housewarming

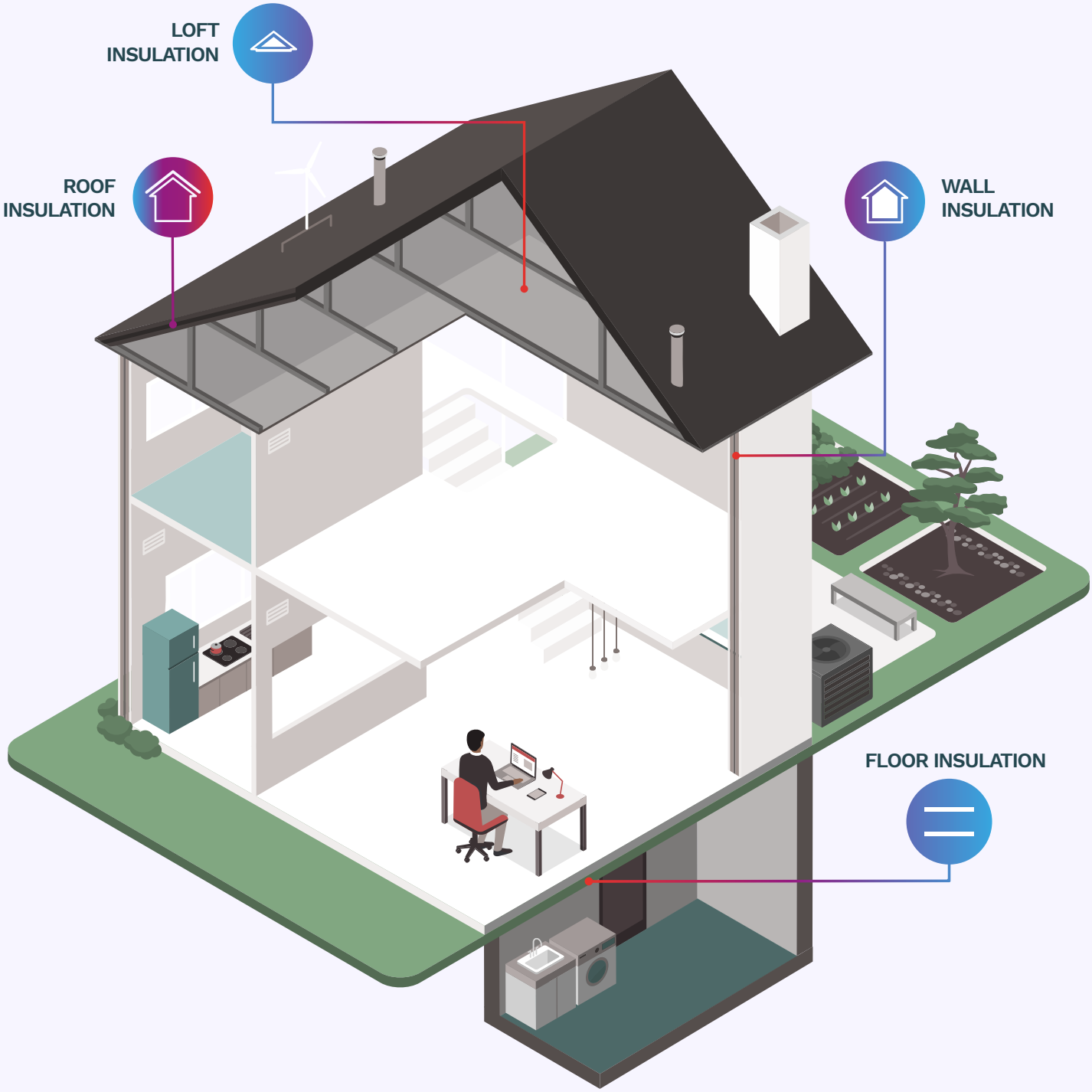
Guides

Insulation

Low Carbon Oxford North

housewarming

Wall, Floor and Roof Insulation



Low Carbon Oxford North

CONTENTS

WELCOME TO OUR SECOND HOUSEWARMING GUIDE

Welcome to the second in the series of Housewarming guides created by Low Carbon Oxford North. This guide explores wall, floor and roof insulation in detail. Improving the insulation in our buildings is fundamental to cutting energy use and the associated carbon emissions. It is an essential step in moving our homes away from fossil fuels to become heat pump ready. Our homes will be warmer, healthier, and more comfortable to live in too.

Our Housewarming series takes an in depth look at each of the core home energy efficiency areas - from the homeowner's perspective. The rest of the series covers windows, ventilation, including mechanical ventilation and draught proofing, heating, including heat pumps and controls and renewable energy, including solar PV. The first guide Taking Stock, focuses on where to begin, and the final guide will explain how to prepare a complete retrofit plan.

We recommend homeowners should take professional advice at each stage of the retrofitting process. The guides are intended as a support - to explain the main elements, measures and choices involved in each retrofit area and to provide knowledge to enable you to have better conversations with whichever professionals you choose to work with. They will cover basic definitions and provide frameworks to help you weigh up the many options and decisions required.

The guides will also include suggestions for immediate energy savings, as there are often simple things homeowners can do straight away to reduce energy consumption before talking to specialists or embarking on retrofit work.

The walls, floors and roof represent the bulk of the exterior elements of most homes – the 'fabric'. Each of these can usually be insulated by adding material to the existing fabric, rather than replacing them. Ideally each one of these areas will be upgraded. However, whether this is possible, the order in which to do it and the standard to achieve are all important questions with answers that are likely to be different for each home.

Over time the way most homes in the UK have been built has changed. The most recently built houses tend to be the best insulated, and the easiest to further insulate. Older homes, particularly those built before the Victorian era are likely to require special care both in terms of the insulation used and how it is installed. Always obtain expert advice, particularly for old and listed homes.

Remember, insulation does NOT have to be done all at once, but we recommend that you should always have a whole house masterplan before you begin. This will save you time and money in the longer term.

DEFINING YOUR INSULATION PROJECT

WHAT IS INSULATION?

Insulating your home is like wearing a coat, hat and scarf when you go out for a winter walk – to stop you losing heat and to keep warm. Insulating your home reduces the rate of heat loss, improving your home's energy efficiency and reducing your bills.

Up to 80% of heat can be lost through a combination of your roof, walls and floors.

There are many different types of insulation materials, and some are more effective than others. How these are used and how well they are installed, will also affect how good they are at stemming heat losses.

The technical measure used to compare the effect of insulation applied to your home is a 'U-value'. This is the construction industry's shorthand for how quickly a part of the fabric of a building loses heat to the outside. By comparing the before and after insulation U-values we can accurately quantify the expected reduction in heat loss.

We know:

- The bigger the fabric area (walls, floors or roof) that form the outside 'envelope' of your home, the more heat is lost.
- The larger the temperature difference between the internal temperature of your home and the temperature outside, the more heat is lost.
- The poorer the insulation of your floors, walls and roof, the more heat is lost.
- Adding insulation will keep your home warmer when it is cold and cooler when it is hot.

UNDERSTANDING U-VALUES

A U-value is a measure of heat loss through the fabric of a building.

What is a U-value?

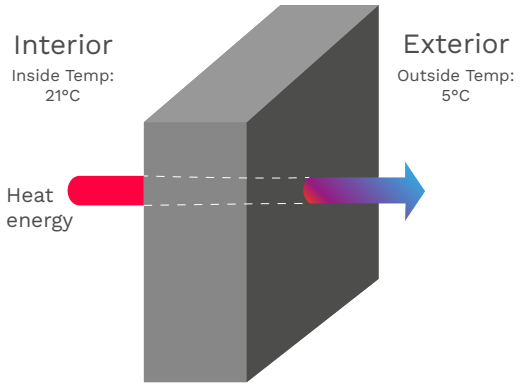
Typically a 'U-value' is a number between 6 and 0.09, the lower the better, as this indicates less heat loss. It is measured in W/m² C - Watts per square metre per degree centigrade difference between the internal and external temperature.

It is complicated and costly to measure the U-values of parts of a particular building. Consequently, the U-values used in a building's energy work are based on laboratory tests of similar fabric or buildings. They are taken to be fixed values for a particular piece of building fabric e.g. a cavity wall or double glazed window.

Strictly they should be varied according to the weather e.g. if the wall has been rained on recently or if it is windy, but for an overall annual energy use estimate this can be accounted for by using an average value. They are generally good enough estimates to work out what to insulate first and how much better a building will be after improvement, though are not perfect.

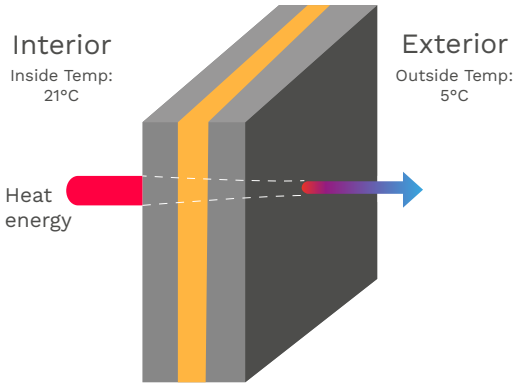
It is possible to run a heat loss assessment to give an actual measure of overall heat loss for a particular home.

Heat lost through solid wall



= U-value: 2

Heat lost through insulated wall



= U-value: 0.25

A SAMPLE CALCULATION

To work out how much heat is being lost (in Watts) we can do a calculation. For example, when the area is 20 square metres and the temperature difference is 10 degrees centigrade we multiply the U-value first by 20 (for the area) and then by 10 (for the temperature difference) to give the actual amount of heat being lost at that time.

So, for a section of wall, floor or roof with a U-value of 0.6, which is 4.5m by 9.075m (for example the side wall or house) when the inside is 20 degrees centigrade and the outside is 10 degrees centigrade, the calculation will be as is shown in the box below.

Using the numbers above, we show that adding insulation reduces heat loss by more than half.

Explanation	Measure	Calculation	Heat Loss
1. Heat loss in watts = U-value x area (m^2) x temperature difference (°C):	**Heat loss in Watts**	**0.6 x (4.5 x 9.075) x (20-10) =**	**240W**
2. If it were colder outside, 0°C for example:	**Heat loss in Watts**	**0.6 x (4.5 x 9.075) x (20-0) =**	**480W**
3. When we insulate a piece of a building, we improve the U-value, so it reduces the heat loss from that part of the building. In example 2 above, if we added insulation and improved the U-value to 0.25, we now have:	**Heat loss in Watts**	**0.25 x (4.5 x 9.075) x (20-0) =**	**205W**

The total heat loss from a building is built up from the heat losses from all the individual elements or parts (see examples in the Whole House Plan guide), such as glazing, wall, floor, roof, draughts and so on. The total can be estimated by repeating this calculation for all the different parts of a building (plus heat loss due to draughts) and then adding them up.

HOW THIS RELATES TO YOUR ENERGY BILL

The uninsulated wall in the example above loses 480 Watts. Over a cold 16-hour period it would lose 16 x 480 = 7648 Watt-hours. That is the same as 7.648 kilo-Watt hours, simplified to kWh. The insulated wall in the example above would only lose 3.28kWh in the same 16 hours.

To keep your internal temperature at 20°C for uninsulated walls, you will need to heat your home more to balance the heat loss. Your energy bill shows you how much you pay per kWh used. Insulated walls lose less than half the heat in the example above over the same 16 hours, so you would pay considerably less.

WHERE ARE YOU STARTING FROM?

When an energy professional or surveyor helps you to design a plan to get your home 'heat-pump ready', they will consider the likely heat loss from all parts of your house. They will then begin to answer three questions:

- How big is the energy bill likely to be for your house, both before and after insulation?
- Which parts of your home make the biggest contribution to heat loss and will make the most difference if improved?
- Could a reasonably sized heat pump be fitted and if not, how much upgrading of insulation is required?

Regardless of what heating system you choose, what type of house you have and the lifestyle you live, it is always best to start by reducing the amount of heating you need.

You will also need to consider your starting point - what materials your home has been built from and how much improvement it has already had. The table overleaf shows how different building materials can have radically different starting U-values.

A passivhaus wall loses only 3% (0.09 / 3.0) of heat lost compared to a 115mm thick (4.5 inch) brick wall (typical of an old Victorian scullery or coal shed). Wherever you start from, make sure you ask what U-value you are moving from and to with any options you are given by builders, architects or other specialists.

What are 'passive' houses or 'passivhaus'?

Passive houses are extremely energy efficient homes with very low energy bills. Some designs require no dedicated heating system at all. They have been a design option for new builds for several decades and there are now international standards for them. In the UK the term 'passivhaus' is generally used; see The Passivhaus Designers Manual, edited by Christina J. Hopfe and Robert S. McLeod or www.passivhaustrust.org.uk

Passive houses have five key characteristics:

- Very high levels of insulation to reduce heat loss to tiny amounts
- Very airtight so there are no draughts
- Active ventilation with heat recovery from the extracted air
- Good thermal mass to moderate short periods of intense cold in winter or heatwaves in summer
- Optimised windows to gain sun in winter and avoid overheating in summer.

There are emerging passive house retrofit standards for upgrading existing houses e.g. EnerPHit:

https://passipedia.org/certification/enerphit

Certified Passivhaus
Passivhaus Institut

COMPARING DIFFERENT U-VALUES

Element	Lower Performance	U-value W/m²C	Higher Performance	U-value W/m²C
Wall	115mm (4.5 inch) brick wall	**3.00**	'passivhaus'	**0.09**
Floor	Suspended timber floor (which is normally over a cold draughty space – a "ventilated void")	**1.50**	Modern floor, insulation around perimeter and below	**0.10**
Roof	No insulation	**1.70**	450mm mineral wool	**0.09**
Window	Steel frame, single glazed	**6.00**	Top of the range system on the market, coated composite or UPVC frame, triple glazing	**0.80**

SETTING YOUR U-VALUE TARGETS

We suggest aiming initially for a 50% reduction in heat loss overall for your house. In our Whole House Plan guide (Guide No 6) we look at designing the overall retrofit plan for your home. We discuss how the improvement in all the fabric and air changes work together to deliver the total heat loss. You may wish to consider the role of each part of the fabric of your home to refine the tradeoffs in cost, complexity or practicality when you create your plan.

CRITERIA FOR CHOOSING YOUR INSULATION

Different types of insulation have different characteristics but, in general, they can be used for any application. Mineral- or glass-wools (for example, Rockwool or Earthwool) are most common in lofts and in slab form (termed a 'batt') for new-build cavity wall insulation but can also be used for floor or other wall types. By comparison, a rigid foam insulation (for instance Celotex or Knauf kooltherm) is typically used under a floor slab or part of a vaulted ceiling and can be more difficult to fit to a loft floor.

To make sure you can make a proper comparison of the internal wall insulation package try to make sure that the company or companies that quote to do your work can offer more than one type of insulation.

When choosing insulation, you may wish to consider some of the following:

- **Your home**
  Certain materials may suit different buildings better: consider what kind of home and what materials it is made from. Is it in a conservation area or is it listed? Are there any features internally or externally that you might want to consider, protect, or must retain?
- **Sustainability / environmental impact**
  This is a complex area. Guides that might help you include BRE's Green Guide To Specification, sections and references in The Environmental Design Pocketbook (RIBA publication) by Sofie Pelsmakers, The Whole House Book, Cindy Harris and Pat Borer, the chapter on Resources and Materials.
- **Cost**
  How much does the insulation cost to buy and install? Might there be more, or less, decoration, or other costs once the work is complete?
- **Space**
  How much space might it take from the walls, floors or roof once installed? How thick is it? What fits in the space available?
- **Safety**
  How flammable is the material, how toxic is it once installed (see THE BUILDING REGULATIONS part B (www.gov.uk/guidance/building-regulations-and-approved-documents-index)?
- **Longevity and reliability**
  Will natural materials last less long than others, and/or encourage pests?
- **Insulation performance**
  What is the best U-value wanted or needed, to achieve for a given cost or to be heat pump ready?
- **Appearance**
  What will it look like once it is in place? How different is this from my existing walls?
- **Certification, manufacturers' warranties and installers guarantees**
  What accreditation, warranty and quality assurance are available from the manufacturer, the installer, or other professional advisers? (Also refer to The Building Regulations Part B for Fire Safety, Part C for Resistance to Moisture, Part L for Conservation of Fuel and Power (i.e. energy), Part F for Means of Ventilation.
- **Other personal choices**
  For example, the colour of a render or finish

Continued overleaf

Your choice will require finding a balance between criteria.

- You might want sustainable materials, but they may not be the best performing in terms of reducing heat loss (U-value).
- You might choose the best performing materials in terms of U-value but be concerned that they may be more flammable or toxic than other options.
- Your lowest cost options may also not necessarily be those that are the most sustainable.
- Sometimes you will simply be trying to reduce the space you might lose on an internal wall, so choose a thinner rather than a thicker internal wall insulation package.
- The cost of the insulating fabric will be different in terms of the type of materials and the brand. We suggest you obtain quotes for different options.

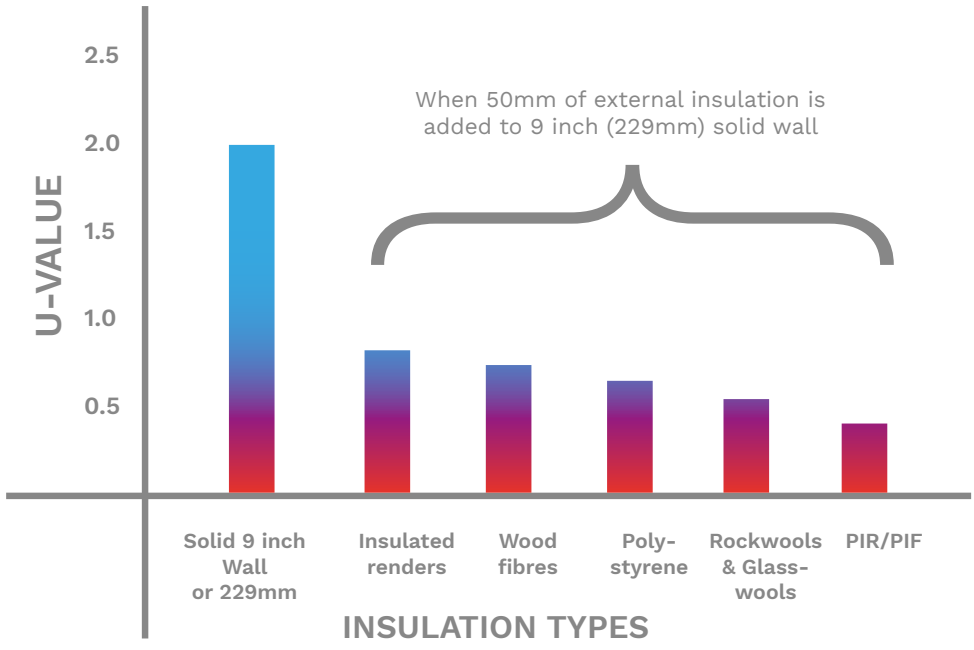
DIFFERENT CATEGORIES OF INSULATION

There are five main categories of insulation materials all of which can be used internally or externally.

The chart below is in order of how well these materials insulate. The U-values stated are indications - your actual U-values will depend on the specific details of your existing walls and the final finishes you choose.

To enable some objective comparison, this chart assumes 50mm of insulation is applied to a 229mm thick (9 inch) solid brick wall with a nominal starting U-value of 2 W/m² C.

THE COMPARATIVE IMPACT OF DIFFERENT INSULATION MATERIALS ON A SOLID 9 INCH (229mm) WALL



COMPARISON OF THE CATEGORIES OF INSULATION TYPE

Category Type	Example Brand	How its Installed	Comments (Check manufacturer's documentation for full details of performance and installation)	U-value (W/m^2C) (Approx. result if 50mm, about 2 inches) applied to solid 9 inch (229mm) wall (initial U-value around 2)
Insulated Renders	Diathonite	Supplied as a wet-applied plaster and applied either by trowel or using a hand-operated spray system.	Fireproof, water resistant, non-toxic; material can be an irritant if not handled carefully during installation.	**0.62**
Wood Fibres	Pavatherm, Gutex or Steico	Come as panels or 'batts' to fix to the wall and then a finish is applied on top.	Can be a carbon store if from sustainable sources. Pavatherm says: "When properly installed the boards will not add significantly to any existing fire hazard. The boards will not present a toxic hazard."	**0.56**
Polystyrene	Jablite, Stylite	Supplied as near rigid sheets fixed to the wall and then the finish applied on top.	Water resistant, non-toxic, oil-based product. Stylite states "Both grades are fire rated Euro Class 'E'" which means they can make a high contribution to a fire. Toxic fumes if burnt (e.g. as waste).	**0.53**
Mineral Wools/ Glass Wools	Knauf earthwool 44	Supplied as semi-flexible 'batts' fixed to the wall and then the finish applied on top.	Fireproof, water resistant, non-toxic; fibres can irritate if not handled carefully during installation or disposal.	**0.49**
PIR / PIF	Celotex, Knauf K18	Supplied as rigid sheets fixed to the wall and then the finish applied on top.	Water resistant, non-toxic but manufactured using hazardous oil-based chemicals, residues of which may remain in the board. Celotex states "fire rated Euro Class 'E'" which means they can make a high contribution to a fire. Toxic fumes if burnt (e.g. as waste).	**0.38**

Note; different products and brands do not all have the same performance!

CONSIDERING INSULATION THICKNESS

We can look at materials another way, by considering the thickness required to achieve a U-value target.

Increasing the effectiveness of the insulation means adding thickness. The table below compares the thickness required for different materials to achieve the same rate of heat loss, a U-value of 0.25W/m² C, which is roughly equivalent to current new build homes.

For ease of comparison the examples in the table are based on adding insulation to a 9 inch (229mm) solid brick wall - typical of a Victorian home. This comparison of thickness might be particularly important if you are considering internal wall insulation and minimising the space you lose in a room.

Type	Example Brand	Thickness to achieve U-value of 0.25 W/m²C applied to solid 9" (229mm) wall*
Insulated renders	Diathonite	Impossible to achieve 0.25 U-value (max 50mm achievable)
Wood fibres	Pavatherm, Gutex or Steico	~140mm
Polystyrene	Jablite, Stylite	~130mm
Mineral / glass wools	Knauf earthwool, Rockwool	~120mm
PIR / PIF	Celotex, Knauf K18	~80mm

*(Note, some additional space may be lost depending on how the insulation materials are applied)

ROLES OF THE PROFESSIONALS

LCON recommends that for a full energy assessment an experienced and/or qualified person should be employed. They are likely to be a chartered professional from RICS, ICE or IMechE for example, and can provide detailed and specific advice. They will typically spend several hours in your house and can provide tailored suggestions relating to your home. They should be able to answer your specific questions and provide a detailed report. A full energy survey can cost around £500.

Below we introduce some of the professionals working in this field. We suggest checking for local recommendations:

- **Energy Assessors**
  A 'Domestic Energy Assessor' or DEA is specifically qualified an EPC (Energy Performance Certificate), legally required at the time of sale or when a building is to be rented out. They spend relatively little time in your property. The cost can be as low as £50.

- **Surveyors**
  A surveyor should be a chartered professional, typically a member of RICS, ICE or CIOB and should have wide experience of all building matters from roofs to drains. If they have specific energy experience that would be helpful. Their role can be to provide a survey of the starting point of your building including any maintenance needs. They should be able to correctly identify the type of walls you have and comment on specific risks of improving your home. A full survey can cost from £500 to a few thousand, depending on how much detail is investigated (for example, woodworm, rot, damp and/

or drainage). This would be the sort of survey you should commission before buying a house.

If you are looking for a deep retrofit survey, then you must choose a professional surveyor with the correct energy specific experience.

- **Architects / Draughtsmen**
  Where you require drawings to provide as part of the specification of the work you want done, Architects or Draughtsmen can do this. They will probably be able to apply for planning permission or building regulations approval on your behalf. You may not need an Architect for a set of drawings and specification for a simple wall insulation but, if you are planning other refurbishment and/or re-organizing the building, then they may be more appropriate.

- **Project Manager**
  If the work is part of a larger overall plan including, for example, new windows and wall insulation, the work needing to be managed is interconnected. You may wish to employ an independent Project Manager to ensure all runs smoothly. If you employed an architect, they may be willing and able to take on this role. If you are instructing a builder to undertake all the work, then it should be part of their responsibility. The designated builder, or lead contractor, should take on the ultimate liability for the whole contract to minimise conflict.

- **Builders and Other Contractors**
  Builders will install what you have specified. A building firm may have all the above professionals 'under one roof' and so may be able to take on the whole set of tasks from survey to handover. Alternatively, you may wish to consult independent professionals at the survey and specification stage and ask for quotes from a few builders.

- **There are Some Specialist Contractors** who provide specific energy efficiency works. These may be highly relevant if, for example, you are interested in just external wall insulation. It is recommended that the earlier survey work is carried out independently then quotes obtained from a few specialists.

- **Retrofit Coordinators**
  There is a new group of people termed Retrofit Coordinators coming to this field; they are essentially project managers. They are the result of the development of a standard 'PAS 2035' intended to ensure a consistent high level of quality is achieved in energy retrofits. PAS 2035 also defines roles for; Retrofit Advisor, Retrofit Assessor, Retrofit Designer, Retrofit Evaluator and Retrofit Installer.

- **Complete Retrofit Service Organisations**
  There are organisations that can bring all of this together and provide a 'one-stop-shop' for survey, design, tendering and installation. Many are companies that provide suitainable building support services alongside other construction related services.

- **Manufacturers**
  Manufacturers have decades of experience making, testing and certifying their materials and so they are best placed to advise on how they should be installed. This is why we state you should always use manufacturer's instructions.

Examples include Eco Design Consultants, CL-PM Ltd, Enhabit (part of Green Building Store).

QUALITY ASSURANCE

There is no overall scheme in the UK currently to check the design, the quality of the materials you choose, or the installers you select. An outline of a scheme is being developed under a draft document referred to as PAS 2035/2030 but it has not yet gone through the full rigour of an international or European standard.

For significant amounts of wall insulation you need to comply with The Building Regulations. These state:

Regulation

Requirements for the renovation or replacement of thermal elements

23. (2) Where the whole or any part of an individual thermal element is proposed to be replaced and the replacement -

(a) constitute a major renovation; or

(b) (in the case of part replacement) amounts to the replacement of more than 50% of the thermal element's surface area;

The whole of the thermal element must be replaced so as to ensure that it complies with paragraph L1(a)(i) of scheme one, in so far as that is technically, functionally and economically feasible.

Consequently, you need to make a building regulations notification to your local authority and only approved installers should install the insulation. The Local Authority Building Control (LABC) organisation has some advice on this.

https://www.labc.co.uk/homeowners/homeowners-guide-building-regulations

- **Insulation materials**
  These need an independent approval The most common is a certificate from the British Board of Agrément. There is also a scheme by BRE in place

  www.bregroup.com/certifiedthermalproducts

CONTRACTS

Always make sure that you have a copy of the insurance certificates from your chosen suppliers before work starts and obtain warranties from them and for the materials. Where possible, make sure you obtain references and see recent work that your chosen installers have completed.

Make sure you have a signed contract in place before you start and make sure that there is a clause that covers remedial work, should you later find a problem. Never pay the whole, or a significant proportion, of the bill upfront.

As the work will not be visible once finished, make sure you have full and correct records, as required by The Building Regulations and for the EPC, when the work is complete.
Take photos of progress and keep certificates of the improvements so that you can use them in future as evidence that your home has excellent energy performance.

Before work starts, check what records you will need with your local authority building control department and the EPC assessor. This may become vital if the government decides to set minimum standards of energy efficiency before you are allowed to sell a home in future.

TOP TIP: You should aim to add as much insulation as you can in one go; that way you get maximum energy savings from day 1. Plus, you are unlikely to have to go through the process again in future.

Always make sure you have detailed plans.

RISKS

As with any alteration to a building, poor quality work may lead to problems. There are three main risks if insulation is not installed properly or according to the manufacturer's instructions:

- Multiplying existing problems
- Trapping moisture within the insulation
- Thermal or cold bridging

AVOID MULTIPLYING EXISTING PROBLEMS

It is vital to fix existing problems including damp, damaged masonry or loose plaster before you begin insulating. We cannot emphasise enough that covering a poorly maintained part of a building with insulation materials will lead to more problems and likely costs later. This is different to problems that might result from poor quality insulation works.

Examples include:

- Ensuring rainwater drainage is working properly so the building structure is not already wet due to overflowing gutters or other issues
- Repairing frost damaged bricks and any loose mortar before covering them with insulation
- Keeping the damp proof course well above the ground so it is not covered by e.g., earth in a flowerbed or blocks/ concrete of a driveway and so would cause rising damp
- Making sure internal water pipes are not leaking into your building
- Completing any re-wiring of the electrical system before installing insulation
- These examples are the most commonly seen by building surveyors, but your home may have others.

TRAPPING MOISTURE WITH INTERNAL AND EXTERNAL INSULATION

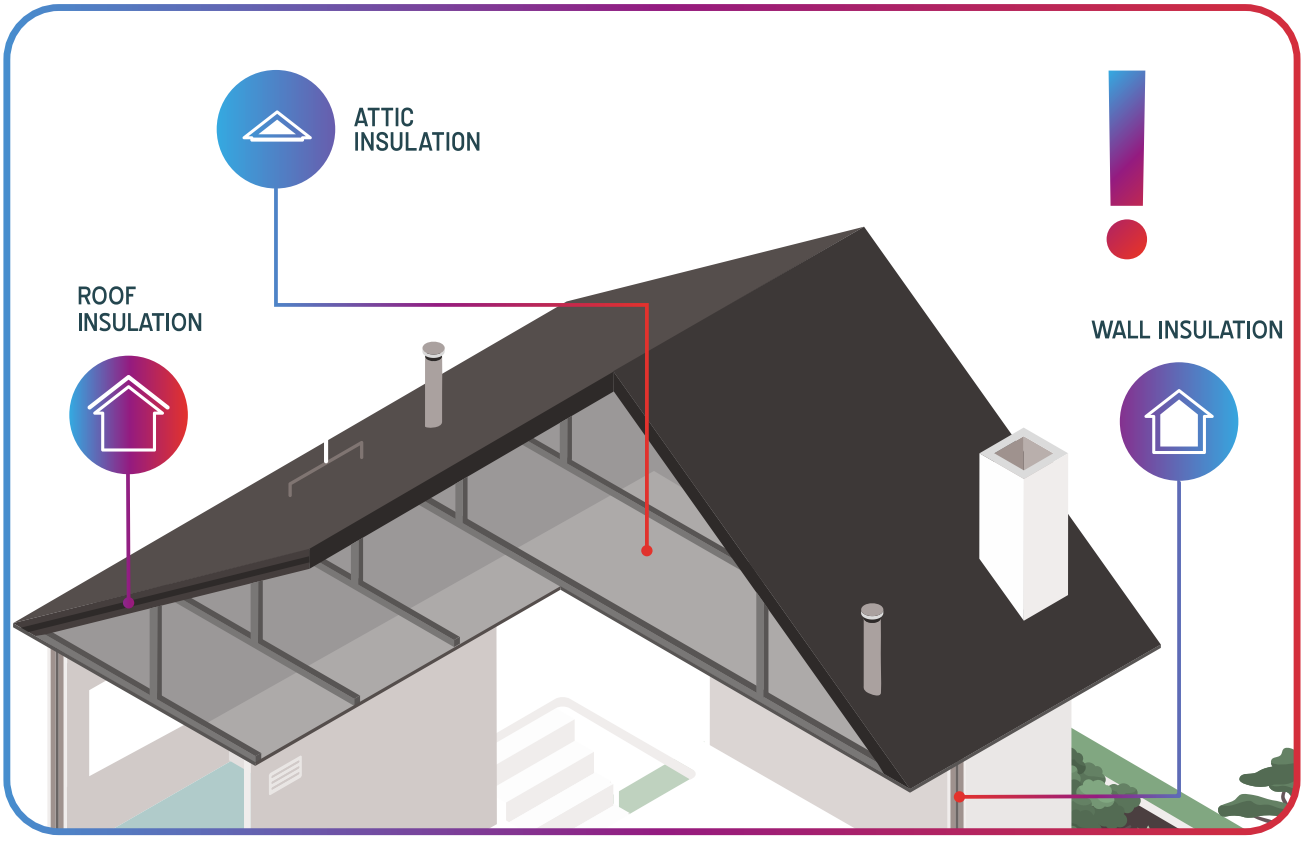
With wall insulation there is a small risk of trapping moisture in the wall and/ or the insulation layer which could lead to damage. However, when insulation is properly installed according to manufacturers' instructions and includes, for example, the correct vapour barriers and damp-proof membranes or a vapour permeable ('breathable') insulation, this is a tiny risk.

THERMAL OR COLD BRIDGING

Thermal bridging, also known as cold bridging, is when a part of the wall (or roof, or floor) has not been insulated, or cannot be, whilst the rest of the area is. Sometimes this is because of the way the house has been originally constructed, for example where an internal wall is connected to the external wall, or there are concrete lintels over windows and doorways in a 1970's house.

It might also be because there is not enough space, for example by the stairs, or a particular feature needs to be preserved. The cold bridge occurs in any place where the insulation is not fully effective.

Cold bridges are particularly a problem if they become a frequent site of condensation in which case a way of insulating the area should be found, potentially have some insulation internally as well as externally.



Different sites for insulation

WALL INSULATION

The walls will usually lose the largest proportion of heat from all the fabric elements of your home.

An 'average' house which has not been improved loses about 35% to 50% of heat through the walls. How much difference you can make will be affected by:

- The relative proportion of wall to other areas exposed to the weather (a mid-terrace has a smaller outside wall area than a detached three storey house – party walls very rarely need insulating).
- The U-values of all the building elements.
- How draughty the building is (we cover draught proofing in a later guide).

It may make sense to have specific surveys to establish what proportion of heat is lost through different elements of the building, particularly if your home is unusual.

The diagrams show how, over the decades, house construction has advanced from solid walls with no cavity or insulation and very poor performance through to today's fully filled cavity walls in a new build.

The filled cavity wall loses only an eighth of that from a solid 229mm (9 inch) thick wall. It is possible to reach or exceed this level by retrofitting insulation. Insulating flats and apartments, and to some degree terraces, whilst technically the same as for houses, brings the need for appropriate agreements with neighbours.

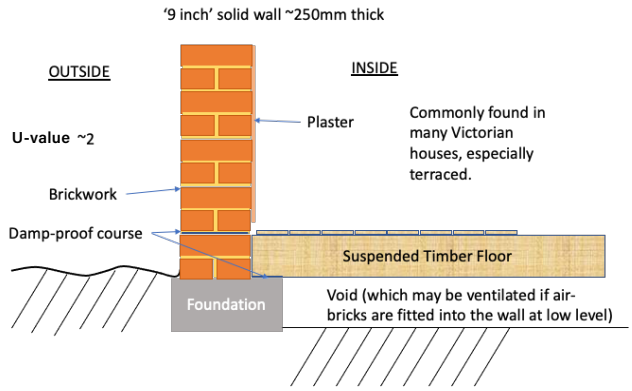
Internal wall insulation may be the quickest improvement, but it is worth discussing a whole-block programme with the residents' association and/or freeholder to have the biggest overall impact and the most cost-effective solution. Otherwise, there can be problems. For instance, your cavity wall insulation can drop down into the cavity of the flat below.

IDENTIFYING YOUR HOME CONSTRUCTION TYPE

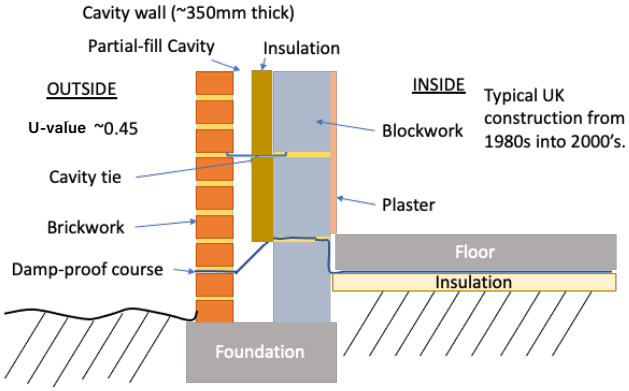
The materials your home is built from will influence your insulation choices. The diagrams below illustrate different wall types that are typical of our homes. Which year your home was built, or when an extension was added will provide a good first identification guide.

THE FOLLOWING DIAGRAMS ILLUSTRATE SEVERAL OF THE MORE COMMON WALL TYPES

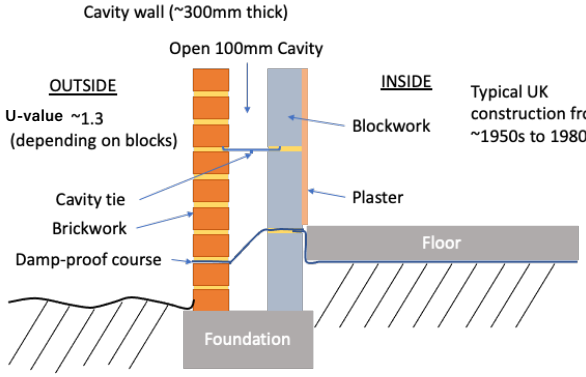
A typical Victorian terraced house



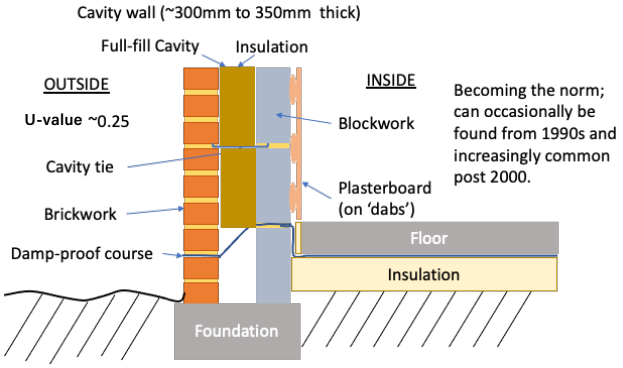
1980 - 2000 typical construction



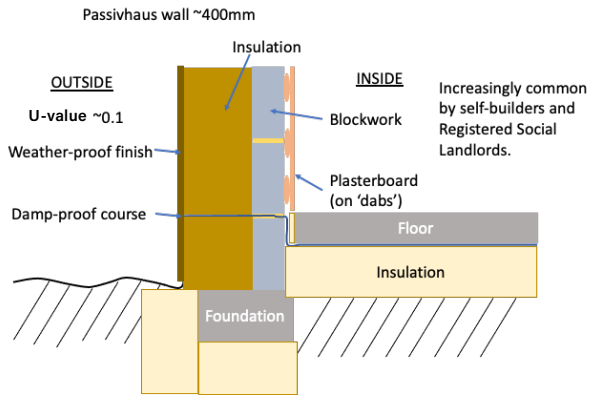
Typical 1950-1980 construction



1990 onwards



Typical Passivhaus Construction



It is often said that the brick bonding (how bricks are laid relative to each other as viewed from outside the house) can be used to determine if the wall is solid or have a cavity. This is not an entirely reliable method before about 1960 although can be useful (see photos overleaf). From about 1960 it provides a good indication but you should always check. A solid wall generally does have a particular pattern, but this pattern is sometimes used in cavity walls as an architectural feature. Sometimes cavity walls are built behind a solid 229mm (9 inch) wall (especially in taller Victorian buildings).

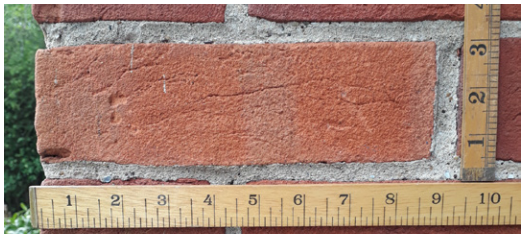
Similarly, the bonding associated with a cavity wall can be used in a 115mm (4.5 inch) thick solid wall, which is the least insulated and has no cavity. In practice, several pieces of information must be gathered to be sure of the wall type.

These include:

- Wall thickness
- Brick bonding (pattern)
- Age of building
- Quality of that part of the building and its original use

To be certain, investigating the wall construction, for example where an extractor fan or waste pipe passes through the wall, will reveal the truth. If significant work is about to be done, such as adding a window, or extending the house, then it may be worth making a hole in the wall to find out. If the building has been extended, then there may be different wall types across the building; a new extension to a Victorian building will have much better insulation than the original house.

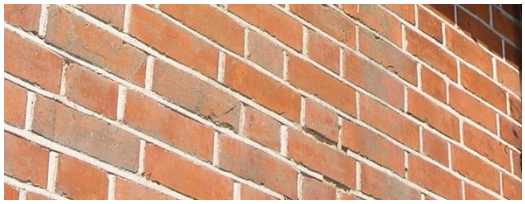
Bricks



Conventional British bricks are about 9 inches (229mm) long by 4½ inches (115mm) wide by 2¾ (70mm) deep.

Walls may not be what they seem

Bonding suggests solid 229mm (9 inch), but is actually cavity



Bonding suggests solid 229mm (9 inch), but is actually cavity

Bonding suggests solid 229mm (9 inch), but is actually cavity

Bonding suggests cavity, but is actually a single brick, thin, solid 115mm (4.5 inch).

PRE-VICTORIAN HOMES

Stone houses, original timber-frame structures, wattle and daub and other constructions are outside the scope of this guide as they require specialist investigations and advice.

BAY WINDOWS AND TILE HUNG OR TIMBER CLAD WALLS

Some parts of a house, such as bay windows, will probably be of different construction to the rest. In a Victorian house a bay might simply be a hollow timber frame with tiles on the outside and plaster on the inside. This will be very poorly insulated.

Tile-hung, timber-clad and rendered external finishes hide the construction that is behind. For example, in the 1970's it was not uncommon to build a 115mm (4 ½ inch) blockwork wall behind tile-hung or timber clad finish which would be poorly insulated. These can be externally insulated by removing the tiles or timber and then replacing them on top of the new insulation. This is most economically done if maintenance or refurbishment is required.

An alternative would be to insulate internally; the space taken up will depend on the materials used and the installation process. At this level of detail, a choice will have to be made about the specific house after a survey taking into account many specific features and details of the building and its use.

CAVITY WALL INSULATION

If your wall has a cavity of at least 50mm, then insulation injected into the cavity is likely to be the best, most cost-effective insulation option subject to a survey and checks. There are several circumstances which prevent installation and a suitably qualified surveyor, assessor or installer will know what to check. In some parts of the country, for example by the coast, frequent wet and windy conditions may mean it is too risky to insulate the cavity as damp may cross into the internal wall.

Cavity Wall Installers should be a member of one of the following:

- The Cavity Insulation Guarantee Agency
  www.ciga.co.uk/installers
- The National Insulation Association
  www.nationalinsulationassociation.org.uk
- The British Urethane Foam Contractors Association
  www.bufca.co.uk

Cavity wall insulation will improve the wall U-value from around 1.3 towards 0.5 or better. When combined with good roof insulation this could halve the total heat loss from the house. It may also reduce draughts which find their way through the cavity and out through floor joists and electrical sockets.

Cavity wall insulation is usually installed by drilling holes in the outside of the wall and pumping insulating material into the cavity. If you are about to redecorate the inside of the whole house, insulation can sometimes be injected by drilling holes from inside to avoid disturbing the external look, for example of a render.

You need to make a building regulations notification to your local authority and only approved installers can install it. They should apply for building regulations approval for you.

Sometimes cavity wall insulation can drop, so if your house has had cavity wall insulation over 7 years ago it is worth checking. Thermal imaging may help identify if your cavity insulation has gaps and if these need to be topped up.

Some much older types of cavity wall insulation, for example Urea Formaldehyde Foam Insulation (UFFI), can sometimes completely collapse leaving the cavity empty again. This can be established using borescopes or small cameras poked into the wall. If the insulation has collapsed, it is usually possible to install new cavity wall insulation, subject to the appropriate surveys.

EXTERNAL WALL INSULATION

As the name implies, external wall insulation (EWI) is fixed to the outside of a wall. EWI is especially beneficial for a solid brick wall and can be particularly effective because:

- It keeps the 'thermal mass' (the wall) inside the building. Thermal mass helps with smoothing out highs and lows of temperature which in turn improve comfort
- There is potential to specify thicker levels of insulation than internally as you are not losing room space
- There are fewer cold bridges than for internal insulation.

EWI should also avoid the risk of damp getting into the wall if the external finish is done properly to keep rain out. There are sometimes reasons why EWI cannot be used or is too complex and costly. For example, if there are many windows and sills, waste pipes; if roof edges are narrow or there is limited space between the wall and the neighbour or the pavement.

As the homeowner you can identify some of the obvious issues before employing a surveyor. These can include:

- What is the external finish? If exposed brick, EWI will change the look of the house
- Is there enough overhanging roof or will it need to be extended, to ensure the guttering is beyond the EWI?
- How far do the window sills extend?
- Are there many pipes, telephone wires, EV charging systems or waste pipes that are fixed to or come through the wall? These need to be treated according to manufacturers' instructions

- If you also plan to replace windows or elements such as air bricks or bathroom ventilation systems, these should all be planned at the same time. For windows, the depth of new sills will need to suit the insulation thickness.
- If the building is listed or located within a conservation area, then you will need planning consent. If the building is already rendered, then this should not present a problem
- If you live in a semi-detached or terraced house, then you will need to agree what to do at the junction with your neighbour's property or persuade them to have EWI at the same time.

INTERNAL WALL INSULATION

Internal wall insulation (IWI) involves fixing materials to the inside of your external walls, room by room. The main disadvantage of this method is the loss of internal space.

The main advantages are:

- The total cost for an individual room is likely to be lower than for a whole external wall and therefore the capital outlay may be easier to manage. You can do the work one room at a time over a longer period as and when the budget is available, or for example, just the back of the house.
- It gives a rapid and substantial improvement to a previously cold room.
- If the room is about to be redecorated and double glazing is going to be fitted, then all the decorating aspects need only be done once. A good example might be a bathroom in a Victorian rear extension; if you are about to have all the fittings renewed, then it is the perfect time to investigate internal wall insulation.

If the whole house is already a 'project' requiring refurbishment, for example an ex-rental Victorian terrace, then internal insulation carried out room-by-room becomes a manageable process where stripping loose plaster and replacing with new insulated plasterboard is a single operation.

The main disadvantages are:

- The room becomes smaller
- If not installed correctly, there is a risk of damp building up in the wall Manufacturers' instructions must be followed, and appropriate choices made with respect to insulation materials. See overleaf for useful best practice guidance.
- Cold bridges can be left where internal walls meet external walls within the house (see earlier notes)
- Internal features, for example cornices, dado rails and windowsills, would need to removed and/or modified or you may wish to replace them if you want to keep the style of the room.
- You lose the benefit of thermal mass which can help to smooth the highs and lows of temperature and improve comfort
- Staircases against an external wall can cause problems if they are made narrower; it may not be possible to insulate alongside the stair and so this will be a significant cold bridge.

MAKING THE CHOICE BETWEEN INTERNAL, EXTERNAL AND CAVITY WALL INSULATION

Useful guidance can be found here:

Oxford City Council has a guide to external wall insulation:
www.oxford.gov.uk/download/downloads/id/5709/rse18_-_external_wall_insulation_technical_advice_note.pdf

The Insulated Render and Cladding Association (INCA) also has a best practice guide:
www.jrmpl2t1z5gzqpmv2vjf0mqh-wpengine.netdna-ssl.com/wp-content/uploads/2016/09/Best-Practice-Guide-Final.pdf

The UK government has a guide to internal wall insulation:
www.assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1018930/iwi-guidance.pdf

SUMMARY OF WALL INSULATION PROS AND CONS

Type	Pros	Cons	Comment
Cavity wall	Best solution if suitable, effective and less disruptive.	Amount of improvement determined by cavity width. May slightly damage render.	Practical, cheap and effective; you should do this if your cavity is suitable.
Internal	Can be done room-by-room; no planning issues (unless you have a listed home).	Does not enclose the thermal mass of the building. Reduces room sizes. All internal fittings (skirtings, light switches etc) on the wall need removal and replacement. May not support shelving and fixings later.	Allows the homeowner to select how much and how fast the work is done. A good option where the front of the house is part of a valued townscape.
External	Technically gives the best performance; any reasonable thickness of insulation can be added; rooms remain same size.	Likely to be a large single project at high cost; may not suit some walls if complicated with bay windows, many pipes and/or limited space to neighbour or footpath. May require windows to be moved outwards.	Works best on a detached house with solid walls which already have a rendered finish and relatively simple architecture. A good option for the rear of a house where the front is part of a valued townscape.

ROOF INSULATION

As a broad indication, for an 'average' house which has not been improved, 20% to 40% of heat is loss is through the roof so improving insulation will make a useful difference.

Your roof may include portions which are flat, vaulted and loft spaces under a pitched roof. Also, specifically if you have a loft, it is normally the easiest part of a building to insulate, and to do yourself, giving instant savings.

The benefits will be affected by:

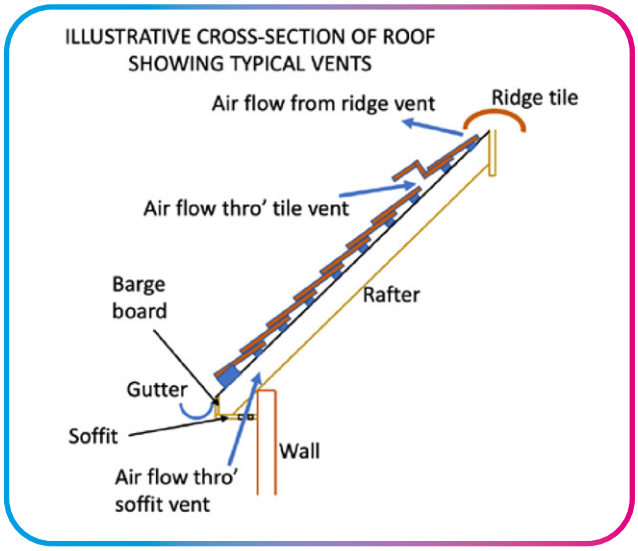
- The relative proportion of roof area to other areas exposed to the weather (a bungalow will have a much higher loss through the roof than a three-story house with the same space).
- The actual U-values of all the elements.
- The amount of insulation already in place – rarely sufficient.

A key issue is that the roof structure needs some ventilation or there is a risk of deterioration in the woodwork. If there is (or will be) a vaulted ceiling directly under rafters, then ventilation is needed under the tiles. In a flat roof it is far more complex. In all cases specialist advice must be sought.

The method of ventilation will depend on the chosen details of insulation but as a guide may include one or more of the following:

- Soffit vents.
- Tile vents.
- Ridge vents.
- Breathable membrane under tile battens (if the roof has recently been or is to be replaced).

Another issue is that the space above, once insulated, will be much colder, so any pipes and tanks in a roof space must be under the insulation, not on top of it, otherwise water could freeze.



It is possible to fix insulation to the underside of the roof rafters, but this uses much more insulation as the total area will be greater than for the flat area of the loft (typically 40% more in a normal pitched roof). Remember that fitting 400mm of insulation between and under the rafters will also reduce the height in the loft.

In addition, this requires more complicated work to ensure the roof structure does not suffer damp (see earlier). A ventilation strategy should be part of the design which in turn should be carried out by a suitably qualified and experienced person or a clear guide from a manufacturer.

Some companies offer to spray insulation under the tiles of a roof. This can be a good approach but needs more care in its application not least because it will be difficult to remove if problems occur, for example tiles are damaged in a gale. For this reason, many mortgage and insurance companies may object. Check before you apply.

The key is to check aspects including:

- That the product has a British Board of Agreement (BBA) or other suitable certificate for use in a roof space: see section on quality assurance.
- That it is being used as per the certificate.
- That a solid warranty and roof risk insurance comes with the installation.
- Check the manufacturers instructions regarding the risk of overheating electrical wiring and fittings.

TYPICAL LAYERS OF A NEW ROOF

1. Hip and Ridge Shingles
2. Tiles/ slates
3. Ventilation
4. Felt/ waterproofing
5. Insulation
6. Ice and water barrier
7. Roof battens & chords
8. Fascia
9. Ceiling insulation
10. Rafters & pitching points
11. Ceiling (often plaster-board.

LOFT INSULATION

The loft is normally the easiest part of a building to insulate and can give instant savings; often this can be a DIY project. Consequently, it makes sense to do this first.

LCON suggests that an aim should be a target U-value of 0.12 W/m² C (stretch target of 0.1). With mineral wool this would require about 400mm thickness, but a more compressed, higher-performance material can also be used.

Mineral wool is by far the most common insulation material used in lofts - rolls of it are frequently seen in loft adverts and are available at DIY stores and builders' merchants. It is extremely easy to use, but care is needed, and you must follow manufacturer's safety guidance.

However, the desire for lower U-values and the depths that this implies with mineral / glass wool, mean that alternatives are sometimes favoured. These can be discussed with certified installers at the time you ask for quotes. If you are going to want to store things in the loft, then you will need to put down a floor. However, you must not squash the insulation, this will stop it working effectively.

There are several approaches which achieve the insulation level and a floor including:

- 'Loft legs', a proprietary product to hold the floorboards above the insulation.
- Rigid foam insulation between ceiling joists which has a better insulation performance for less thickness, typically only 200mm will be required. This will cost more.
- Mineral wool between the joists with insulation-backed boards over the top.

Some light fittings may require covers over and/or in the space around the lamp, under the insulation. This is to prevent heat build-up when the lights are on for long periods. This can cause damage to the lamp and a small risk of fire. Examples include Loftleg Loftlids, Spotclips and Thermahoods.

TOP TIP: Insulate the loft now! Do it this summer! It such an easy win and once it is done you will save energy next winter and all the winters in future.

FLAT AND VAULTED CEILINGS

Flat and vaulted ceilings require a different insulation approach to open lofts. If improvement work is being done from inside there may be plasterboard to take down and replace. Ventilation is required to avoid damp problems and a ventilation strategy should be part of the design which in turn should be carried out by a suitably qualified and experienced person.

For a flat roof the added issue is the relatively high probability of it leaking rain into the insulated space at some point in its life. Consequently, LCON recommends that manufacturer specified systems are used for flat roofs. This will ensure that all the components of the roof work properly together and that the whole system can be guaranteed by one provider.

Vaulted ceilings (with a pitched roof outside) are a little more straightforward as the risk of leaks is much lower. LCON suggests that a target U-value should be 0.12 (stretch target of 0.1) which requires about 200mm of a high-performance rigid foam insulation. The approach differs for existing and new roofs. Ventilation should already be present in an existing vaulted ceiling if it was installed properly. Insulation and plasterboard can be added internally over a vaulted ceiling if the existing design is known to be constructed properly.

Practical issues such as moving electric light fittings will need to be considered and proper fixings used to hold the new insulation and plasterboard in place. If a new roof is being built on an extension or an old roof is being replaced, then a complete system should be designed to comply with building regulations.

ROOF REPLACEMENT

If you are considering a roof replacement, now is the time to consider going beyond the minimum levels specified in The Building Regulations. A new roof may have insulation outside the rafters and therefore directly under the tiles (or other finish). This can avoid the need for ventilation and so the whole depth of rafters can be filled with insulation.

Generally, for flats, all the occupants have responsibility for maintenance of the roof and so should make a contribution to improving the insulation. This might be when a new roof is required.

If you are going to want to store things in the loft, then you will need to put down a floor.

FLOOR INSULATION

The construction of floors has probably changed most through the decades. Very early houses often still have flagstones laid directly on soil and this will be very cold. Short of complete removal and replacement there is nothing that can be done.

The Victorians moved to have suspended timber floors with a space below, often ventilated to keep the timbers dry and free from rot. In the late 1990's the first meaningful level of floor insulation was required in The Building Regulations.

Current construction has insulation included within the floor structure. Insulation levels have improved dramatically from about a U-value of 2 W/m² C plus draughts to an air-tight floor with a U-value of 0.25 being the minimum you are permitted to have today.

There are therefore three ways in which the floor can affect heat loss and comfort:

- Poor level of insulation, for instance a concrete floor slab or stone.
- A cold feeling from this poorly insulated surface.
- Draughts, most significant with a wooden floor but often present in a modern beam and block floor, where there are gaps in the floor and especially around the perimeter.

Because there is such a wide range of floor types and their effects on draughts, it is not practical to give a range of heat losses but a minimum of 15% of the heat losses from the building fabric is likely.

With a solid floor, it is difficult to add insulation, as the floor has to be dug up in its entirety or insulation added on top requiring all skirting and doors to be lifted. Both are rarely worth doing.

Thick underlay and carpet, or cork tiles make a floor feel warmer although they don't add much insulation. Care is needed in selecting a floor covering when underfloor heating is installed, as it may prevent the system working properly.

If you have a suspended timber floor over an empty space which is also ventilated with airbricks, it is definitely worth considering insulation and draught-proofing.

There are two main ways of doing this, and a third cheaper way of making useful gains:

- Remove floorboards, insulate, draught proof and replace boards.
- Apply insulation from below, for example q-bot. Care is needed in application especially near wires and pipes as it will be difficult to remove should maintenance be required.
- Manage the ventilation in the void through a suitable mechanical ventilation system.

REMOVING FLOORBOARDS

Lifting the floorboards is a major operation. You will need to remove the skirting boards too and perhaps some parts of the doorways and radiator pipes. However, the benefit is that the work can be done to a high standard from above and all the appropriate layers can be fitted as specified in manufacturers' instructions and certification.

In addition, this allows the installation of suitable underfloor heating which in turn helps to make a room feel warmer for a slightly lower temperature, thus saving more energy.

If there is a 'crawl-space' or larger below the floor, then contractors may be willing and able to install insulation from below after an access hatch has been created. In this case appropriate materials used according to the manufacturers' instructions will make a big difference.

For both these options either a flexible insulation such as mineral wool or wood-fibre batts can be used or rigid foam insulation. The advantage of mineral wool or wood fibre is that they can be fitted snugly to the timbers.

Rigid foams provide more insulation for the same thickness and, if fitted tightly to the timbers, also prevent any draughts, which may get through the mineral wool system. However, fitting rigid foams is more difficult to get right. We must emphasise that, all the appropriate layers must be fitted as specified in manufacturers' instructions and certification.

APPLY INSULATION FROM BELOW

With a very small space, a novel approach is being taken by the start-up company q-bot. They drive a remotely controlled spraying robot under the floor and spray a suitable insulation from below. This seals air gaps and adds a significant layer of insulation.

Care is needed in application especially near wires and pipes as it will be difficult to remove should maintenance be required.

MANAGE THE VENTILATION IN THE VOID

If access is impossible, too disruptive or costly to add insulation, then a lower cost approach has been developed by another start-up company, AIREX to manage air flows under the floor.

Where there are airbricks which ventilate to avoid rot in the timbers these are replaced with intelligent airbricks. These open and close based on the conditions in the air below the floor so less cold air comes in under the floor, but you still avoid timber rot.

SUMMARY

When you are considering insulating your home, there are a few critical questions to ask and important decisions to make. Whatever you plan to do, make sure you have read all of this document to guide your decisions and make you an informed buyer.

- Can I simply bring the insulation level in my loft up to the current standard – or more – with about 400mm of mineral wool or equivalent? This will bring a quick saving.
- What type of wall construction do I have? If cavity and it is not already insulated, can I have cavity wall insulation installed?
- If my walls are solid and therefore very poorly insulating, can I fit internal or external wall insulation? If the outside of my house has simple architecture, is rendered or painted and has few, small windows and few pipes, then external wall insulation may be the answer.
- If my budget is smaller, or if there are complications with adding external insulation, should I choose internal insulation?
- What type of floor do I have? If suspended timber can I lift the boards and add insulation and draught proofing underneath?
- Could I fit underfloor heating to make the heating even more efficient and accelerate my transition to a heat pump?

In most houses, about half the heat is lost through the fabric of your building and the rest from ventilation losses (see **Housewarming Guide H4: Draughts and Ventilation**). It is appropriate, therefore, to focus on improving the insulation in your walls, roof and floor as a priority.

In most cases, these improvements will require a lot of capital and, when inside the dwelling, be disruptive for several days. However, it is possible to make a substantial reduction to heat loss and the cost of your heating bills, so please persevere.

There are many examples of houses which have been retrofitted to halve the heat loss and there are a few examples of really ambitious targets to reach passivhaus standard. Relatively little in this deep dive can be undertaken on a solely DIY basis: you will require the assistance of a professional or skilled tradesperson in making your decisions and drawing up the appropriate specification.

We recommend that you:

- Have a survey from a trusted energy assessor or similar, to help identify the options in your house.
- Use an architect, suitably qualified draughtsman or skilled builder to finalise your decisions and draw up the specification.
- Obtain quotes for the work from around three builders, all of whom are suitably qualified and experienced companies with appropriate insurance.
- Have a contract with the installer, signed by all parties, before work is undertaken.
- Require that manufacturer's instructions and specification sheets are used to avoid damage to the property and to ensure the intended performance is achieved.
- Only use products with appropriate independent certification for the intended use e.g a BBA (British Board of Agreement) certificate.

Enjoy the result - a warmer, less polluting home.

Follow this guide and the results will be a warmer home.

DISCLAIMER

This guidance document is written with the intention of providing a better basis for home owners to decide how to reduce the energy consumption and carbon emissions of their homes.

We have not surveyed your home and so the suggestions and discussions in this document can only be a general guide and LCON and its consultants cannot be held responsible for or accept any liability for damage, failures or disputes which result from the use of this document.

We recommend that specific decisions are made only after a suitable survey by an appropriately qualified specialist.

We recommend gaining several quotes for work from a number of suppliers and suitably qualified and experienced companies with appropriate insurance.

It is essential to follow material manufacturer's instructions and specification sheets to avoid risks of damage to structure and property and to ensure the intended performance is achieved. We recommend the use of only those products with appropriate independent certification for the intended use e.g a BBA (British Board of Agreement) certificate.

We recommend appropriate contracts are used and signed by all parties before work is undertaken and suitable legal advice should be sought.

CREDITS

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