity while allowing rainwater to drain*. The cavity trays should be continuous throughout the cavity, at each floor level. After inserting the cavity trays, replace the bricks that have been removed, and make the brickwork good, re-pointing as necessary
- In all other respects, Core Specification A: Cavity Wall Insulation applies.
*For example, Carbon Cut cavity trays (see www.cavitytrays.net) as developed with support from BEIS, or similar

11: Metal Framed / Timber Framed Cavity walls

Dwelling: Semi-detached house & Flat
Drawings: A
Description: This specification is for metal and timber framed dwellings where the framing cavity cannot be filled. Internal wall insulation should therefore be applied.
Approach: Internal wall insulation
Apply Core Specification C

12: Flat roof insulation

Dwelling: Low rise block of flats
Drawings: F&G
The existing uninsulated flat roof has a timber structure supporting a plywood deck on firrings in a square pyramidal configuration with 1:100 falls from the central apex to the edge of the roof. The roof is finished with three-layer bitumen felt laid on the deck, turned up 150 mm at the edges and built into a 450 mm high brick parapet with a precast concrete coping. There are four lead-lined drainage outlets through the parapet, located at the middle of each side of the roof and leading rainwater to hoppers outside the parapet. The outlets and hoppers will need to be maintained (i.e. raised and made good) as part of the insulation work.
Dwelling: End terrace extension
Only the extension of this property needs insulation. The roof is finished with three layer bitumen felt laid on the deck.

Approach: Warm deck insulation. Apply Core Specification E.

13: Room in roof / Mansard / Chalet roof (from above)

Dwelling: Semi-detached house
Drawings:
Description: This specification applies to the installation of pitched roof insulation, inserted from above, in a room-in-roof.
Approach: Pitched Roof Insulation from Above
Apply Core Specification G.

14: Room in roof / Mansard / Chalet roof (from below)

Dwelling: Semi-detached house
Drawings:
Description: This specification applies to the installation of pitched roof insulation, inserted from below, in a room-in-roof.
Approach: Pitched Roof Insulation from Below
Apply Core Specification F.

15: Loft without access

Dwelling: Semi-detached house
Drawings: A
Description: This supplementary specification applies to the insulation of lofts beneath pitched roofs, to which there is no access, so access must first be provided. It does not apply to roofs supported by trussed rafters.
Approach: Create loft hatch and install mineral wool insulation
Apply Core Specification D.

Core Specification A: Cavity Wall Insulation (EPS Beads)

Introduction

Where dwellings are identified for the installation of cavity wall insulation the Contractor or Installer is to:

1 Carry out a pre-installation assessment.

2 Submit notices as required by the Building Regulations.

3 Install cavity wall insulation.

4 Provide a guarantee of the work.

Pre-Installation Assessment

The pre-installation assessment is to be carried out by an assessor approved under the *BBA Approved Assessor Scheme for Assessing the Suitability of Buildings for the Installation of Cavity Wall Insulation*. The assessment is to comply with the requirements of that scheme, and is to confirm the type of wall construction, establish the width of the wall cavities, confirm that they have not previously been filled with insulation and confirm that they are suitable for filling with the insulation material proposed. The assessment should also record any identified problems, define any areas of wall not to be insulated (and record the reasons) and identify any special requirements for making good.

A written proforma report of every assessment is to be provided. In addition to the information listed above, all reports are to include the minimum contents required by the *BBA Approved Assessor Scheme for Assessing the Suitability of Buildings for the Installation of Cavity Wall Insulation*.

Only empty cavities in walls of masonry construction (with brick, concrete block or stone inner and outer leaves) are to be filled. Cavities in other forms of construction discovered during pre-installation inspections are not to be filled.

Walls of the following types should be recorded as non-standard and not suitable for filling with insulation in accordance with this specification:

- Walls with cavities less than 50 mm wide.
- Walls that have already been filled with insulation, fully or partially, either at the time of construction or subsequently.
- Walls in locations that are more exposed than recommended in Table 1 of the BRE guide *Thermal insulation: avoiding risks*[10], because of the combination of cavity width, external finish or (in walls with externally exposed masonry) the type of mortar joints.
- Walls that are particularly exposed to driving rain because they are close to the coast, at high elevation, on the edge of an urban or suburban area adjacent to open land, or

[10] STIRLING C (2002) *Thermal Insulation: avoiding risks* BRE report BR262, ISBN 1-86081-515-4, BRE, Watford. See http://www.brebookshop.com/details.jsp?id=556

elevated above the surrounding townscape (irrespective of the exposure zone identified in *Thermal Insulation: avoiding risks*).

- Walls where there is evidence of structural or frost damage in the form of cracking or spalling of the outer leaf.
- Walls where there is evidence of rising or penetrating damp on the inner faces.
- Walls where there is evidence that the cavity is obstructed and the obstruction(s) may transmit water towards the inner leaf.
- Walls that are rendered externally, where the render shows evidence of being defective.
- Walls in which the cavity is being used as a source of combustion air or as a flue for ventilation purposes (this will be rare).

Alternative specifications will be provided for some of the above cases.

Submission of Building Control Notices

The Contractor or Installer is to submit formal notice of the work to the local Building Control Body, as required by the Building Regulations. Alternatively, if the contractor is a member of a Competent Persons Scheme recognised by the Department of Communities and Local Government (DCLG) and thus able to self-certify the compliance of the work with the Regulations, then notice need not be submitted but a certificate of compliance is to be supplied.

Installation of Cavity Wall Insulation

Subject to identification during the pre-installation inspection as suitable for filling, cavity walls are to be insulated to achieve *maximum* thermal transmittances (U values) as follows:

Cavity width (mm)	**U value** (W/m^2K)
50	0.52
75	0.38
100	0.30

The insulation material is to be expanded polystyrene (EPS) in bead form, combined with a bonding agent. The chosen product is to be the subject of a British Board of Agrément (BBA) certificate confirming its suitability for use as cavity wall insulation, a copy of which is to be supplied. The insulation material and any bonding agent are to be delivered to sites in packaging that carries the BBA identification mark and the number of the BBA certificate.

The insulation material and any necessary bonding agent are to be injected into the walls by Installers trained and approved by the holder of the BBA certificate for the insulation product and by the BBA. An approved Installer is one who:

- has been required to satisfy an initial site installation check by the BBA and is subject to the *BBA Assessment and Surveillance Scheme for Installation of Cavity Wall Insulation*;
- has undertaken to comply with the BBA certificate holder's installation procedure;
- employs technicians who have been issued with appropriate identity cards by the holder of the BBA certificate (at least one member of each installation team must carry a card); and

- is subject to oversight and inspection by the holder of the BBA certificate.

The installation of the insulation is to be strictly in accordance with:
- the procedure set out in the BBA Certificate;
- the *BBA Assessment and Surveillance Scheme for Installation of Cavity Wall Insulation*;
- the BBA Certificate holder's instructions and recommendations; and
- the requirements of the Cavity Insulation Guarantee Agency (CIGA) for the issue of a guarantee certificate.

During the installation, the Installer is to:
- use only injection equipment approved by the BBA and marked with the appropriate BBA certificate number;
- ensure that injection holes drilled through the outer leaves of the walls (where possible through the mortar joints between bricks) are of the minimum diameter specified in the BBA Certificate for the insulation product;
- check and confirm in writing that the pattern of injection holes complies with the description and recommended spacing in the BBA certificate for the insulation product;
- drill additional holes as required to help ensure that the filled cavity will be void free; and
- ensure that injection of the insulation material takes place at every hole to ensure complete filling of the cavity

After installation of the insulation material the Installer is to:
- make the walls good by fully filling the drill holes with mortar of a type, colour, texture and weather-tightness similar to the existing mortar;
- check all air vents (e.g. those providing under-floor ventilation or combustion air for heating appliances) by means of an appropriate test (e.g. a smoke test) to confirm that they have not been blocked by insulation material;
- remove any insulation material that has been blown through the top of the wall cavities into the loft space; and
- seal any points of leakage of the insulation material.

Provision of Guarantee

Within thirty days of the completion of each installation, the Contractor is to provide a guarantee certificate issued by the Cavity Insulation Guarantee Agency (CIGA) for each dwelling that has been insulated. The guarantee is to be valid for twenty-five years from the date of installation, and each certificate is to include the full address of the dwelling to which it applies.

Introduction

Where dwellings with solid masonry external walls are identified for the installation of external wall insulation (EWI) the Contractor or Installer is to:

1 Carry out a pre-installation assessment.

2 Prepare a design and specification for the installation.

3 Submit notices as required by the Building Regulations.

4 Install external wall insulation.

5 Provide a guarantee of the work.

Pre-Installation Assessment

The pre-installation assessment is to be carried out by an assessor trained and approved by the Contractor or by the specialist Installer of the EWI. The assessment is to include:

- Contact with the local authority's Planning Department to establish whether planning permission is required for installation of EWI[11].
- Assessment of whether the existing dwelling should be classified as 'vulnerable' (i.e. it was constructed prior to 1920) and whether the external walls are of vapour permeable construction (i.e. porous brickwork with lime mortar and lime plaster) or vapour sealed (i.e. with gypsum plaster or cement render).
- A check of whether there is sufficient space for EWI to be installed (both space for the EWI system and for access for installation and subsequent maintenance). This is particularly important where the external walls are located close to property boundaries.
- Measurement of the dimensions of the external walls, including heights and openings; and a line and level survey to determine if a dubbing out or a levelling coat is required before EWI can be installed.
- A record of any architectural features or details that should be preserved or repositioned or replicated within or upon the EWI.
- Identification of attachments to the walls such as gates and fences, sheds, clothes lines, trellises and satellite dishes, which will have to be removed prior to installation of EWI and subsequently re-fixed and made good.
- Identification of any vines, creepers or adjacent soft landscaping that will have to be disturbed during the installation of EWI and subsequently made good, or permanently removed.
- Identification of services such as electricity, TV, telephone and broadband cables and equipment, gas or oil pipe work, electricity and gas meters, lights, rainwater goods, brackets, etc. that will have to be removed or repositioned prior to the installation of EWI and subsequently re-fixed, reconnected and made good.

[11] External wall insulation is Permitted Development for planning purposes, provided that the external appearance of the building is not changed; otherwise planning permission is required; planning permission is *always* required if the building is Listed as of Special Architectural or Historic Interest, or is located in a Conservation Area or an Area of Outstanding Natural Beauty, or is part of a World Heritage Site.

- Assessment of how the EWI can be connected or overlapped with existing or future insulation in adjacent elements (other exposed walls, roofs and exposed floors) in order to minimise thermal bridging and preserve air-tightness at the junctions.
- Evaluation of appropriate colours and textures for the EWI finishes.
- A record of any evident structural defects (e.g. cracks, bulges) and assessment of their causes and of the remedial work required before installation of EWI.
- A record of any evident rising or penetrating damp, and assessment of its causes and of the remedial work and drying-out required before the installation of EWI.
- A record of any existing movement joints that should be taken account of in the design of the EWI.
- A record of the positions of damp proof courses that should be taken account of in the design of the EWI.
- A record of any moss, lichen or mould on wall surfaces, and assessment of any treatment required prior to the installation of EWI.
- A record of any efflorescence (lime bloom), or if efflorescence has been treated a check that the masonry has dried out sufficiently.
- Testing of the walls to establish acceptable pull-out loads so that EWI fixing types and spacings can be determined.

Walls of the following types should be recorded as not suitable for EWI in accordance with this specification:

- Walls with a high proportion (by area) of window openings and/or architectural detail that requires preservation or reinstatement, so that EWI would not be cost effective.
- Walls with cavities (unless the cavities have already been fully filled with insulation).
- Walls where there is evidence of structural or frost damage in the form of cracking or bulging, or spalling of the outer leaf.
- Walls where there is evidence of rising or penetrating damp on the inner faces.
- Walls that are rendered externally, where the render shows evidence of being defective (unless defective render will be removed prior to installation of EWI).

A written proforma report of every assessment is to be provided. Where it is determined that planning permission or Listed Building Consent is required for the installation of EWI, this is to be reported and no installation work is to be carried out until the required consent has been obtained.

Submission of Building Control Notices

The Contractor is to submit formal notice of the work to the local Building Control Body, as required by the Building Regulations. The Building Control Body may require details of the proposed work. Alternatively, if the contractor is a member of a Solid Wall Insulation Competent Persons Scheme recognised by the Department of Communities and Local Government (DCLG) and thus able to self-certify the compliance of the work with the Regulations, then notice need not be submitted but a certificate of compliance is to be supplied.

Design and Specification of EWI Installations

Once the pre-installation assessment has been completed, drawings and specifications are to be prepared for each installation, and submitted for approval.

The requirements for all designs are:

- Where the existing walls are of vapour permeable construction, only vapour permeable insulation materials (e.g. wood fibre or rock wool), adhesives and finishes may be used; the maximum thickness of the insulation is 100 mm.
- Where the existing walls are of vapour closed construction, vapour closed insulation materials, etc., are acceptable, and the insulated external walls are to have thermal transmittances (U values) not exceeding 0.30 W/m^{2}K.
- In both cases, U values are to be calculated in accordance with BS EN ISO 6946: 2007 and BRE report BR443, and copies of the U value calculations are to be supplied.
- Notwithstanding the above requirements, the insulation layer may consist of mineral wool slabs, wood fibre slabs, expanded polystyrene (EPS) boards, graphite enhanced polystyrene boards or phenolic foam boards. Mineral wool or wood fibre slabs are preferred (but note that the maximum vapour permeable thickness for wood fibre insulation is 100 mm). Insulation is to be fixed to the existing walls with adhesive *and* with mechanical fixings.
- In locations where the thickness of the insulation is limited (e.g. window and door sills, soffits and reveals, alongside narrow alleyways or where a wall is very close to a property boundary), very high performance insulation (e.g. polyurethane board or aerogel board) should be used[12].
- EWI is generally to be finished with through-coloured thin-coat (5 mm) acrylic or silicate render (both are vapour permeable) on appropriate scrim and basecoat layers. Dark coloured renders are less durable than light coloured ones, so only light coloured renders are to be used.
- All EWI must be continuous (to eliminate thermal bridging), air-tight (to eliminate the possibility of cold external air getting behind the insulation layer, causing thermal by-pass) and water-tight (to eliminate the possibility of rainwater penetrating into or behind the insulation). Exposed edges of the insulation layer must be protected by adequate overhangs, overlaps, seals, flashings or extended cills, as appropriate.
- Metal fittings (fixings, trays, beads, etc.) are <u>not</u> to be used, because they introduce unacceptable thermal bridges. Only plastic fittings are acceptable.
- Fixings through the EWI (for rainwater downpipes, satellite dishes, etc.) are to be through timber blocks placed in the insulation layer.
- In order to minimise thermal bridging, the EWI must connect or overlap with the existing (or future) roof insulation at eaves, gables and verges, as appropriate. Connection of the two insulation elements (or provision for connection) is preferred, but if connection is not practical an overlap of at least 400 mm is required.
- Where the existing eaves overhang is inadequate to protect the top of the insulation, the eaves roof construction and finishes should be extended over the top of the insulation. Similarly, where the overhangs at gable verges are inadequate to protect the top of the insulation, gable ladders should be constructed and the roof finishes extended. These arrangements will also facilitate connection of the EWI with the roof insulation.
- Alternatively, and only where extension of eaves, gables and verges is not possible, powder-coated aluminium or stainless steel copings may be used to protect the top of the EWI, provided that all joints in the copings are lapped at least 100 mm and sealed, and that special corner pieces are used (cut joints and mitred corners are not acceptable). Copings must be watertight and remain so for the life of the EWI. The use of overhanging eaves and verges is preferred.

[12] Aerogel board is expensive, so its use should be restricted to locations where the thickness of insulation is limited to less than 40 mm.

- In order to minimise thermal bridging, the EWI must not terminate above the level of the damp proof course (DPC). The DPC is to be preserved through the EWI layer, and waterproof insulation (e.g. expanded extruded polystyrene, XPS) is to be used below DPC level. The EWI must overlap with the existing (or future) ground floor insulation by at least 400 mm. Note that this will usually involve ground works and subsequent making-good.
- Wherever possible, existing windows and external doors are to be moved into the plane of the insulation, and the internal finishes are to be made good. Where the windows and external doors are to be replaced, this work will be carried at out by others at the same time as the EWI installation, and the Contractors will be required to cooperate.
- In both cases, the windows are to be supported in the plane of the insulation by minimum 50 mm x 50 mm timber battens around the entire perimeter of the openings, fixed to the walls and sealed with tape. Windows are then to be fixed and sealed to the battens, and the EWI should overlap the window frames by at least 10 mm (subject to there being sufficient clearance for window opening.
- Where the windows and doors are not moved into the plane of the insulation, the EWI layer must continue into the reveals of the openings (using a thin, high performance insulant such as aerogel board) and overlap the window frames by at least 10 mm (subject to there being sufficient clearance for window opening).

The drawings and specification must include:

- The type of EWI system to be used. Only ETICS (External Thermal Insulation Composite Systems) certified by the British Board of Agrément (BBA) as suitable for use as external wall insulation are acceptable, and a copy of the BBA certificate for every proposed system is to be supplied.
- Confirmation of whether the proposed EWI system includes vapour permeable or vapour closed materials.
- Details of how the EWI will connect with or overlap existing or future roof insulation at eaves and verges, and how the top of the EWI will be protected.
- Details of how the EWI will connect or overlap with existing or future floor insulation, including details of the type of insulation to be used below the damp proof course and below ground level[13], and how the ground adjacent to the building will be made good.
- Details of how the windows will be dealt with, and how the EWI will be configured around door and window openings (including soffits, reveals and cills), around projecting balconies, and at copings, abutments, extensions, etc.[3]
- Details of how architectural features i.e. quoins, external cornices, projecting string courses, keystones, corbels, arches, flat bands, raised or recessed bands, ashlar cuts and columns etc., will be treated.[3]
- Details of how services such as electricity, TV, telephone and broadband cables and equipment, satellite dishes, gas or oil pipes, electricity and gas meters, lights, rainwater goods, brackets, etc. will be dealt with.
- The type and pattern of fixings.
- The types and locations of fittings (trays, beads, trims, copings and flashings)
- The positions of starter tracks and render beads, and the positions and amounts of reinforcement scrim, corner mesh and scrim patches to be used at corners and around openings.

[13] Standard or generic details associated with the ETICS system may be used, but all relevant details must be supplied.

- The types and locations of weather seals and sealants.
- The types and positions of damp proof courses (DPCs).
- The types and positions of fire barriers (if required).
- The locations of movement joints and details of how they will be carried through the EWI layer.
- Proposed colours of render and/or weatherboarding.
- Details of how attachments such as gates, fences, clothes lines, satellite dishes and sheds will be dealt with.

Installation of External Wall Insulation

Installation of EWI must be carried out by an approved Installer recommended or recognised by the holder of the BBA certificate for the ETICS. The Installer must:

- undertake to comply with the installation procedures specified by the holder of the BBA certificate; and
- employ operatives trained and approved by the holder of the BBA certificate, working in teams each containing at least one operative trained by the holder of the BBA certificate;
- be subject to at least one inspection per year (including unannounced inspections) by the holder of the BBA certificate to confirm that suitable site practices are being employed.

EWI installations are to be strictly in accordance with the designs submitted and approved, and be consistent with the guidance in *Best Practice Guide: External Wall Insulation* published by the Insulated Render and Cladding Association (INCA) in 2015.
EWI should not be installed when the temperature is below 5°C or above 25°C.
Before EWI is installed, the existing wall surfaces should be cleaned by brushing and/or power-washing with mild detergent solution, as appropriate, then allowed to dry out completely. EWI should only be applied to walls that are clean and completely dry.
If a wall has an existing rendered finish, and the render is in poor condition, the render should be removed using a hammer drill. Areas of loose render should also be hammer tested and removed locally. Any rendered areas that have been removed should be made good with either sand and cement or a proprietary render repair system, before the EWI is installed.
Insulation boards should be fixed to walls with 100% coverage of adhesive applied with a notched trowel to produce an adhesive coat between 2 mm and 5 mm in thickness. A minimum of four mechanical fixings should be used per square metre of wall, unless a greater fixing frequency is specified in the design.
Insulation boards should be arranged so that vertical joints are staggered and boards are overlapped at building corners; the edges of boards must be butted tightly together; all joints and gaps should be filled with strips of insulation and/or with expanding polyurethane foam sealant, as appropriate, before the render coats are applied.
Insulation boards, once fixed and sealed, should be allowed to stabilise before basecoats, scrim and render finishes are applied.
All rendering is to be in accordance with the BBA certificate for the ETICS and with BS EN 139141-1. Rendering should only be carried out when the weather is fine and free from rain. The base cementitious render should be applied in two coats, incorporate a scrim reinforcement layer between them and be completed by a finishing coat.

Particular attention should be paid to thickness and to allowing adequate curing time after the application of each layer. Render finishes must be protected from rapid drying and should not be applied to elevations that are in direct sunlight or where the substrate is hot, or in high winds.
During breaks in the work (e.g. at weekends or during inclement weather) unfinished EWI should be protected by opaque tarpaulin or nylon-reinforced polythene temporarily restrained to the structure or scaffolding. Any insulation material that becomes wet must be cut out and replaced.

Provision of Guarantee
Within thirty days of the completion of each installation, the Contractor is to provide a guarantee certificate issued by the Solid Wall Insulation Guarantee Agency (SWIGA) for each dwelling that has been insulated. The guarantee is to be valid for twenty-five years from the date of installation, and each certificate is to include the full address of the dwelling to which it applies.

Introduction

Where dwellings with solid masonry external walls are identified for the installation of internal wall insulation (IWI) the Contractor or Installer is to:

- Carry out a pre-installation assessment.
- Prepare a design for the installation for approval.
- Submit notices as required by the Building Regulations.
- Install internal wall insulation.
- Provide a guarantee of the work.

Pre-Installation Assessment

The pre-installation assessment is to be carried out by an assessor trained and approved by the Contractor or by a specialist Installer of IWI. The assessment is to include:

- Assessment of whether the existing dwelling should be classified as 'vulnerable' (i.e. it was constructed prior to 1920) and whether the external walls are of vapour permeable construction (i.e. porous brickwork with lime mortar and lime plaster) or vapour sealed (i.e. with gypsum plaster or sand-cement render).
- A check of whether there is sufficient space for IWI to be installed without compromising access or circulation within the house.
- Measurement of the dimensions of the internal walls, including heights and openings.
- A record of any internal architectural features or details (e.g. coving, picture rails, dado rails) that should be preserved or replicated within or upon the IWI.
- Identification of internal fittings (e.g. kitchen fittings, bathroom fittings, fitted shelving and cupboards, etc.) that will have to be removed prior to installation of IWI and subsequently re-fixed and made good, possibly after modification.
- Identification of services such as electricity, TV, telephone and broadband cables and equipment, sockets and switches, radiators, gas pipework, electricity and gas meters, lights, brackets, etc. that will have to be removed or repositioned prior to the installation of IWI and subsequently re-fixed, reconnected and made good.
- Assessment of how the IWI can be connected or overlapped with existing or future insulation in adjacent elements (other exposed walls, roofs and exposed floors) in order to minimise thermal bridging and preserve air-tightness at the junctions.
- A record of any condensation or mould on internal wall surfaces, and assessment of any treatment required prior to the installation of IWI.
- A record of the external condition of the walls, especially of any defects in brickwork pointing or render finishes, and identification of any remedial work required prior to the installation of IWI.
- A record of any evident structural defects (e.g. cracks, bulges) and assessment of their causes and of the remedial work required before installation of IWI.
- A record of any evident rising or penetrating damp, and assessment of its causes and of the remedial work and drying-out required before the installation of IWI.
- A record of any external efflorescence (lime bloom), or if efflorescence has been treated a check that the masonry has dried out sufficiently.

- A record of any existing movement joints that should be taken account of in the design of the IWI.
- Liaison with the occupants to identify appropriate colours for the IWI finishes.

Walls of the following types should be recorded as not suitable for IWI in accordance with this specification unless appropriate remedial works are first carried out:

- Walls where there is evidence of structural or frost damage in the form of cracking or bulging, or spalling of the outer leaf brickwork.
- Walls where there is evidence of rising or penetrating damp on the inner faces.
- Walls that are rendered externally, where the render shows evidence of being defective (unless defective render will be repaired and the wall allowed to dry out prior to installation of IWI).

A written proforma report of every assessment is to be supplied. Where it is determined that Listed Building Consent is required for the installation of IWI, this is to be reported and no installation work is to be carried out until the required consent has been obtained.

Submission of Building Control Notices

The Contractor is to submit formal notice of the work to the local Building Control Body, as required by the Building Regulations. The Building Control Body may require details of the proposed work. Alternatively, if the contractor is a member of a Solid Wall Insulation Competent Persons Scheme recognised by the Department of Communities and Local Government (DCLG) and thus able to self-certify the compliance of the work with the Regulations, then notice need not be submitted but a certificate of compliance is to be supplied.

Design and Specification of IWI Installations

Once the pre-installation assessment has been completed, drawings and specifications are to be prepared for each installation, and submitted for approval. Designs should comply with the guidance in *A Bristolians' Guide to Solid Wall Insulation* (Bristol City Council 2015), as endorsed by the Department of Energy and Climate Change (DECC, now the Department or Business, Energy Innovation and Skills) and the Sustainable Traditional Buildings Alliance (STBA).

The requirements for all designs are:

- All suitable walls are to be insulated to achieve a thermal transmittance (U value) of approximately 0.60 W/m^2K*, with maximum insulation thickness of 60 mm. U values are to be calculated in accordance with BS EN ISO 6946: 2007 and BRE report BR443, and copies of the U value calculations are to be supplied.
- Only vapour permeable ('moisture open') insulation materials, adhesives and finishes may be used. These materials are compatible with traditionally-constructed buildings and have greater capacity for moisture absorbance and drying than moisture closed, impermeable systems, thus reducing the risk of interstitial condensation and mould growth.

* This is consistent with the guidance in Building Regulations Approved Document L1B (2013), because significant technical risk is associated with greater thicknesses of IWI installed in existing dwellings to achieve lower U values such as 0.30 W/m^2K.

- The insulation layer is to consist of wood fibre board with an integral mineral layer to help control moisture. The insulation system should comprise: a minimum 5 mm thick layer of absorbent lime plaster applied to the prepared existing wall; an insulation layer of tongued-and-grooved wood fibre board with an integral mineral layer; 60 mm wide sealing tape for external corners, joints and edges; and an internal finishing layer of gypsum plasterboard. The system is to be installed strictly in accordance with the supplier's instructions and recommendations.
- In locations where the thickness of the insulation is limited (e.g. window and door cills, soffits and reveals, or beside narrow stairways) high performance vapour permeable insulation (e.g. plasterboard-faced aerogel board) should be used.
- All IWI must be continuous (to eliminate thermal bridging) and air-tight (to eliminate the possibility of warm moist air getting behind the insulation layer, causing condensation and mould growth). *These requirements are critical and must be given detailed attention in the design*.
- In order to minimise thermal bridging, the IWI must connect to or overlap with the existing (or future) roof insulation at eaves, gables and verges, as appropriate. Connection of the two insulation elements (or provision for connection) is preferred, but if connection is not practical an overlap of at least 400 mm is required.
- In order to minimise thermal bridging, the IWI must connect with the existing (or future) ground floor insulation.
- At junctions of the insulated external wall with party walls or with internal masonry partitions, in order to minimise thermal bridging, the IWI must be returned along party walls and along both sides of internal masonry partitions for a distance of at least 400 mm.
- At intermediate floors, the wall adjacent to the floor void is to be made airtight with a minimum 5 mm layer of absorbent lime plaster, then insulated between the joists with maximum 60 mm thick wood fibre board (of the same specification as used on the main parts of the external walls) cut to fit tightly between the joists and sealed to them with expanding tape.
- Where the existing windows and external doors are to be replaced, this work to be carried at out at the same time as the IWI installation, and the Contractors will be required to cooperate.
- The insulation applied to window and external door cills, reveals and soffits should overlap the new or existing window frames by at least 10 mm (subject to there being sufficient clearance for window opening).
- As part of the installation process, electric power sockets and switches, and radiators located on the external wall, should all be re-located on to adjacent internal or party walls, as far as possible, in order to maintain the integrity of the air barrier. Where this is not possible, fixings through the IWI (e.g. for radiator brackets) are to be through timber blocks placed in the insulation layer, and pipework must run only on the warm side of the insulation, not through it. Wiring penetrations are to be minimised, and are to be sealed with mastic at the back of the backbox; metal backboxes are to be replaced with plastic ones.

The drawings and specification must include:

- The type of IWI system to be used. Only systems certified by the British Board of Agrément (BBA) as suitable for use as internal solid wall insulation are acceptable, and a copy of the BBA certificate for every proposed system is to be supplied.
- Confirmation that the proposed IWI system includes only vapour permeable materials.
- Details of how the IWI will connect with or overlap existing or future roof insulation at eaves and verges.

- Details of how the IWI will connect or overlap with existing or future floor insulation.
- Details of the insulation of external walls adjacent to intermediate floor voids.
- Details of how the windows will be dealt with, and how the IWI will be configured around door and window openings (including soffits, reveals and cills).
- Details of how architectural features i.e. coving, picture rails, dado rails, etc., will be treated.
- Details of how services such as electricity, TV, telephone and broadband cables power outlet sockets and switches, electricity and gas meters, lights, etc., will be dealt with.
- Details of kitchen and bathroom fittings, fitted furniture, shelving, etc. that will be affected by the installation of IWI will be treated, including arrangements for their removal, modification (if necessary), reinstatement and making good.

Installation of Internal Wall Insulation

Installation of IWI must be carried out by an Installer trained and approved by the holder of the BBA certificate for the IWI system. The Installer must:

- undertake to comply with the installation procedures specified by the holder of the BBA certificate; and
- employ operatives trained and approved by the holder of the BBA certificate, working in teams each containing a foreman and at least one in three operatives trained by the holder of the BBA certificate;
- be subject to at least one inspection per year (including unannounced inspections) by the holder of the BBA certificate to confirm that suitable site practices are being employed.

IWI installations are to be strictly in accordance with the submitted and approved designs, and with the suppliers' instructions and recommendations.

The installation process is to consist of:

1 Liaison with residents to secure the temporary removal of furniture and other possessions from the rooms in which installation work will be carried out (and subsequent replacement after the installation has been completed).

2 Preparatory work, including:
   - the removal and safe storage of fixtures and fittings that will be affected by the installation (including kitchen and bathroom fittings, fitted furniture, shelving, coving, picture rails, dado rails, skirting boards, etc.);
   - the removal of any existing wallpaper and any oil-based paint finishes;
   - lifting of floorboards to facilitate the insulation of intermediate floor voids.

3 Installation of the internal wall insulation system in accordance with the approved design.

4 Decoration of the new internal wall surfaces, and making-good of any adjacent decorations damaged during the course of the work.

5 Replacement of floor boards, and modification (if necessary), reinstatement, re-finishing and making-good of fixtures and fittings affected by the installation.

Provision of Guarantee

Within thirty days of the completion of each installation, the Contractor is to provide a guarantee certificate issued by a recognised guarantee agency for each dwelling that has been insulated. The guarantee is to be valid for twenty-five years from the date of

installation, and each certificate is to include the full address of the dwelling to which it applies.
The Contractor is also to provide a copy of the supplier's ten-year product warranty for the IWI system, and a list of the dwellings (including full addresses) to which it applies.

Core Specification D: Loft Insulation in Roofs with Access Issues

Introduction

Where dwellings are identified for the installation of loft insulation, but where access to the loft space is limited, the Contractor or Installer is to:

1 Provide access to the loft space

2 Carry out a pre-installation assessment.

3 Define and agree the scope of work required to insulate the loft properly.

4 Install loft insulation in accordance with the agreed scope of work.

Provision of Access

Before conducting the pre-installation assessment and installation, access must be provided to the loft space:

- Assess the dwelling to confirm that there are lofts beneath pitched roofs to which there is no access, and that it is feasible to install one or more access hatches in safe positions for ladder access, above which there will be sufficient headroom for the installation of insulation.
- Clear or protect the existing finishes, fittings, furnishings, etc. from beneath the selected locations for the installation of loft hatches.
- Remove the ceiling linings to expose the ceiling joists and check the direction of span and the size of the joists to ensure that they are capable of carrying the extra weight of insulation.
- Prop the ceiling structure to ensure its stability, then cut through the existing ceiling joists to create openings formed on two sides by existing joists and on the other two sides by new timber trimmers. Do not cut the ties of timber trusses or trussed rafters.
- Install proprietary loft hatches, each at least 600 mm x 450 mm and complete with a frame and an insulated and draught-stripped hatch cover incorporating a catch that compresses the draught-stripping on all four sides of the hatch when closed.
- Make the ceiling lining and decorations good around the new loft hatch(es), and replace the fittings, finishes, furniture, etc.

Pre-Installation Assessment

The pre-installation assessment is to be carried out by an assessor trained and approved by the Contractor. The purpose of the assessment is:

- to confirm the type of roof construction (including whether there are trusses or trussed rafters);
- to establish the type, thickness, location and extent of any existing insulation;
- to identify any services located in the loft (e.g. water tanks, ventilation equipment, solar PV installations, wiring, lighting);
- to establish how the loft is ventilated;
- to assess the severity of any condensation (and associated mould or rot);
- to identify any access constraints;

- to determine whether the loft hatch is insulated and/or draught-stripped; and
- to assess whether residents' property needs to be cleared before loft insulation can be installed.

A written proforma report of every assessment is to be supplied.

Lofts with the following characteristics should be recorded as not suitable for the installation of loft insulation in accordance with this specification:

- Lofts with at least 300 mm thickness of existing mineral wool quilt insulation (or the equivalent thickness of another insulation material) laid between and over the ceiling joists over the whole loft area, without gaps and in good condition.
- Lofts which are insulated in the plane of the pitched roof (i.e. between and over or between and under the rafters) and which are therefore 'warm lofts'.
- Lofts in which there is evidence of condensation, mould growth or timber rot.
- Lofts in which there is inadequate provision for ventilation by outside air (i.e. eaves ventilation and or tile ventilators, ridge ventilators or air-bricks in gable walls) and work is required to improve the ventilation as described below.

Scope of Work

The scope of work to be carried out is to be defined separately for each dwelling, subject to the following requirements:

- All suitable lofts are to be insulated to achieve a maximum thermal transmittance (U value) of 0.16 W/m^{2}K, or with at least 300 mm thickness of mineral fibre quilt (placed between and over the ceiling joists), or with the thermally equivalent thickness of another insulation material.
- Assess the dwelling to confirm that there are lofts beneath pitched roofs to which there is no access, and that it is feasible to install one or more access hatches in safe positions for ladder access, above which there will be sufficient headroom for the installation of insulation.
- Clear or protect the existing finishes, fittings, furnishings, etc. from beneath the selected locations for the installation of loft hatches.
- Remove the ceiling linings to expose the ceiling joists and check the direction of span and the size of the joists to ensure that they are capable of carrying the extra weight of insulation.
- Prop the ceiling structure to ensure its stability, then cut through the existing ceiling joists to create openings formed on two sides by existing joists and on the other two sides by new timber trimmers. Do not cut the ties of timber trusses or trussed rafters.
- If loose-fill insulation is to be used, build plywood bulkheads around all sides of the hatch openings, to prevent the insulation material falling through the openings.
- Install proprietary loft hatches, each at least 600 mm x 450 mm and complete with a frame and an insulated and draught-stripped hatch cover incorporating a catch that compresses the draught-stripping on all four sides of the hatch when closed.
- Make the ceiling lining and decorations good around the new loft hatch(es), and replace the fittings, finishes, furniture, etc.
- Apply Core Specification D *Loft Insulation* or Core Specification F *Pitched Roof Insulation (from below)*, as appropriate. Where there is existing insulation in poor condition (i.e. disturbed, damaged or not covering the whole of the loft area) it is to be removed and replaced with new insulation to achieve the required standard.

- Where there is existing insulation in good condition additional insulation is to be added in order to bring thermal performance of the construction up to the required thermal standard.
- Where the roof structure consists of simple rafters (possibly supported on purlins), new insulation is to consist of mineral fibre quilt in two layers, placed between the ceiling joists (to the full depth of the joists) and over the ceiling joists (at right angles to the direction of span) to achieve the required thermal standard or minimum thickness, and covering the whole of the loft area.
- Where the roof structure consists of timber trusses or trussed rafters with ties connected the ceiling joists, new insulation is to be a loose material (e.g. vermiculite or cellulose fibre) blown into place to cover the whole of the ceiling area, and of sufficient thickness to cover the ceiling joists and achieve the required thermal standard.
- The insulated loft space must be adequately ventilated in accordance with the guidance in the BRE guide *Thermal insulation: avoiding risks*[14]: existing eaves ventilation equivalent to a continuous 25 mm wide gap is to be maintained on two opposite sides of the loft, and not blocked by new insulation material (install proprietary plastic ventilation trays if necessary); existing tile ventilators, ridge ventilators and air-bricks are to be inspected and cleared if necessary.
- Where the loft space cannot be cross-ventilated (i.e. from one side to the other at eaves level) new tile ventilators or ridge ventilators are to be installed to facilitate adequate cross ventilation equivalent to that provided by a continuous 25 mm wide gap at eaves level.
- Insulation material is to be placed in such a way that cold air (from outside or from inside the loft) cannot penetrate to the warm side of the insulation through gaps, joints between rolls of material, beside timber joists, at party-wall junctions or at the eaves.
- Where water tanks are located in the loft, insulation is not to be placed beneath them (and blown insulation is to be excluded from beneath them); the sides and tops of tanks, and all associated pipework, are to be carefully insulated with an appropriate closely-fitted insulating material which connects with the loft insulation, in accordance with the guidance in the BRE Guide *Thermal insulation: avoiding risks* (mineral wool quilt should be turned up the sides of the tanks to make the connection).
- Electrical wiring running in the loft space must not be buried beneath insulation; it must be disconnected, realigned to run on the cold side of the insulation, reconnected and tested; points where wiring penetrates through the insulation layer are to be carefully sealed to eliminate air leakage.
- Recessed lighting fittings located in the ceiling (serving the rooms below) are to be boxed in plywood with 50 mm clear space all around each fitting, to separate them from the overlaid insulation.
- Where residents have stored property in the loft space, provide a timber platform above the insulation, supported by legs or blocks fixed to the joists below (a proprietary platform product may be used); the platform should be at least 6 m^2 in area and located adjacent to the loft hatch.

[14] STIRLING C (2002) *Thermal Insulation: avoiding risks* BRE report BR262, ISBN 1-86081-515-4, BRE, Watford. See http://www.brebookshop.com/details.jsp?id=556

- Where blown insulation material is used, construct a plywood bulkhead around the loft hatch opening to contain the insulation material and prevent it from falling through the hatch.
- Where the loft hatch is not already insulated, fix rigid foam insulation to the top of the hatch, of a thickness sufficient to provide thermal performance equivalent to that of the adjacent loft insulation (approximately 150 mm thick).
- Where the loft hatch is not already draught-proofed, install draught-proofing and ensure that the hatch has a catch that forces the hatch to compress the seal when it is closed.

Introduction

Where dwellings are identified for the installation of flat roof insulation, the Contractor or Installer is to:

- Carry out a pre-installation assessment.
- Define and agree the scope of work required to insulate the roof properly.
- Install flat roof insulation in accordance with the agreed scope of work.

Pre-Installation Assessment

The pre-installation assessment is to be carried out by an assessor trained and approved by the Contractor. The purpose of the assessment is:

- to confirm the type of roof construction and finish;
- to establish the type, thickness, location and extent of any existing insulation, and whether it is a 'warm roof' (insulation above the deck) or a 'cold roof' (insulation below the deck), as far as possible;
- to identify any services penetrating the roof (e.g. soil and vent pipes, extract fan terminals, etc.).
- to assess the severity of any internal condensation (and associated mould or rot) beneath the roof or within the roof structure;
- to identify any access constraints, e.g. height, boundaries, etc.

A written proforma report of every assessment is to be supplied.

Roofs with the following characteristics should be recorded as not suitable for the installation of flat roof insulation in accordance with this specification:

- Roofs already insulated with at least 100 mm thickness of expanded polystyrene (EPS) insulation (or the equivalent thickness of another insulation material) laid over the whole roof area, without gaps and in good condition.
- Roofs in which there is evidence of condensation, mould growth or timber rot (these defects must be repaired before insulation is installed).

Scope of Work

The scope of work to be carried out is to be defined separately for each dwelling, subject to the following requirements:

- All suitable roofs are to be insulated to achieve a maximum thermal transmittance (U value) of 0.18 W/m^{2}K, using rigid insulation boards (expanded polystyrene, polyisocyanurate, phenolic foam or polyurethane) installed above the roof deck to form a 'warm roof' or 'warm sandwich deck' construction, all in accordance with the guidance in the BRE publication *Thermal Insulation: avoiding risks*[15].
- Remove the existing flat roof finish, including all associated flashings, etc., and ensure that the exposed roof deck is clean, dry and smooth, and is protected from weather. Lay a suitable vapour control layer directly on to the exposed roof deck. Bond the insulation on top of the vapour control layer, and ensure that there are no gaps

[15] STIRLING C (2002) *Thermal Insulation: avoiding risks* BRE report BR262, ISBN 1-86081-515-4, BRE, Watford. See http://www.brebookshop.com/details.jsp?id=556

between boards or at the edges of the roof (use tongued and grooved insulation boards if possible). Turn the edges of the vapour control layer up at the edges of the insulation layer and back over the insulation board a distance of at least 200 mm, all around the perimeter of the roof. Lay a new waterproof roof finish (complete with solar reflective topping) on top of the insulation board and bond it to the turned-back vapour control layer around the whole perimeter of the roof. Re-install all necessary flashings, etc., using cut pieces of insulation board where fillets are required at upstands, and make good.

- Test the newly insulated roof to ensure that it is watertight.
- Insulation material is to be installed in such a way that cold external air cannot penetrate to the warm side of the insulation through gaps, at the edges of the roof, or at abutments or upstands for service penetrations.
- Where a roof includes existing insulation in poor condition (i.e. disturbed, damaged or not covering the whole of the roof area) it is to be removed and replaced with new insulation (as described above) to achieve the required standard.
- Where there is existing insulation in good condition but of inadequate thickness to achieve the required U value, additional insulation is to be added (as described above) in order to bring the thermal performance of the construction up to the required standard.

Introduction

Where dwellings are identified for the installation of pitched roof insulation inserted from below, the Contractor or Installer is to:

- Carry out a pre-installation assessment.
- Define and agree the scope of work required to insulate the roof properly.
- Install pitched roof insulation in accordance with the agreed scope of work.

Pre-Installation Assessment

The pre-installation assessment is to be carried out by an assessor trained and approved by the Contractor. The purpose of the assessment is:

- to confirm the type of roof construction and finish, and its state of repair;
- to establish the type, thickness, location and extent of any existing insulation, and whether the weatherproof membrane (beneath the slate or tiles and battens) is vapour permeable (i.e. whether it is a 'breather' membrane) or not[16];
- to identify any services penetrating the roof (e.g. soil and vent pipes, extract fan terminals, etc.).
- to assess the severity of any internal condensation (and associated mould or rot) beneath the roof or within the roof structure;
- to identify any access constraints, e.g. height, boundaries, etc.

A written proforma report of every assessment is to be supplied.

Roofs with the following characteristics should be recorded as <u>not</u> suitable for the installation of pitched roof insulation in accordance with this specification:

- Roofs already insulated with at least 150 mm thick expanded polystyrene (EPS) insulation (or the equivalent thickness of another insulation material) covering the whole of the pitched roof area, without gaps and in good condition.
- Roofs in which there is evidence of condensation, mould growth or timber rot or where the slate or tile finish or the waterproof membrane are damaged (these defects must be repaired before insulation is installed).

Scope of Work

The scope of work to be carried out is to be defined separately for each dwelling, subject to the following requirements:

- All suitable roofs are to be insulated to achieve a maximum thermal transmittance (U value) of 0.18 W/m^{2}K, using rigid insulation boards (expanded polystyrene, polyisocyanurate, phenolic foam or polyurethane) installed between and under the rafters, all in accordance with the guidance in the BRE publication *Thermal Insulation: avoiding risks*[17].

[16] Vapour permeable 'breather' membranes are usually identifiable from printed branding (e.g. 'Tyvek')

[17] STIRLING C (2002) *Thermal Insulation: avoiding risks* BRE report BR262, ISBN 1-86081-515-4, BRE, Watford. See http://www.brebookshop.com/details.jsp?id=556

- For roofs with non-vapour permeable weatherproof membranes (e.g. roofing felt), remove any internal linings. Repair any damage to the weatherproof membrane. Fix 50 mm timber battens to both sides of all the rafters, aligned with the top edges of the rafters. Install rigid insulation boards (as described above) cut to fit tightly between the rafters to the remaining depth of the rafters, whilst maintaining a 50 mm wide ventilation gap above the insulation (between the battens) between each pair of rafters. Seal the joints between the insulation and rafters with expanding polyurethane (PU) foam. Ensure that all the ventilation gaps are open at the eaves on both sides of the roof, or if cross ventilation is not possible install ridge ventilators. Install an additional layer of insulation, at least 25 mm thick, beneath the rafters. Fix a polythene vapour barrier beneath the insulation (i.e. on the warm side), and ensure that all edges and joints in the barrier are lapped at least 150 mm and sealed with tape. Seal the vapour barrier around any service penetrations. Re-fix the linings, if necessary, and make good. Test the newly insulated roof to ensure that it is still watertight.
- Alternatively, for roofs with vapour permeable weatherproof membranes (i.e. 'breather' membranes), remove any internal linings. Repair any damage to the weatherproof membrane. Install rigid insulation boards (as described above) of thickness to match the depth of the rafters and cut to fit tightly between the rafters (with no ventilation gap above the insulation). Seal the joints between the insulation and rafters with expanding polyurethane (PU) foam. Install an additional layer of insulation, at least 25 mm thick, beneath the rafters. Fix a polythene vapour barrier beneath the insulation (i.e. on the warm side), and ensure that all edges and joints in the barrier are lapped at least 150 mm and sealed with tape. Seal the vapour barrier around any service penetrations. Re-fix the linings, if necessary, and make good. Test the newly insulated roof to ensure that it is still watertight.
- In both cases, insulation material is to be installed in such a way that cold external air cannot penetrate to the warm side of the insulation through gaps, at the edges of the roof, or at abutments or service penetrations.
- Where a roof includes existing insulation in poor condition (i.e. disturbed, damaged or not covering the whole of the roof area) it is to be removed and replaced with new insulation (as described above) to achieve the required standard.
- Where there is existing insulation in good condition but of inadequate thickness to achieve the required U value, additional insulation is to be added (as described above) in order to bring the thermal performance of the construction up to the required standard.

Introduction

Where dwellings are identified for the installation of pitched roof insulation inserted from above, the Contractor or Installer is to:

- Carry out a pre-installation assessment.
- Define and agree the scope of work required to insulate the roof properly.
- Install pitched roof insulation in accordance with the agreed scope of work.

Pre-Installation Assessment

The pre-installation assessment is to be carried out by an assessor trained and approved by the Contractor. The purpose of the assessment is:

- to confirm the type of roof construction and finish, and its state of repair;
- to establish the type, thickness, location and extent of any existing insulation, and whether the weatherproof membrane (beneath the slate or tiles and battens) is vapour permeable (i.e. whether it is a 'breather' membrane) or not[18];
- to identify any services penetrating the roof (e.g. soil and vent pipes, extract fan terminals, etc.).
- to assess the severity of any internal condensation (and associated mould or rot) beneath the roof or within the roof structure;
- to identify any access constraints, e.g. height, boundaries, etc.

A written proforma report of every assessment is to be supplied.

Roofs with the following characteristics should be recorded as <u>not</u> suitable for the installation of pitched roof insulation in accordance with this specification:

- Roofs already insulated with at least 150 mm thick expanded polystyrene (EPS) insulation (or the equivalent thickness of another insulation material) covering the whole of the pitched roof area, without gaps and in good condition.
- Roofs in which there is evidence of condensation, mould growth or timber rot (these defects must be repaired before insulation is installed).

Scope of Work

The scope of work to be carried out is to be defined separately for each dwelling, subject to the following requirements:

- All suitable roofs are to be insulated to achieve a maximum thermal transmittance (U value) of 0.18 W/m^{2}K, using rigid insulation boards (expanded polystyrene, polyisocyanurate, phenolic foam or polyurethane) installed between and under the rafters, all in accordance with the guidance in the BRE publication *Thermal Insulation: avoiding risks*[19].
- Remove the tile or slate coverings, flashings, rainwater goods, etc., the tiling battens and the weatherproof membrane to expose the rafters and the loft space, or the

[18] Vapour permeable 'breather' membranes are usually identifiable from printed branding (e.g. 'Tyvek')

[19] STIRLING C (2002) *Thermal Insulation: avoiding risks* BRE report BR262, ISBN 1-86081-515-4, BRE, Watford. See http://www.brebookshop.com/details.jsp?id=556

upper surface of any internal lining. Cut and notch the insulation boards to half the thickness of the rafters, so that they fit tightly between and over the rafters, with at least 50 mm thickness of insulation over the rafters. Seal the joints between the insulation boards, and all service penetrations, with expanding polyurethane (PU) foam. Secure the insulation in place with pressure impregnated timber counter-battens of the same thickness as the rafters, fixed above the insulation along the lines of the rafters so that the insulation is held tightly against the tops of the rafters. If the existing weatherproof membrane is vapour permeable, repair any damage and re-fix the membrane over the counter battens. If the existing weatherproof membrane is not vapour permeable discard it and fix a new vapour permeable weatherproof membrane over the counter battens. Replace any damaged tiling battens, and re-fix them. Replace any damaged slates or tiles, and re-fix them. Make-good all roof flashings, rainwater goods, service penetrations, etc. Test the newly insulated roof to ensure that it is watertight.

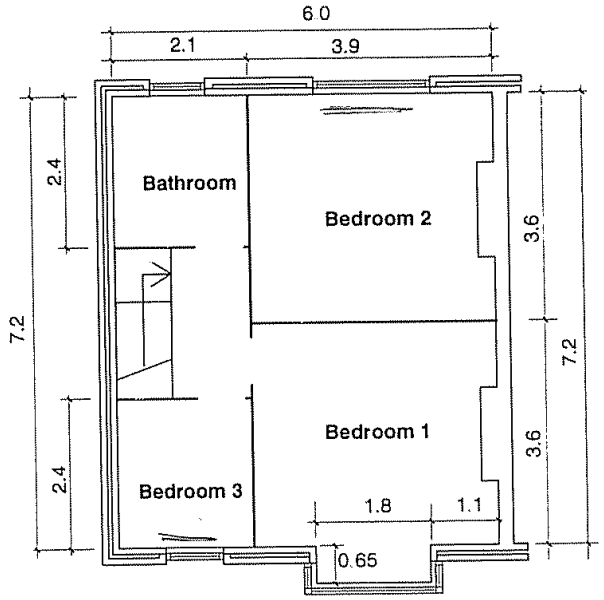
- In both cases, insulation material is to be installed in such a way that cold external air cannot penetrate to the warm side of the insulation through gaps, at the edges of the roof, or at abutments or service penetrations.
- Where a roof includes existing insulation of inadequate thickness to achieve the required U value, regardless of its condition, it is to be removed and replaced with new insulation (as described above) to achieve the required standard.
- The roof and all its components, and the dwelling beneath, are to be protected from weather (especially water penetration and wind) during the work.

Drawings

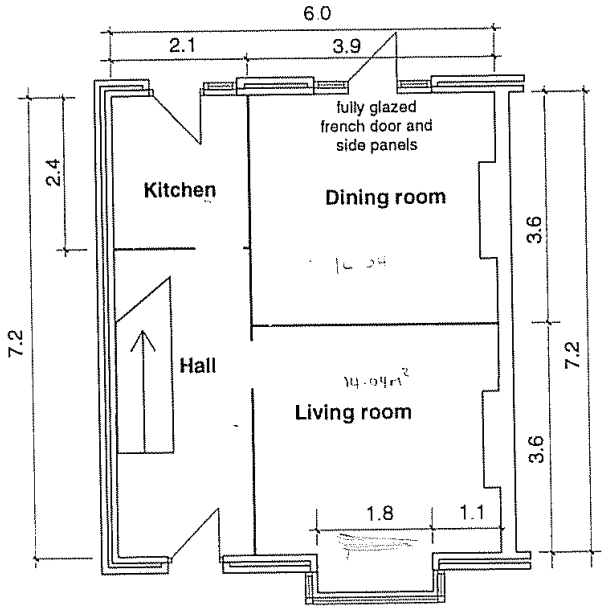
A: SEMI DETACHED HOUSE

	Area (m^2)	Storey height (m)
Ground floor	44.4	2.4
First Floor	44.4	2.6
Windows	16.9	
Doors	3.8	
External walls (excluding doors / windows)	81.8	
External walls (including doors / windows)	102.5	
Perimeter	20.5 m	

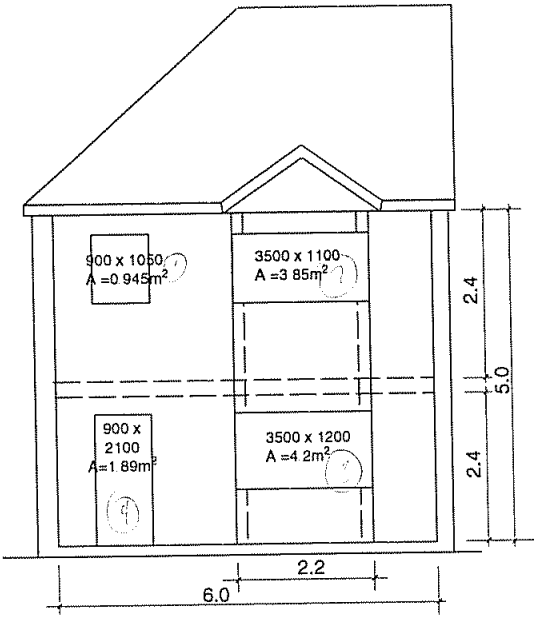
First floor



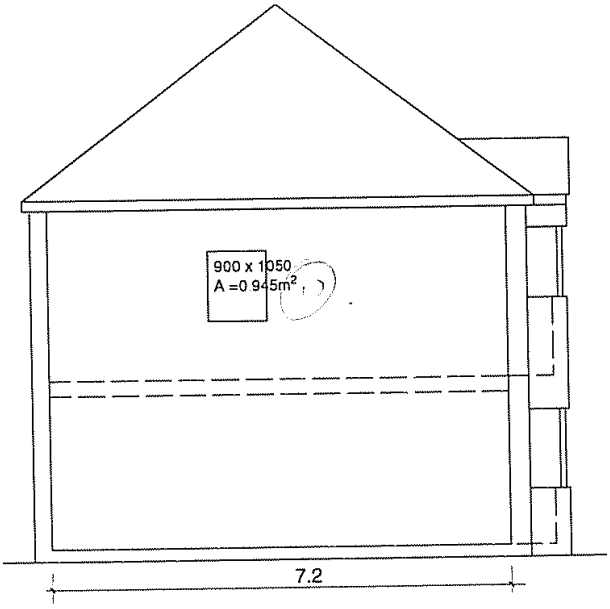
Ground floor



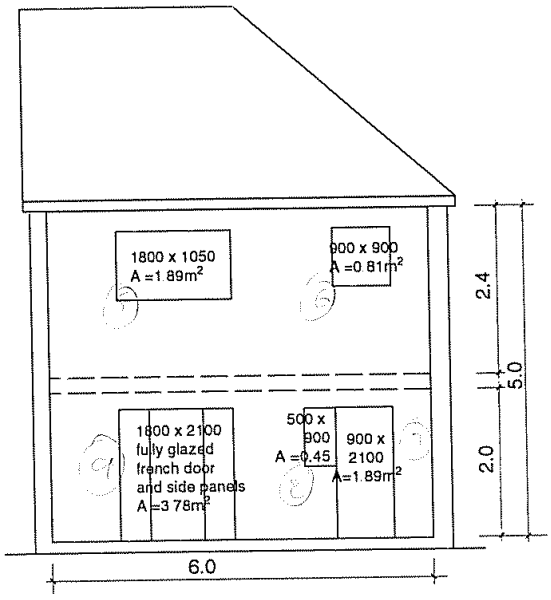
Front Wall



Side Wall



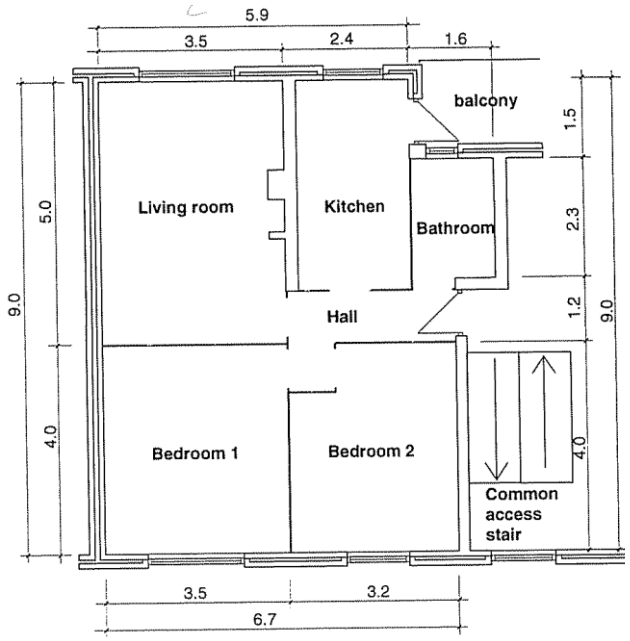
Rear Wall



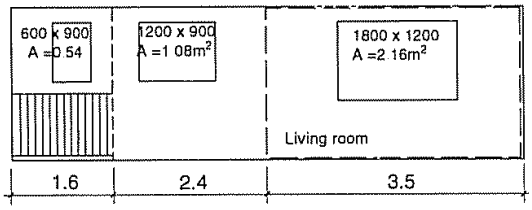
B: FLAT

	Area (m^2)	Storey height (m)
Ground floor	60.9	2.4
Windows	6.9	
Doors	1.9	
External walls (excluding doors / windows)	28.9	
External walls (including doors / windows)	19.9	
Perimeter	15.7 m	
The flat is positioned on the 5th storey of a 7 storey building		

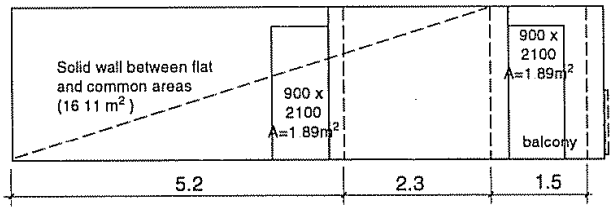
Floor



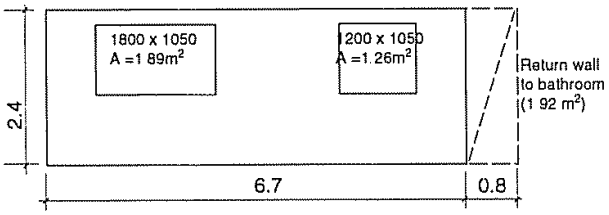
Rear wall



Wall at entrance to flat

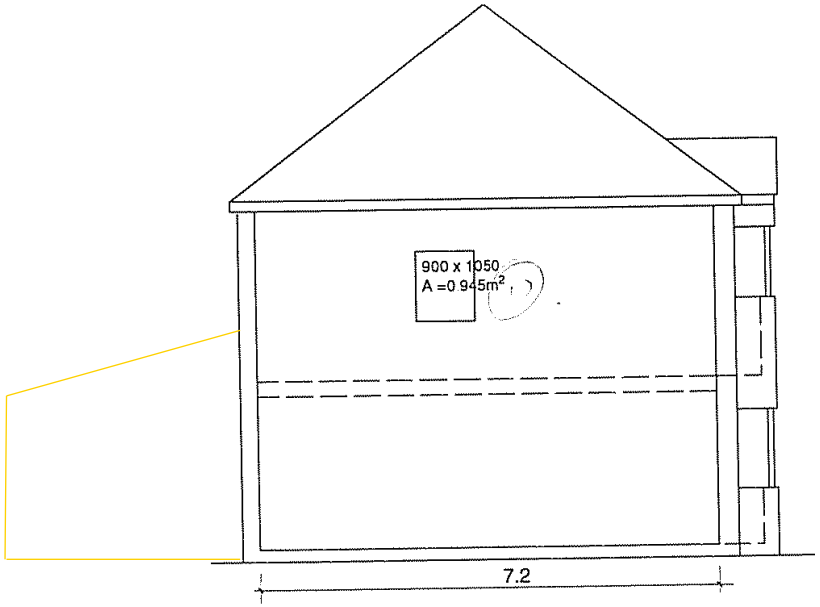


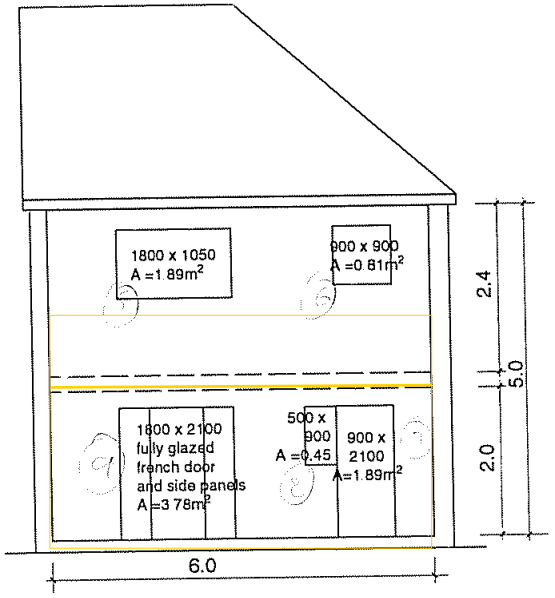
Front wall



C: HOUSE WITH CONSERVATORY

Dimensions are the same as the semi-detached house

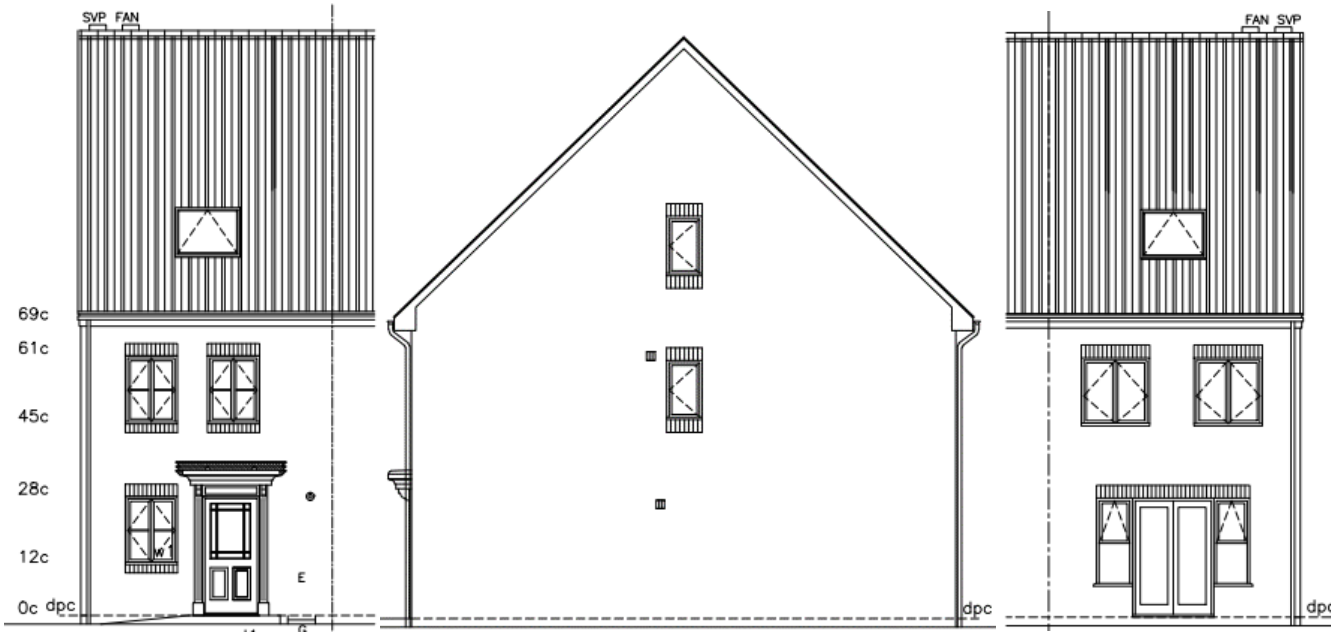




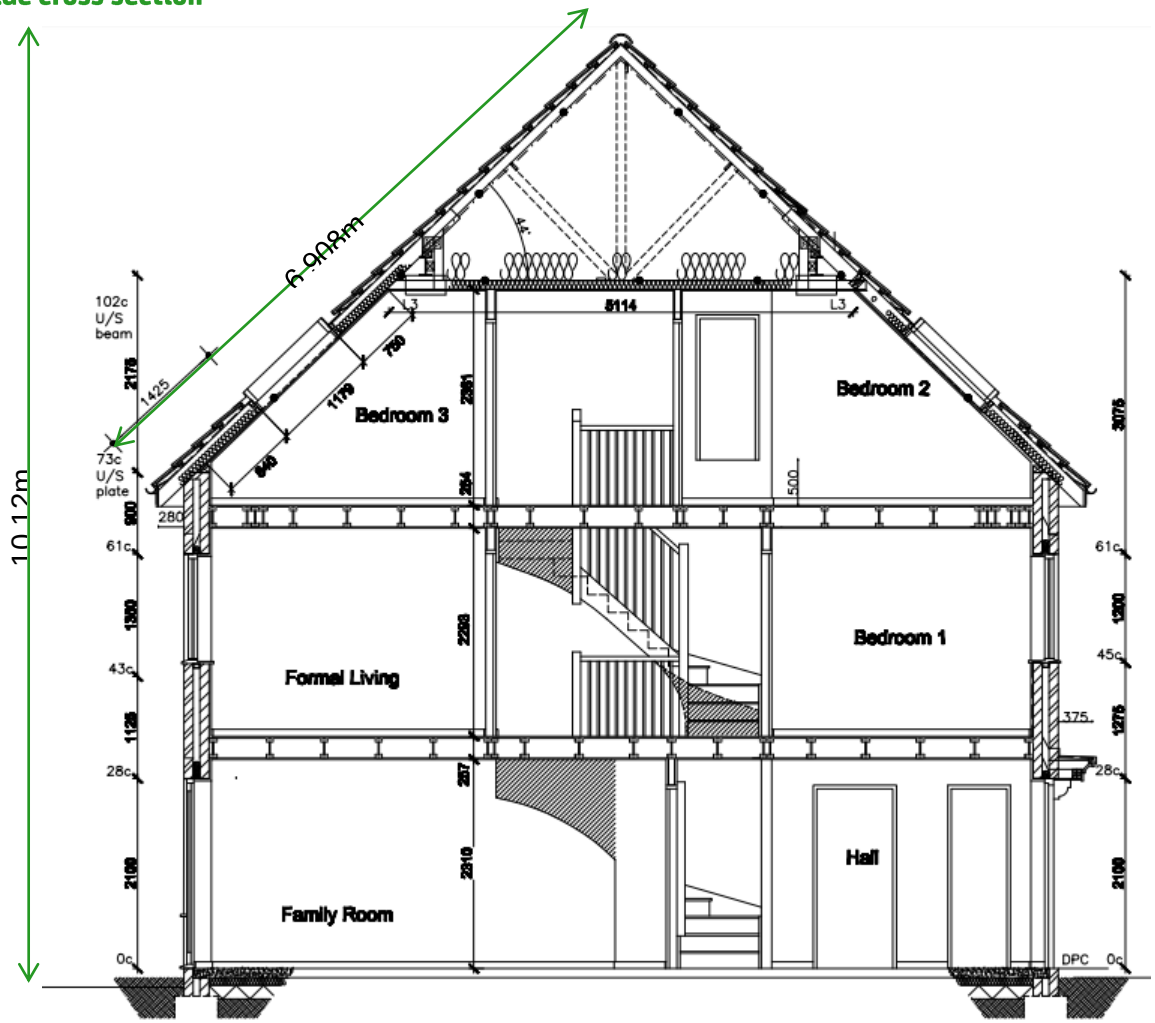
D: End-terrace with room in roof

	Area (m^2)	Storey height (m)
Ground floor	44.12	2.57
First floor	44.12	2.55
Second floor	44.12	2.38
Unheated ceiling void	20.46	2.62
Roof area including roof windows	14.82	
Roof area excluding roof windows	12.13	
Dormer window dimensions	1.14m x 1.18m (x2)	

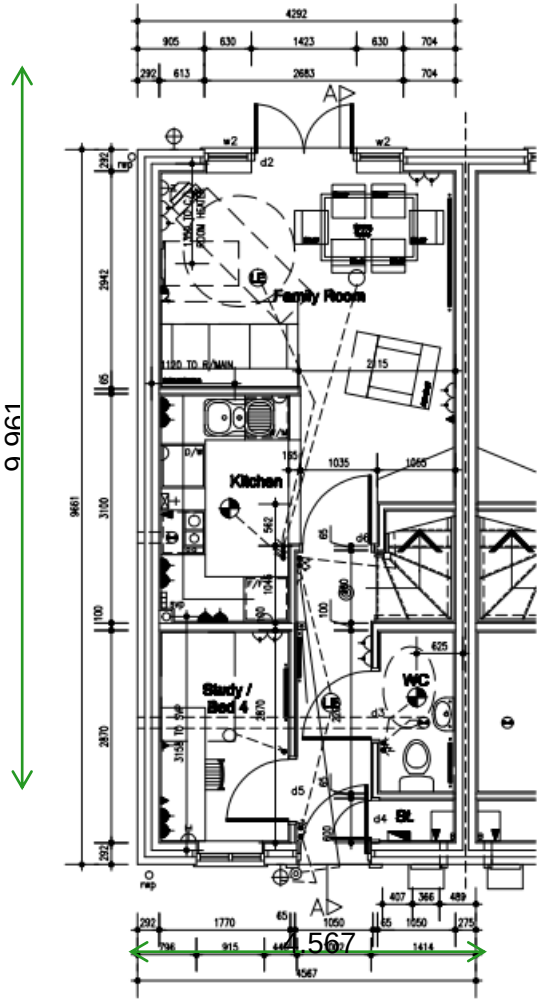
Front view **Side view** **Rear view**



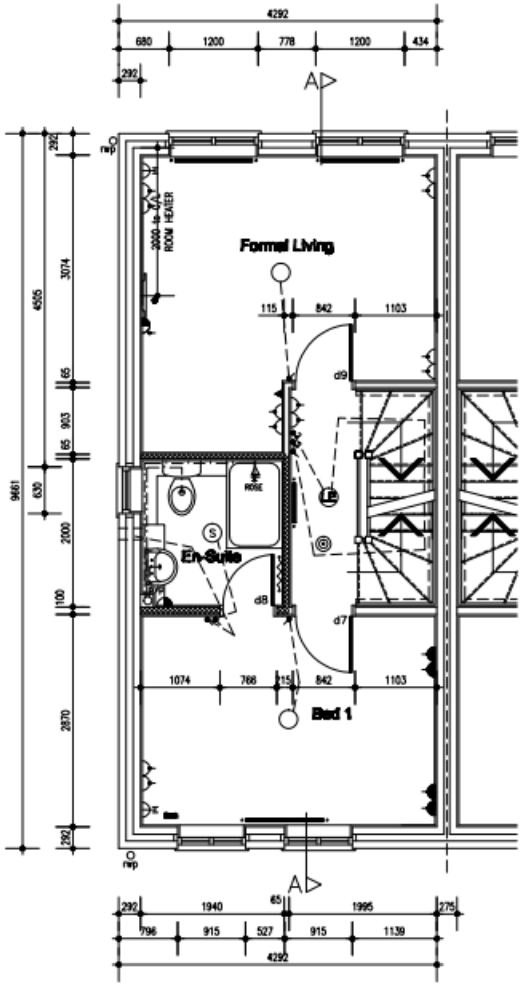
Side cross section



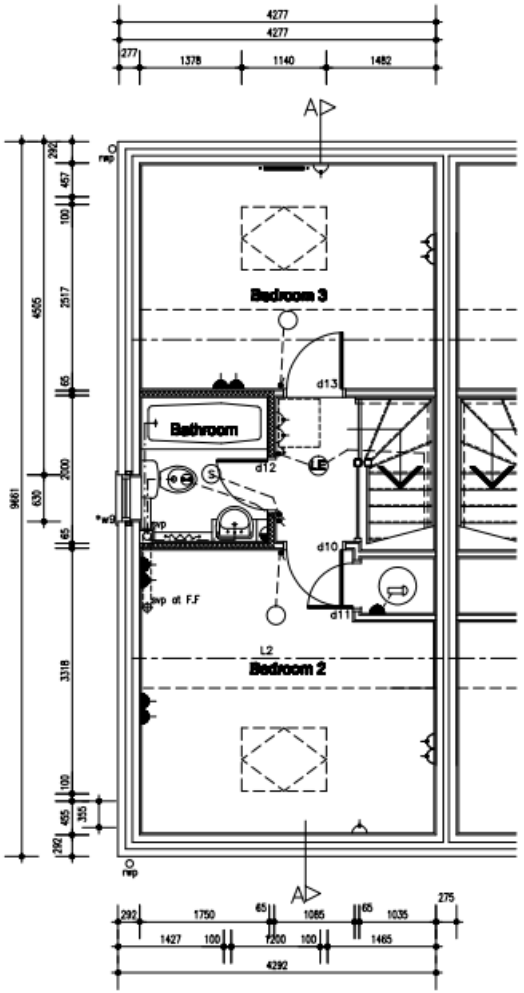
Ground floor



First floor



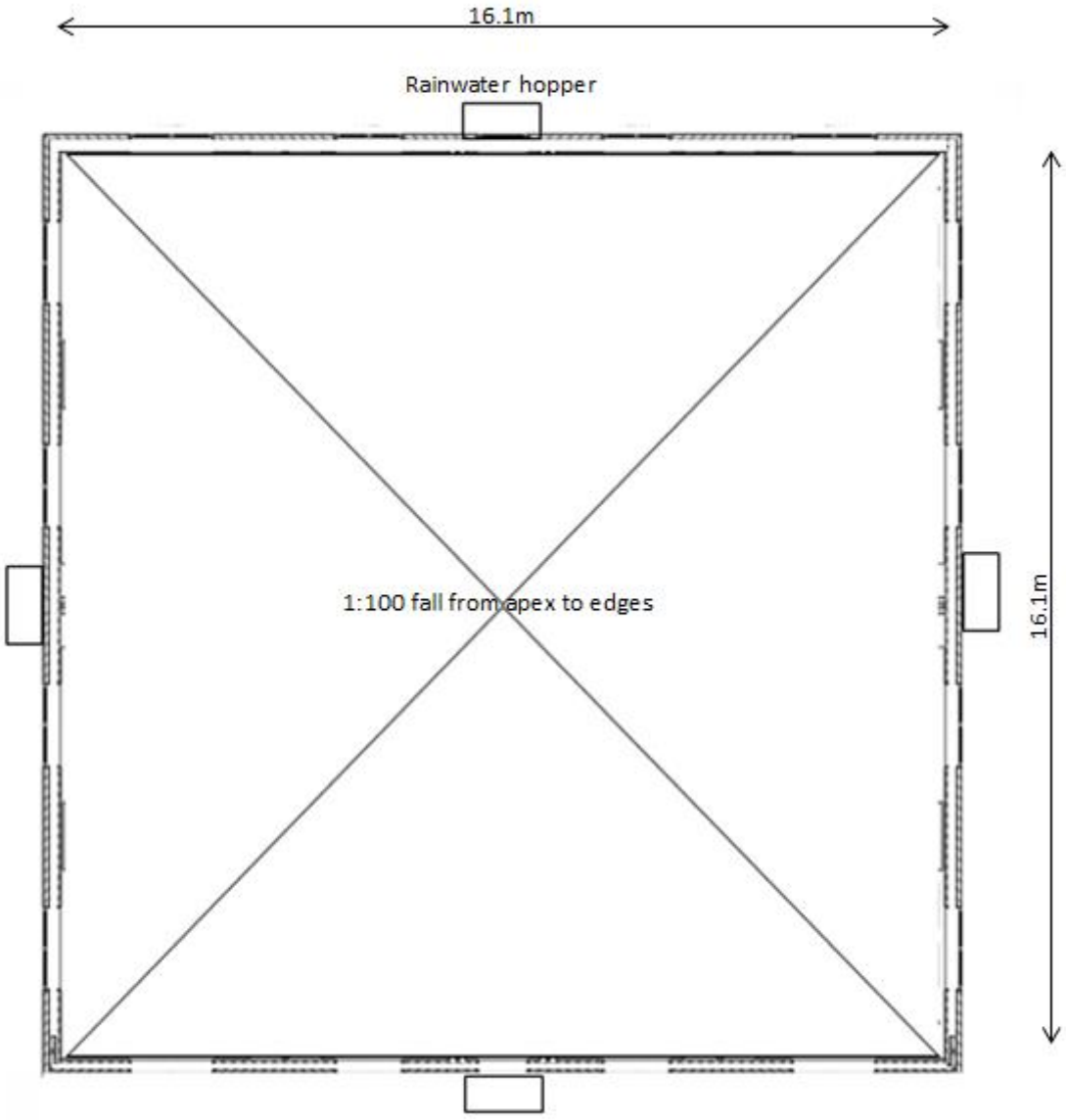
Second floor



E: Low rise block with flat roof

Roof area	259.21 m^2
Parapet height	450mm
Roof incline	1:100 from apex to edges
Roof height	12m

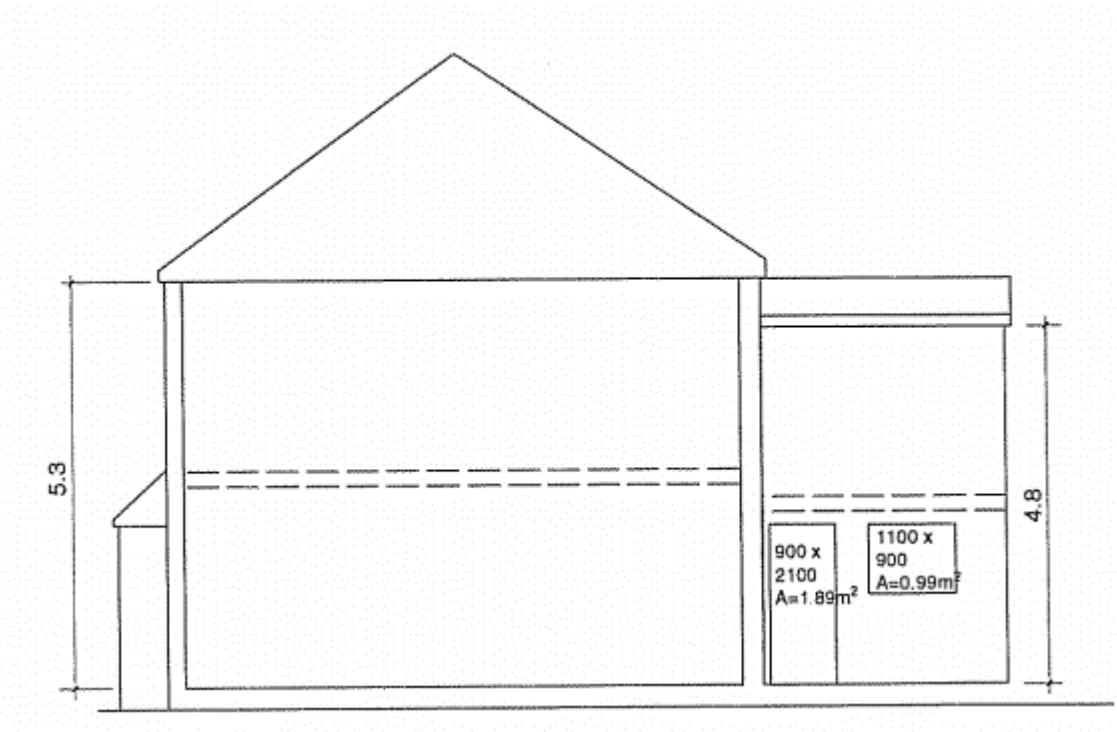
View of roof



F: Period mid terrace with flat-roofed extension

Flat Roof area	9.12m^2
Flat Roof height	4.8 m^2

Side view



Ground floor