Historic England

Energy Efficiency and Historic Buildings

Insulating Dormer windows

This guidance note has been prepared and edited by David Pickles. It forms one of a series of thirteen guidance notes covering the thermal upgrading of building elements such as roofs, walls and floors. This guidance should be read in conjunction with two other guidance notes in this series: *Insulating Pitched Roofs at Rafter Level* and *Insulating Pitched Roofs at Ceiling Level*.

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www.HistoricEngland.org.uk/energyefficiency

Front cover
Dormer windows are a very prominent feature of many historic buildings and changes in their proportion or detailing are rarely acceptable.
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Summary

This guidance note provides advice on the principles, risks, materials and methods for insulating dormer windows. Dormers come in a large variety of shapes, sizes and materials and can be a particularly difficult element to insulate. However, if insulation is omitted or is poorly detailed then the energy performance of the whole roof can be compromised.

Retro-fitting insulation to any existing building is not straightforward, even if it is of relatively recent construction. Considerable ingenuity and attention to detail is required to ensure that the insulation is installed effectively at every awkward junction and gap. Solutions will normally need to be designed for each situation and professional advice will often be required. This guidance discusses approaches to these challenges in general terms, it cannot advocate standard solutions because of the complexities involved in individual situations. Ideally the upgrading of dormer windows should, wherever possible, be undertaken in conjunction with general roof upgrading work.

Dormer windows can be a very prominent and significant feature of many historic buildings and changes in their proportion or external detailing should be avoided in any upgrading. This is particularly important if their design reflects that of other windows on the building or of matching dormer windows in neighbouring buildings. For listed buildings and those in conservation areas, the addition of insulation to dormers should be discussed in advance with the local planning authority, particularly if there are likely to be any changes in appearance.

Contents

Introduction

Energy Planning

Before contemplating measures to enhance the thermal performance of a historic building it is important to assess the building and the way it is used in order to understand:

- the heritage values (significance) of the building
- the construction and condition of the building fabric and building services
- the existing hygrothermal behaviour of the building
- the likely effectiveness and value for money of measures to improve energy performance
- the impact of the measures on significance
- the technical risks associated with the measures

This will help to identify the measures best suited to an individual building or household, taking behaviour into consideration as well as the building envelope and services.

Technical Risks

Altering the thermal performance of older buildings is not without risks. The most significant risk is that of creating condensation which can be on the surface of a building component or between layers of the building fabric, which is referred to as 'interstitial condensation'. Condensation can give rise to mould forming and potential health problems for occupants. It can also damage the building fabric through decay. Avoiding the risk of condensation can be complex as a wide range of variables come into play.

Where advice is given in this series of guidance notes on adding insulation into existing permeable construction, we generally consider that insulation which has hygroscopic properties is used as this offers a beneficial 'buffering' effect during fluctuations in temperature and vapour pressure, thus reducing the risk of surface and interstitial condensation occurring. However, high levels of humidity can still pose problems even when the insulation is hygroscopic. Insulation materials with low permeability are not entirely incompatible with older construction but careful thought needs to be given to reducing levels of water vapour moving through such construction either by means of effectively ventilated cavities or through vapour control layers.

The movement of water vapour through parts of the construction is a key issue when considering thermal upgrading, but many other factors need to be considered to arrive at an optimum solution such as heating regimes and the orientation and exposure of the particular building.

More research is needed to help us fully understand the passage of moisture through buildings and how certain forms of construction and materials can mitigate these risks. For older buildings there is no 'one size fits all' solution, each building needs to be considered and an optimum solution devised.

Technical Details

The technical drawings included in this guidance document are diagrammatic only and are used to illustrate general principles. They are not intended to be used as drawings for purposes of construction.

Older buildings need to be evaluated individually to assess the most suitable form of construction based on a wide variety of possible variables.

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1 Dormer Window Construction

A dormer is a frame projecting from a pitched roof generally used to increase the amount of space and light in rooms contained within the roof-space. Dormer windows normally have a roof, two sides (or 'cheeks'), and a window at the front although a considerable range of variations on this theme can be found. Most dormers will be 'projecting,' that is positioned completely above the line of the pitched roof although others can be recessed or semi-recessed.

Dormers are sometimes cut into the eaves of a building to allow light into rooms inserted in a one and a half-storey building. Such dormers that are flush with and built from the same material as the masonry facade of the building are sometimes referred to as semi-or half dormers. The insulation of these dormers will combine elements of the wall insulation with the dormer insulation.

Dormers can have several different styles of roof. Most common is a small pitched roof with a central ridge creating a small triangular gable above the window. Others are hipped at the front or have roofs that slope to the front, sometimes called a 'cat-slide' roof. Often thatched roofs have dormers where the sides are also thatched in one smooth curve creating an eyebrow-shaped dormer at the front.

Figure 1 (top)
A projecting dormer positioned above the roof slope.

Figure 2 (above)
A semi or half dormer connected to the front wall.
© Oxley Conservation.

Figures 3-5
Dormer windows are a very prominent feature of many historic buildings and changes in their proportion or detailing are rarely acceptable.
Figures 3-4 © Oxley Conservation.

The other common form of dormer has a flat roof. These are a slightly pitched to shed rainwater to the front, to the sides or to the rear. Larger variants may have gutters but often these simply drain directly onto the main roof slope.

The material used for the roofs of pitched dormers is usually the same as the main roof. However, flat dormer roofs are traditionally made of lead, but can be other metals such as zinc or copper, or asphalt or bituminous felt.

Dormer cheeks can also match the roof covering, but more often they are of lead or wooden boarding. It is unusual to find dormer cheeks made of masonry because their weight has to be borne by the roof structure.

Traditional dormers are normally made of simple, lightweight timber frames. The inside faces of the frame are typically covered with lath and plaster, timber boarding, or replacement plasterboard. Dormers are often quite insubstantial structures and are sometimes regarded as historically unimportant. But the size, materials and detailing of dormers often reveals information about the development of the building, and should not be changed arbitrarily. The timbers, though often lightweight, can be of archaeological significance. The windows are particularly important, and if historically significant should not be replaced merely to improve energy efficiency. Consideration could however be given to their upgrading.

2 Adding Insulation

The need to insulate a dormer is triggered by the insulation of the pitched roof in which it sits. The task of insulating will be substantially easier if carried out at the same time as the insulation of the main roof, but occasionally it will be necessary where a roof has already been insulated.

The main aims when insulating a roof with dormers should be:

- To upgrade the thermal performance of the dormer window as much as possible
- To add enough insulation to the dormer to prevent heat loss, and 'cold bridging'
- To ensure that air-tightness is maintained around the dormer, preventing draughts
- To ensure that ventilation paths to any ventilated roof spaces above the dormers are not disturbed
- To minimise the risk of corrosion to the underside of any lead used to clad the dormer cheeks or roof by careful detailing and installation

All of the different elements which make up a dormer should be considered together when adding insulation. The benefits of insulating the dormer roof will only be marginal if the cheeks have little or no insulation and the effectiveness of insulation to the main roof can be significantly compromised if dormers are left un-insulated.

The cheeks which are often the narrowest part of a dormer window can be challenging to upgrade as it is often very difficult to install a sufficient thickness of insulation whilst also creating the ventilation paths which are required. In most cases it will not be possible to change the proportions of the dormer at all and at best only by the width of a counter-batten (25mm) in the others. If more flexibility exists, for example if the dormer faces into a hidden valley, then better results can be achieved.

Adding insulation to the main roof will often require changes to be made to the dormers themselves. In particular, insulation laid above the rafters of the main roof will require the dormer being moved up, or more often, forwards.

It is usually feasible to remove the roof and cheek claddings from a dormer in order to install insulation, even if the roof coverings are not being removed from the main roof slopes. This may not be necessary if the internal lining of the dormer can be removed and replaced, though removing historic boarding or lath and plaster should be avoided if possible. It will not be possible to adequately insulate a dormer without removing either the inner or outer cladding.

In most cases, the only space available to insulate the cheeks will be within the spaces between the elements of the frame. This may mean insulation thicknesses of 75mm or less, which is not normally enough to meet Building Regulation targets (see below) but the exemptions and special considerations applicable to historic buildings mean that a sensible compromise should result. To make the insulation work effectively it should be packed consistently into all corners of the spaces, otherwise cold bridging will be likely.

As timber has only a moderate insulation value, the timber elements of the frame will tend to act as a cold bridge in any case. It is therefore highly

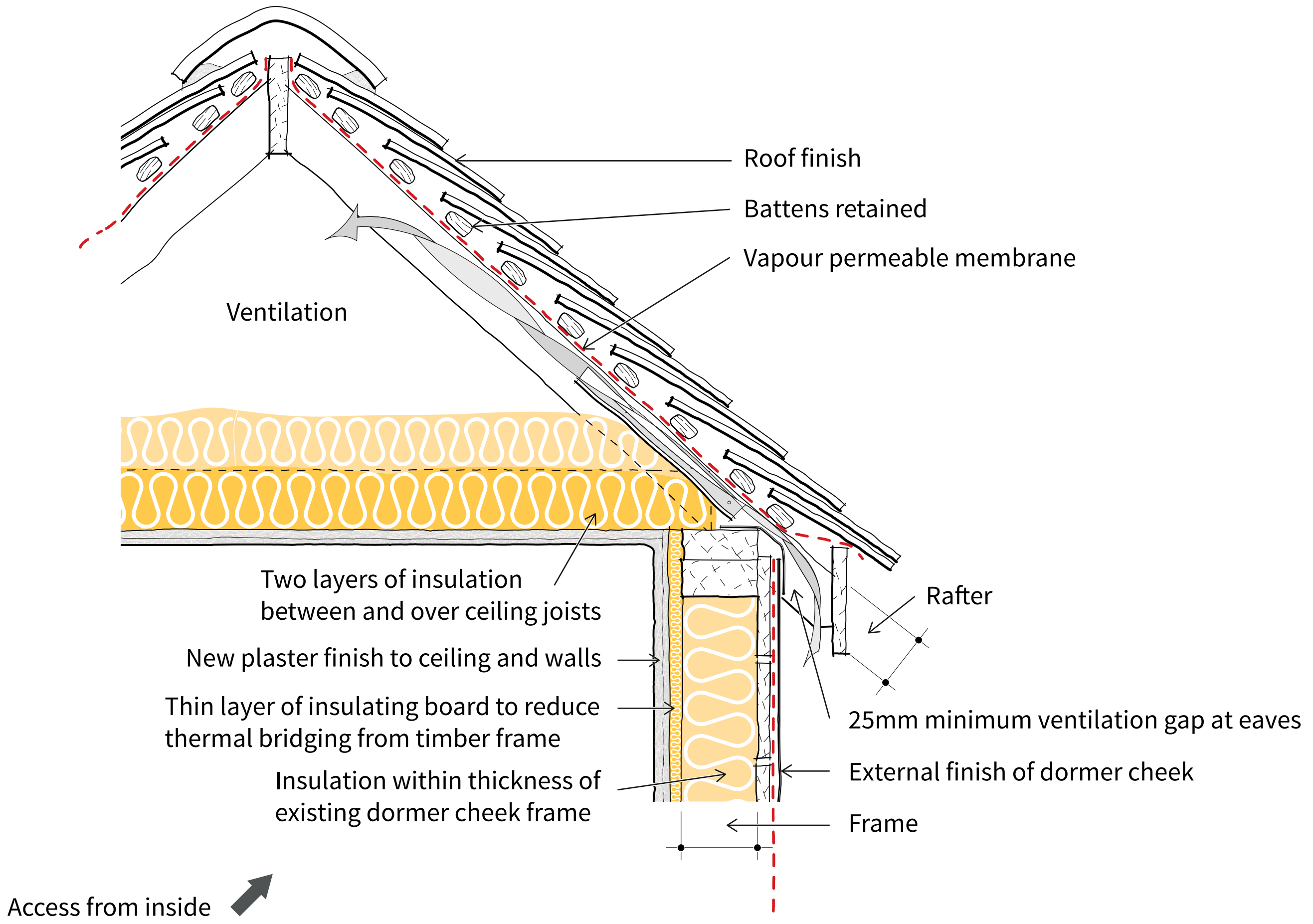

Figure 6: Insulation of dormer windows (Insulation placed within cheeks of dormer)
Insulation can often be added within the thickness of the existing frame without disturbing the external finish to the cheeks of the dormer. However, the thickness will in many cases be quite minimal. A thinner layer of insulation board is shown on the inside of the timber frame to reduce any potential the cold bridging from the frame itself. It the dormer is pitched then insulation can also be added to the roof void but it is important to maintain ventilation to this space.

desirable to add at least a thin layer of insulating board either outside, or inside the frame. Even 20mm can have a significant effect on the overall insulation value and on reducing cold bridges.

If, as is usual, the upgraded insulation of the dormer is not as thick as in the remainder of the roof there will always be a risk that condensation will form on the inside of the lining and also within the structure and insulation itself. Whilst this can theoretically be controlled by the introduction of a vapour barrier inside the new insulation, in practice it is virtually impossible to adequately seal such a barrier in a historic structure and it is in any case likely to trap and concentrate moisture against vulnerable fabric. The best way to avoid mould growth and deterioration of finishes is to use vapour permeable paints and breathable lime plasters

Figure 7
The cheeks, which are often the narrowest part of a dormer window, can be challenging to upgrade.
© Oxley Conservation.

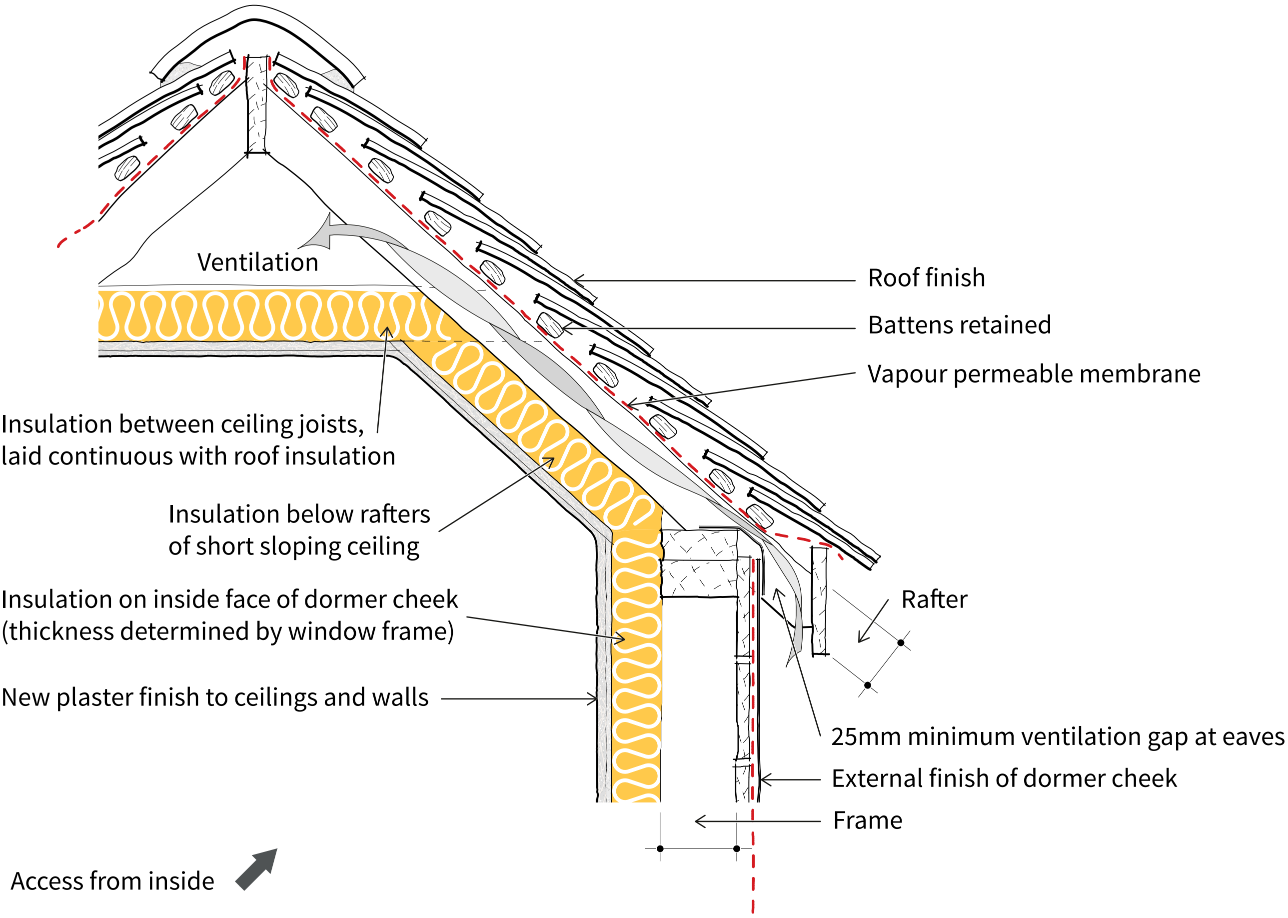

Figure 8: Insulation of dormer windows
(Insulation placed to internal face of dormer cheek and below rafters)
Placing insulation on the inside of the dormer cheek avoids disturbing the existing construction but may be rather limited by the size of the window frame.

This detail also shows insulation added to the sloping ceiling and to the roof void above.

so that any damage caused by condensation will be minimised by allowing it to easily evaporate back out again as soon as conditions change.

2.1 Flat roofs

Flat dormer roofs are similarly difficult to insulate, as often the roof line cannot be raised or the ceiling lowered. Like the cheeks, the insulation may only be able to be added between the joists supporting the roof, though a layer of insulating board either inside or outside would again be helpful to minimise thermal bridging.

2.2 Pitched roofs

Pitched roofs of dormers often have a small void above a horizontal ceiling. This gives plenty of space for insulation and in some cases the best solution may even be to completely fill the void with natural-fibre based insulation - although as with many roofs, a ventilation path above the insulation is preferred.

Figure 9
An 'eyebrow' dormer in a newly thatched roof before final trimming.
© Oxley Conservation.

If the ceiling is sloped, following the underside of the dormer rafters, the insulation may have to be confined between the rafters in a similar manner to the cheeks. However, unless there is a historic ceiling with significant detailing, it is often quite possible to add some insulation to the inner face without obstructing the window or causing an unacceptable loss of head room.

2.3 Cat-slide roofs

Most dormers with cat-slide roofs will have sloping ceilings under the roof. These roofs may be able to accommodate a thin sarking insulation board above the rafters, insulation between the rafters, and some thickness of insulation beneath the rafters, provided that it is shaped to not block the window at the front.

2.4 Air-tightness

Cold air entering and warm air leaving a building through gaps are major causes of heat loss and create uncomfortable draughts. Whenever elements are insulated careful thought should be given to eliminating such gaps. The best way to ensure continuity of air-tightness is to use a breathable membrane in the construction, to carefully tape all joints, and to attempt to minimise discontinuities at awkward junctions. Attention should also be focussed on these joints to minimise infiltration.

Ensuring air-tightness around a dormer will be easier if the dormer is being insulated at the same time as the main roof, and the roof coverings are being lifted. Typically, in this situation, a vapour permeable roofing felt can be laid in a contiguous layer beneath the roof coverings, up and around the dormer. If only the dormer is being insulated, or if the insulation is being added from the inside, more ingenuity will be required to ensure air-tightness.

2.5 Prevention of underside corrosion

The underside of lead roofs can be exposed to water caused by condensation or by wetting of the substrate during construction, and can also be exposed to acids leaching from the boarding on which it sits. This combination can cause corrosion and premature failure of lead roofs. Zinc roofs also are vulnerable to underside corrosion though zinc sheets are available with a factory applied underside coating that prevents corrosion. Historic England has published separate guidance on underside lead corrosion, which should be consulted if this is likely to be an issue.

2.6 Ventilation of main roof

Dormers are often situated in attic rooms that have a roof-space above them. This space must be ventilated to prevent condensation build up. Often this ventilation is provided through a void between counter-battens on the main roof or through eaves ventilators. Dormer windows can block part of this air flow. In a large roof with a few isolated dormers this will only have a small impact, and enough air will pass through the remainder of the roof. However, it is not unusual to see roofs with several dormers blocking more than half of the possible ventilation channels. In this situation it will be necessary to supplement the ventilation of the main roof space, perhaps by installing vents on the gables of the building, or by concealed vents just above the roof of the dormer.

2.7 Upgrading windows

An important way to improve the performance of the dormer is to improve the window itself. The simplest way to do this is to ensure that it is well fitting and in good repair. That will eliminate most of the draughts.

Adding draught proofing to the window can make a further improvement without affecting the appearance or character of the window. Secondary glazing is an option for dormer windows, particularly those facing onto busy roads where sound insulation would be a benefit. Installing secondary glazing into the tight confines of some dormer windows can be challenging, particularly, if as is often the case, there is little or no internal window sill. Fitting internal shutters, curtains or blinds to a dormer window in such a way that they have a meaningful effect on heat loss is difficult but often worth the effort.

For more information on upgrading windows see Historic England guidance:
Traditional windows: their care, repair and upgrading.

3 Appropriate Insulation Materials

It is important that all materials used in buildings of traditional construction are appropriate, particularly that they are 'breathable'. Much of the information and advice contained in this guidance is based upon the development and integration during the last ten years of 'natural' insulation materials in the repair and improvement of historic buildings. Before this time the insulation materials available were designed for use in modern buildings and were incompatible with the performance of many traditional buildings.

The presence of moisture in any part of the fabric of a traditional building cannot be ruled out because of their permeable nature. Condensation can occur both at the surface and within the pores of vapour permeable materials. Insulation materials added to traditional buildings therefore need to be able to absorb and release moisture in parallel with the older materials around them, as well as to perform well as an insulator whilst accommodating a range of moisture contents.

3.1 Rigid boards

Rigid boards may be used to insulate inside or outside the dormer frame. The most appropriate material for older buildings that is currently available is wood-fibre board, which has the following performance characteristics:

- Sufficient insulation qualities to reduce heat loss
- Sufficient insulation qualities to reduce the risks of cold bridging above the rafters
- Sufficient thermal mass to reduce the risks of over-heating
- Can be laid to be tight fitting to reduce gaps and unwanted air infiltration. Wood-fibre boards are available with interlocking joints to assist with this, though it is still essential to seal edges
- Vapour permeable; to achieve a vapour-balanced 'breathing' construction

3.2 Insulating batts

There are several types of materials suitable for insulation within the dormer frame. The most appropriate materials are natural-fibre based insulation such as sheep's wool and hemp-fibre insulation. These have the following performance characteristics:

- They are hygroscopic; that is they can absorb but also release excess moisture
- They retain their insulation qualities when damp (although not when fully saturated)
- They are non-hazardous fibres

The use of flexible insulation batts and rolls between the rafters improves the ability to achieve a tight-fitting insulation. In contrast rigid insulation boards are difficult to cut and scribe tightly between elements of the frame, which in many cases p9are highly irregular.

3.3 Amounts of insulation

The Approved Document that gives practical guidance to Part L of the Building Regulations (2010) for existing dwellings (ADLIB) has a specific target of 0.30W/m2K for the sides of dormers but not for other elements of a dormer. The Approved Document states that the expected levels for other walls and roofs will apply to dormers and are 0.18 W/m2K for refurbished flat roofs, 0.18 W/m2K for refurbished pitched roofs and 0.30 W/m2K for walls.

In most cases it will be very difficult to achieve these levels of insulation in dormers without substantially compromising the appearance of the dormer. Therefore in most historic buildings it will be necessary to simply achieve the best degree of upgrading which the existing structure can allow.

Figure 10 (top)
This simple apex dormer is relatively easy to upgrade along with the adjacent roof repair works.
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Figure 11 (above)
The repaired dormer surrounded by wood-fibre sarking insulation board. The joints have been taped to maintain air-tightness.
© Oxley Conservation.

U-Values

U-values measure how quickly energy will pass through one square metre of a barrier when the air temperatures on either side differ by one degree.

U-values are expressed in units of Watts per square metre per degree of temperature difference (W/m2K).

The importance of ‘breathing’ performance

Most traditional buildings are made of permeable materials and do not incorporate the barriers to external moisture such as cavities, rain-screens, damp-proof courses, vapour barriers and membranes which are standard in modern construction. As a result, the permeable fabric in historic structures tends to absorb more moisture, which is then released by internal and external evaporation. When traditional buildings are working as they were designed to, the evaporation will keep dampness levels in the building fabric below the levels at which decay can start to develop. This is often referred to as a ‘breathing’ building.

If properly maintained a ‘breathing’ building has definite advantages over a modern impermeable building. Permeable materials such as lime and/or earth based mortars, renders, plasters and limewash act as a buffer for environmental moisture, absorbing it from the air when humidity is high, and releasing it when the air is dry. Modern construction relies on mechanical extraction to remove water vapour formed by the activities of occupants.

As traditional buildings need to ‘breathe’ the use of vapour barriers and many materials commonly found in modern buildings must be avoided when making improvements to energy efficiency, as these materials can trap and hold moisture and create problems for the building. The use of modern materials needs to be based upon an informed analysis where the implications of their inclusion and the risk of problems are fully understood.

It is also important that buildings are well maintained, otherwise improvements made in energy efficiency will be cancelled out by the problems associated with water ingress and/ or excessive draughts. primary and secondary glazing

4 Where to Get Advice

This guidance forms part of a series of thirteen documents which are listed below, providing advice on the principles, risks, materials and methods for improving the energy efficiency of various building elements such as roofs, walls and floors in older buildings.

This series forms part of a wider comprehensive suite of guidance providing good practice advice on adaptation to reduce energy use and the application and likely impact of carbon legislation on older buildings.

The complete series of guidance is available to download from the Historic England website: HistoricEngland.org.uk/energyefficiency

Roofs

- *Insulating pitched roofs at rafter level*
- *Insulating pitched roofs at ceiling level*
- *Insulating flat roofs*
- *Insulating thatched roofs*
- *Open fires, chimneys and flues*
- *Insulating dormer windows*

Walls

- *Insulating timber-framed walls*
- *Insulating solid walls*
- *Insulating early cavity walls*

Windows and doors

- *Draught-proofing windows and doors*
- *Secondary glazing for windows*

Floors

- *Insulating suspended timber floors*
- *Insulating solid ground floors*

For information on consents and regulations for energy improvement work see historicengland.org.uk/advice/your-home/saving-energy/consent-regulations/

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