Energy Efficiency Best Practice in Housing

Energy efficient loft extensions

This guide explains how to achieve Best Practice standards of energy efficiency. Intended for designers, builders and homeowners carrying out loft conversions, it deals with:

- insulation in roofs, dormers, gables and chimney breasts;
- energy efficient windows;
- efficient heating;
- controlled ventilation;
- energy efficient lighting.

Two companion guides are also available: *Energy Efficient Domestic Extensions* (CE122) and *Energy Efficient Garage Conversions* (CE121).

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Introduction

In the UK, homes are responsible for approximately 28 per cent of carbon dioxide emissions, a major contributor to climate change. Domestic emissions arise from the use of energy for space and water heating, cooking, and the use of lighting and electrical appliances. To meet our international commitments and tackle climate change, we must significantly reduce energy related emissions in homes. By following Best Practice standards, new build and refurbished housing will be more energy efficient and will reduce these emissions, saving energy, money and the environment.

Converting a roofspace or loft into extra living area can be a very practical and cost-effective alternative to relocation. However, it requires significant investment both in time and money. The resulting accommodation is likely to remain in use for more than 60 years, so it is important to design and build to a high standard. Many homeowners engage architects to assist them; others rely on reputable builders; a few design and convert their roofspaces themselves.

This guide is for designers, builders and homeowners contemplating loft conversions. It explains how to incorporate energy efficiency into the design and specification, dealing with:

- conversion options;
- insulation of roofs, dormers, gables and chimney breasts;
- energy efficient, high-performance windows;
- thermal bridging and air leakage;
- controlled ventilation;
- efficient heating;
- energy efficient lighting.

There are two companion guides, Energy Efficient Domestic Extensions (CE122) and Energy Efficient Garage Conversions (CE121).

Energy efficiency

Loft conversions are important; they can provide new, energy efficient accommodation and can also improve the overall energy efficiency of the houses. Converting a loft into a living area provides more space but need not increase heat losses or fuel costs. The homeowner can quickly recover any additional costs for energy efficiency measures through reduced fuel bills. Payback periods are usually less than seven years, and fuel costs are reduced for the entire life of the building.

The three most important factors that contribute to energy efficiency are:

- the level of insulation and the air-tightness of the walls and roof;
- the choice of fuel and the efficiency of the heating system;
- the efficiency of lights and electrical appliances.

Converting a loft

The process of converting a loft usually falls into the following stages.

1. Reviewing the options, and preparing an outline design.
2. Obtaining planning permission.
3. Preparing a detailed design and specification.
4. Obtaining building regulations approval.
5. Selecting a builder.
6. Construction.

The main opportunity to ensure a high standard of energy efficiency occurs at stage 3, when the detailed specifications for materials and products are prepared. However, it should also be borne in mind at stage 1, because the form of the conversion affects its energy efficiency. The quality of the builder's work (stage 6) can have a significant impact on the effectiveness of the insulation and the degree of air-tightness, which will in turn affect both energy efficiency and comfort.

When converting a loft, it may be worthwhile to improve the energy efficiency of the rest of the house at the same time; see *Energy Efficient Refurbishment of Existing Housing* (CE83).

Loft conversion options

Some conversions are inherently easier to make energy efficient than others. The most efficient forms minimise heat losses by reducing the ratio of heat loss area (i.e. exposed walls and roofs) to floor area. They also allow easy installation of insulation. The main choices are as follows.

- Use of dormer windows. This provides good headroom over more of the floorspace than other options, and allows conventional windows to be used. However, the roof form is complex, with more complicated construction and greater heat loss area. Figures 1 and 2 illustrate ways in which such conversions can be insulated.
- Incorporation of roof windows, within the pitch of the existing roof. This produces a 'cathedral' type conversion, with relatively simple form and construction. Figures 3 and 4 illustrate ways in which this type of conversion may be insulated.
- Conversion of a loft that already has vertical walls (usually between 0.6 m and 1.8 m high) beneath the roof itself. This option is rare today, as most such lofts have already been converted. Figure 5 illustrates a typical 'half-wall' conversion.

Many roofs constructed during the last 30 years are supported by 'trussed rafters'. Here the lofts are criss-crossed by timber ties that brace the thin timber rafters. These ties cannot easily be removed, which makes conversion of the roofspace more difficult and expensive, usually involving either very limited additional accommodation or re-building the roof. A garage conversion or an extension is likely to be a more cost-effective option.

Figure 1: Insulating a 'dormer' type conversion (option 1)

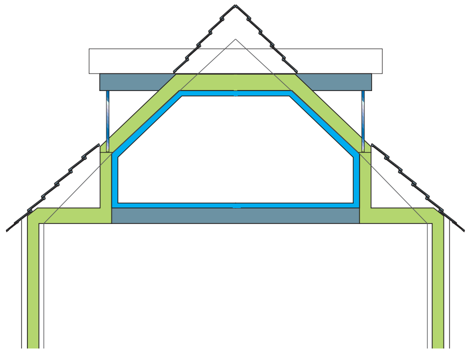


Figure 2: Insulating a 'dormer' type conversion (option 2)

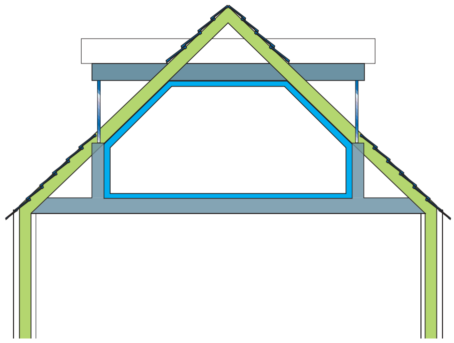


Figure 3: Insulating a 'cathedral' type conversion (option 1)

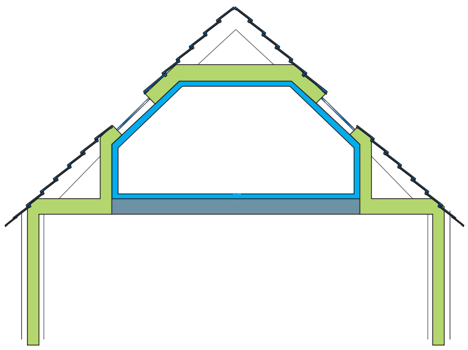


Figure 4: Insulating a 'cathedral' type conversion (option 2)

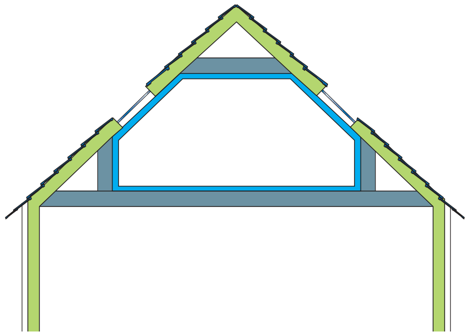
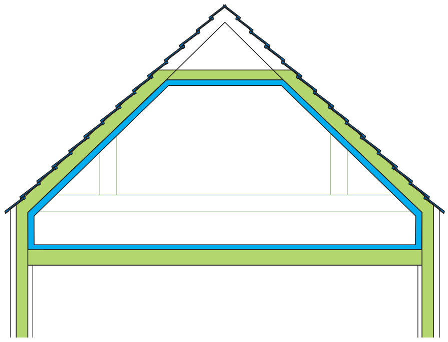


Figure 5: A 'half wall' conversion



Insulation

Loft insulation is the most cost effective energy efficiency measure and the easiest to install. Standards of loft insulation have increased in recent times. Some previously insulated lofts should be 'topped-up' as building regulations now specify a minimum of 250mm thick insulation.

UK Building regulations impose minimum insulation standards for loft conversions, which are considered to be 'material alterations'. The thermal transmittances (U-values) of exposed walls, roofs and openings must not exceed set maximum values.

Best Practice insulation standards set out in Table 1 provide for a better overall standard of insulation, thus reducing fuel use, fuel costs and carbon emissions. These cost savings (and the chance to buy smaller heating systems because of reduced heat losses) will offset higher expenditure on insulation.

Table 1: Recommended Best Practice elemental U-values for domestic roofspace conversions. The values for glazed openings (windows, doors and rooflights) are area-weighted averages for all the openings in the conversion.

Exposed element	Maximum U-value (W/m²K)
Roofs	0.13
Existing walls (e.g. gables)	0.35-0.45
New walls (e.g. dormers)	0.25
Windows and rooflights	1.80

U-values

The U-value of a construction is its thermal transmittance, in W/m²K. The more insulation a construction contains, the lower the U-value. Thus thermal insulation standards for building elements are usually expressed as maximum permissible U-values.

Three types of insulation are commonly used in roofspace conversions:

- rigid insulation;
- flexible insulation;
- thermal lining boards.

Rigid insulation is usually a form of plastic foam board, e.g. polyisocyanurate board. Glass fibre and mineral fibre quilts are examples of flexible insulation. Thermal lining board usually consists of mineral wool or plastic foam insulation bonded to plasterboard and contains an integral vapour check.

Insulation materials are readily available and can be installed by DIYers. Installing loft insulation can save (on average) £80 to £100 on annual heating bills.

For a given thickness, rigid insulants usually have better insulating properties (i.e. lower thermal conductivity) than flexible types. See *Effective use of insulation in dwellings: a guide for specifiers and contractors* (CE23).

Roof insulation

Existing roofs should be insulated to Best Practice standards – as detailed in Table 1 above, (i.e. to achieve maximum U-values of 0.13W/m²K).
The following two technical factors affect the insulation of existing roofs.

- For an insulated pitched roof (where the insulation is placed between the rafters) the building regulations specify that a 50mm wide ventilation gap must be maintained above the insulation (and beneath the roofing felt and tiles); this is to reduce the risk of interstitial condensation. Consequently, the thickness of any insulation placed between the rafters must be at least 50mm less than the depth of the rafters. Eaves ventilators and ridge or abutment ventilators must also be installed, in order to let ventilation air in at eaves level and out at the top of the roof.
- Where new ceiling linings of plasterboard (rather than thermal boards) are fixed beneath the newly insulated construction, polythene vapour barriers must be fixed beneath the joists or rafters (behind the linings). This reduces the risk of interstitial condensation. Edges, joints and any breaks in the vapour barriers (e.g. at electrical switches and sockets) should be sealed with tape.

If the existing rafters are not deep enough to take the depth of insulation needed to achieve the recommended U-value (plus the 50mm ventilation gap) there are three options:

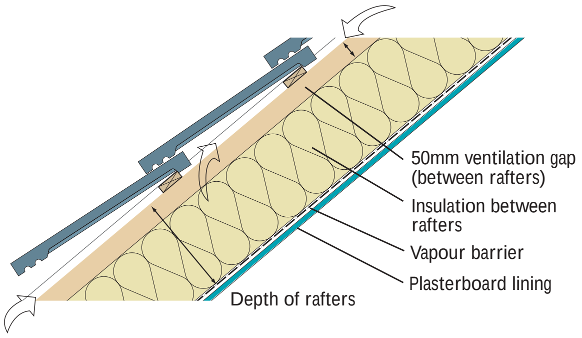
- supplement the insulation between the rafters by using a thermal board (instead of ordinary plasterboard) for the internal ceiling lining;
- increase the depth of the rafters by fixing timber battens to them (but this involves a loss of headroom);
- use a form of construction called a 'vapour-balanced' or 'breathing' roof.

These options may be combined.

Vapour-balanced 'breathing' construction

A vapour-balanced roof construction allows moisture to permeate, removing the need for ventilation of the roof construction. The vapour resistance on the inside of the construction should be five times that on the outside. The impervious roofing felt is replaced by 'breather felt'. The 50mm ventilation gap, the soffit and ridge ventilators as well as the polythene vapour barrier are all omitted. This simplifies the construction and leaves more space for insulation. However, as the existing roofing felt must be replaced by the vapour-permeable type, all the existing slates (or tiles) and tiling battens must be removed and replaced.

Figure 6: A ventilated pitched roof with insulation between the rafters (incorporating a 50mm wide ventilated cavity)



If an unheated roofspace or residual loft remains beneath a pitched roof, flexible insulation quilt may be placed immediately above the ceiling, between the timber ties (or ceiling joists). The insulation will be supported by the ceiling lining (usually plasterboard or thermal board). For maximum effectiveness:

- the insulation quilt should be in two layers, one between the ceiling joists and the other across them, so as to prevent thermal bridging;
- the ceiling lining should be thermal board instead of ordinary plasterboard;
- the insulation material should not be compressed when it is tucked into tight corners.

It is important to ventilate this residual roofspace, above the insulation, in order to reduce the risk of condensation. If the area is to be used for storage, bearer boards should be placed across the existing joists, to prevent the insulation being compressed.

Figure 7: A ventilated pitched roof, with insulation between rafters supplemented by a ceiling lining of thermal board

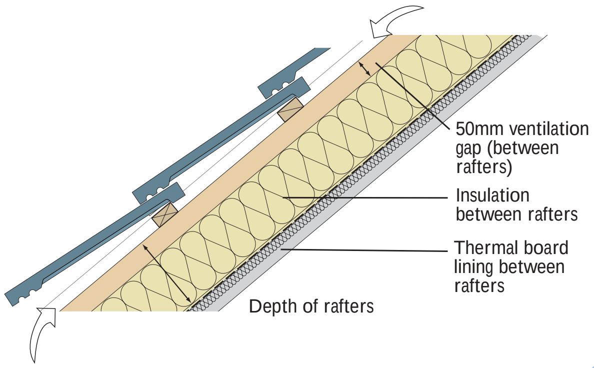


Figure 9: A roof insulated by placing insulation between and across the ceiling joists

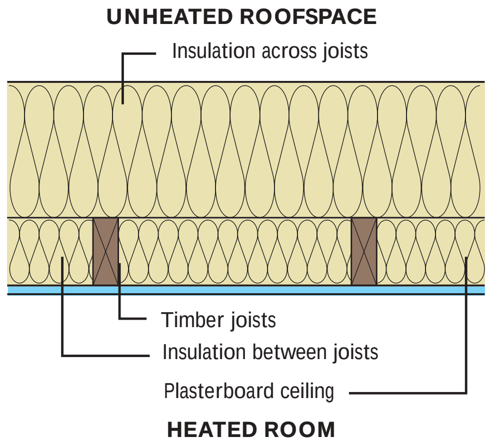
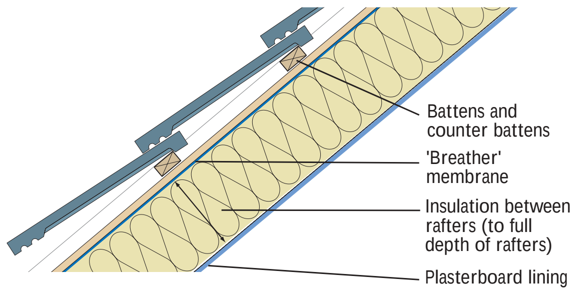


Figure 8: An unventilated insulated pitched roof with vapour balanced or 'breathing' construction, and incorporating insulation



Dormers

The walls and roofs of dormers should be insulated to Best Practice standards (i.e. to achieve maximum U-values of 0.25W/m²K for walls and 0.13W/m²K for roofs) – see Table 1. Since dormers are almost always of timber-framed construction, this will involve a combination of flexible insulation quilt within the frame and thermal lining board on the inside.

- Where felt is used, under tiles or as the finished surface, an internal vapour barrier is critical. A high interstitial condensation risk (even with a vapour barrier) means that lead coverings should only be used for small areas.
- If ordinary plasterboard linings are used (rather than thermal board), polythene vapour barriers should be included on the warmer side of the insulation, behind the linings, in order to reduce the risk of interstitial condensation.
- All edges, joints and breaks in the vapour barriers (e.g. at electrical switches and sockets) should be sealed with tape.

Figure 10: Insulated dormer walls

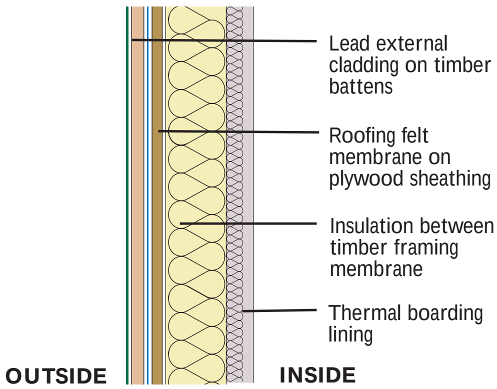
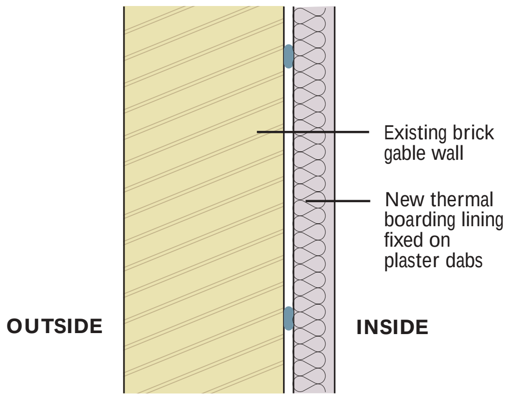


Figure 11: Insulating exposed gable walls internally using a proprietary insulation board



Gable walls and chimney breasts

When a loft is converted, exposed gable walls and any attached chimney breasts become the external walls of the new living space. Insulation should be installed to achieve Best Practice (i.e. U-values between 0.35W/m²K and 0.45W/m²K) – see Table 1.

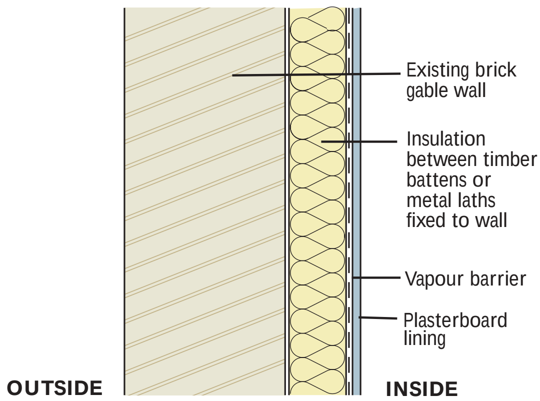
Gable walls and chimney breasts are usually insulated internally, behind new plasterboard linings. However, if the existing wall is of cavity construction and is not already insulated, this can be achieved by blowing mineral fibre, plastic bead or foam insulation into the cavity. This is a specialist operation that involves drilling holes in the brickwork at approximately one metre spacing (horizontally and vertically), then blowing insulation material into the void. It can be carried out from inside, before any plaster or linings are fixed, so the external appearance of the dwelling is not affected. Further information appears in *Cavity wall insulation in existing housing* (CE16).

For solid walls, there are two methods of insulating internally:

- line the wall with a thermal board;
- fix a metal or timber framing system to the wall, place insulation between the frame members and then line the wall internally with plasterboard.

The easiest method of dry-lining is to fix a proprietary insulating board to the inside of the wall. This consists of a layer of plasterboard bonded to a layer of rigid insulation. This can be fixed to the wall mechanically or, more usually, by plaster dabs.

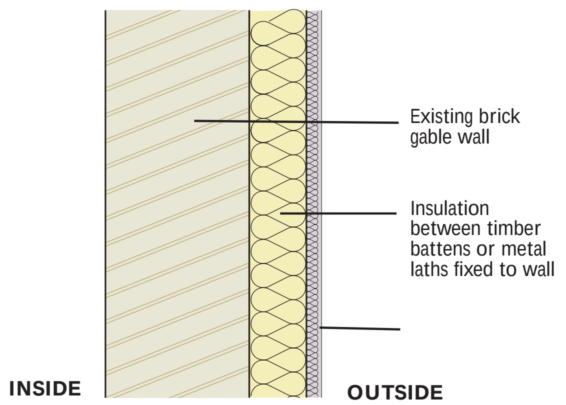
Figure 12: Insulating exposed gable walls internally using a composite framing system and ordinary plasterboard lining



An alternative method involves fixing galvanised steel laths or timber battens to the wall, placing insulation between them, and then lining with plasterboard. This can achieve a better standard of insulation than proprietary lining boards, but at the expense of room space. Insulation is usually 50mm thick, but up to 100mm of insulation can be included. Note that the insulation is 'bridged' by the framing. This problem can be dealt with by combining the two methods of dry-lining which will also deliver better thermal performance, in line with Best Practice standards.

Whichever dry-lining method is used, it is important to seal the edges and joints in the lining board (and any penetrations for services such as electrical switches and sockets). This is done to prevent warm, moist air getting behind the lining, resulting in hidden condensation on the cold masonry surface. Sealing should be carried out with tape, and/or a skim of wet plaster, before the linings are painted.

Figure 13: Combined dry-lining of an exposed gable wall



Other risks of thermal bridging and internal surface condensation need to be considered.

- Where the walls have chimneys or piers attached, the insulated lining should be taken around them – not just butted up to each side.
- Insulation should also be installed in the reveals and soffits of window openings, and beneath window sill boards.

Glazing

Glazing (in windows, roof windows and glazed doors) fulfils several functions. It provides a view out, lets daylight in and assists ventilation. However, the heat loss through one square metre of even modern, high-performance double-glazed windows is much greater than the heat loss through one square metre of insulated external wall or roof. Excessive glazing is therefore a cause of unwanted heat loss.

For loft conversions, building regulations in each part of the UK specify maximum allowable areas of glazed openings (windows, doors and roof windows). They also specify maximum U-values for new openings (windows, doors and rooflights). Adopting the higher, Best Practice standards for openings set out in Table 1 will reduce fuel use, fuel costs and carbon emissions.

There are many possible combinations of frame and glazing types for new openings. Examples of conventional window types (i.e. in vertical gable walls) that meet Best Practice standards are:

- timber-framed windows with double glazing, incorporating at least a 16mm glazing gap, argon gas fill and a 'soft' low emissivity coating;
- timber-framed windows with triple glazing, 12mm glazing gaps, and a 'hard' low emissivity coating;
- metal-framed windows (incorporating thermal breaks) with triple glazing, incorporating at least 16mm glazing gaps, argon gas fill and a 'soft' low emissivity coating.

Examples of roof window types (i.e. in pitched roofs) that meet Best Practice are:

- timber-framed roof windows with triple glazing, incorporating at least 16mm glazing gaps and a 'hard' low emissivity coating;
- timber-framed roof windows with triple glazing, incorporating 12mm glazing gaps and a 'soft' low emissivity coating;
- timber-framed roof windows with triple glazing, incorporating 12mm glazing gaps, argon gas fill and a 'hard' low emissivity coating.

Low emissivity coatings
Low emissivity ('low-e') coatings for glazing are of two main types, known as 'hard' and 'soft'. The soft coatings provide better performance at little additional cost.

Gas filling
The most common form of gas filling for double and triple glazing is argon. Better performance is obtainable at a higher cost by filling with krypton or xenon.

All windows and external doors must be weather-stripped. They should also be equipped with good-quality locking mechanisms that ensure good compression in the seals when closed.

For more information see *Windows for New and Existing Housing: a summary of Best Practice* (CE66) and *Benefits of Best Practice: Glazing* (CE14).

Window energy ratings
The British Fenestration Rating Council (BFRC) Window Energy Label provides an objective standard against which to judge different window types. Selecting an A or B rated product ensures that the windows achieve the manufacturer's claimed performance, and also that air leakage and draughts are kept to a minimum. Since February 2005 Band C and above windows are Energy Efficiency Recommended by Energy Saving Trust (EST).

Ventilation

Housing in the UK has traditionally relied on air infiltration through the building fabric to provide background ventilation. Window opening and the use of extractor fans supplement this when required.

As modern construction methods and regulations deliver a higher standard of airtightness, it is no longer acceptable to rely on infiltration for background ventilation. Today's maxim is 'build tight, ventilate right'. In roofspace conversions, appropriate, controlled ventilation is essential for good air quality and to avoid the risk of condensation. Excessive ventilation, though, results in heat loss with consequent increased fuel use, energy bills and carbon emissions.

Ventilation falls into the following three types.

- Background ventilation is provided by air bricks (with 'hit-and-miss' shutters), trickle ventilators in window heads, and the option on some windows to secure them slightly open in a 'slot ventilation' position.
- Rapid or 'purge' ventilation is achieved by opening windows, when there is a need to expel pollutants or admit fresh air quickly.
- Extract ventilation expels moist stale air from 'wet areas' (kitchens, bathrooms and utility rooms) in order to reduce the risk of surface condensation.

Minimum requirements for each type are set out in building regulations for each part of the UK.

For ventilation to be really energy efficient, it must be provided only when and where it is needed. Wet areas must be provided with extract ventilation, in the form of electric fans or 'passive stack ventilation'.

- Extract ventilation fans should be controlled by humidistats, or wired to operate with light switches (with timed 'run-on').
- Energy efficient, low power fans incorporating DC motors are now available. Fans of this type reduce fuel use, energy costs and carbon emissions.

Heat-recovery room ventilators (HRRVs) combine supply and extract fans in a single 'through the wall' unit. Extracted warm stale air is passed over a plastic cross-flow heat exchanger and the heat in the air is transferred to cool, fresh external air coming into the room. HRRVs reduce the heat loss penalty associated with electric ventilation fans.

Passive stack ventilation

In roofspace conversions, extract ventilation can often be provided by passive stack ventilators. These are vertical plastic ducts, connecting ventilation grilles in ceilings of 'wet spaces' with terminals on or above the roof of the building. Warm, moist air rises up these ducts because of its natural buoyancy (assisted by wind blowing across the roof) and is replaced by fresh air that enters via trickle ventilators in window frames throughout the house. For the stack effect to work properly, the ventilation duct must be at least one metre high, and terminate at or above the highest point of the roof (usually the ridge). Passive stack ventilation is especially good for ensuite bathrooms because it is silent.

For more information see *Energy efficient ventilation in housing: a guide for specifiers on the requirements and options for ventilation* (GPG 268).

Heating

For houses with gas- or oil-fired central heating, a key issue is whether the existing boiler has adequate capacity to heat the enlarged house once the loft conversion is completed. In many cases, the additional heating load makes it necessary to install a new boiler with extra capacity, at significant cost.

A well insulated loft conversion, though, may reduce (or at least leave virtually unchanged) the overall heat loss of the house by improving insulation levels in the exposed roof or walls – thus avoiding the need for a new boiler. Sometimes the original boiler was over-sized, and it may be able to cope perfectly adequately with an increase in heat demand in the order of 10 per cent. It is therefore worth calculating the effect of the proposed conversion on the overall heat requirement of the house at an early stage of the design. Adopting the Best Practice insulation standards in Table 1 will reduce the heat loss of the conversion. This may avoid a requirement for a new boiler, with the associated additional costs. For more information see CIBSE's (The Chartered Institute of Building Services Engineers) *Domestic Heating – Design Guide.*

If a new boiler is required, building regulations require it to have a minimum seasonal efficiency. The Best Practice standard is to install a boiler of seasonal efficiency grade A or B (i.e. at least 90 per cent).[1] Further to this, from 1 April 2005, all gas boilers installed in England and Wales are required to be condensing boilers (aside from a small number of exceptions). In addition, if the boiler is replaced, the regulations require that:

- the heating system must be 'fully pumped' circulation (i.e. not 'gravity feed');
- the heating controls are graded to include a programmer, a room thermostat and a thermostat on any hot water storage cylinder;
- the room thermostat must be 'interlocked' to the boiler (preventing the boiler from firing if there is no demand for heat).

Rooms with internal or solar heat gains (bathrooms, and rooms with south-facing glazing) should also have responsive heating controls such as thermostatic radiator valves (TRVs). These ensure that the heat input is reduced when 'free' heat gains are available. They improve efficiency and reduce the risk of overheating.

For more information on heating and controls, see *Central heating system specifications (CHeSS)* year 2005 (CE51), *Domestic heating by gas: boiler systems* (CE30) and *Domestic heating by oil: boiler systems* (CE29).

1 The seasonal efficiency (and efficiency grade) of any gas- or oil-fired boiler available in the UK may be obtained from the public boiler efficiency database at www.boilers.org.uk.

Condensing boilers

The condensing boiler is the most efficient type available and is becoming the standard choice in most parts of the UK. Further to this, from 1 April 2005, all gas boilers installed in England and Wales are required to be condensing boilers (aside from a small number of exceptions).

Condensing boilers have larger heat exchangers than regular boilers, and achieve seasonal efficiencies of 86-91 per cent. The efficiency of a condensing boiler remains high even at a low level of output (for example, in summer when only providing hot water).

Where a new boiler is required to cope with the additional heat load of an extension, the improved efficiency of a condensing boiler (compared with a conventional model) may compensate for all or part of the extra demand. This results in little or no increase in fuel costs.

Room heaters

If the house whose loft is being converted does not already have a central heating system, it is a good idea to consider installing one (with a condensing boiler). If this is not appropriate or affordable, the new living space may be fitted with fixed individual room heaters.

Several types of room heater are available, running on gas or electricity.[2] Better models have time and temperature controls. A room heater (unless electric or employing a balanced flue) needs a supply of combustion air from outside.

In addition to traditional open hearth and fireplace installations, natural gas heaters are available in wall-mounted models. Wall-mounted units offer some flexibility in room design. Some models must be fitted on an external wall, but others can be fitted on an internal wall with the flue routed to an external wall. The efficiencies of natural gas heaters vary. Some decorative 'open-basket' focal-point heaters have efficiencies as low as 20 per cent, but those of closed radiant convector heaters (including some with the popular coal effect) can exceed 75 per cent.
Electric panel heaters, convector heaters and radiant heaters are 100 per cent efficient (all the energy in the electricity is turned into heat) but they are very expensive to run because they use on-peak electricity, and the associated carbon emissions are high. Where possible, these heaters should be equipped with programmers or time-clocks, and thermostatic controls.

A gas-fired room heater will produce much lower carbon emissions than an electric heater.

Lighting

In most homes, lighting accounts for between 10 per cent and 15 per cent of the electricity bill, and so contributes significantly to carbon emissions. Building regulations in the UK require that new accommodation (including loft conversions) has some light fittings that will only accept energy efficient lamps. At least one new room in three should have such fittings.

- There are two types of energy efficient lamps – fluorescent tubes and compact fluorescent lamps (CFLs).
- Modern CFLs offer good lighting effects. A wide range is available, including spot lamps, candle lamps and coloured lamps of every description.
- Energy efficient lighting is more cost-effective the longer it is in use. It should be considered for any room where the lighting is used for more than four hours each day.
- Installing energy efficient lighting in a loft conversion can produce savings of over £50 per lamp over the life of each lamp, even though it is initially more expensive.

Lighting should be designed according to the use of the room. Properly designed energy efficient lighting can improve the 'feel' of a room as well as saving energy.

The Energy Saving Trust (EST) manages a labelling scheme for products of proven energy efficiency. The scheme currently covers a range of lighting fixtures and fittings. These products carry the Energy Efficiency Recommended label. Currently endorsed products can be found at www.est.org.uk/myhome.

For more information see: *Energy Efficiency Primer* (CE101); *Cost benefit of lighting* (CE56); *Low energy domestic lighting – summary guide* (CE81); *Energy efficient lighting – a guide for installers and specifiers* (CE61); and *Domestic lighting innovations* (CE80).

2 Portable bottled gas and paraffin heaters are not recommended as they have no chimney or flue to allow exhaust gases to escape. Substantial ventilation (involving significant heat loss) must be provided to remove carbon dioxide and water vapour; otherwise there is a significant risk of surface condensation and asphyxiation.

Frequently asked questions

Convert or extend?

Q Is it better to convert a loft, or build an extension?

A This depends on the particular circumstances. Loft conversions can be complex and expensive, but they are usually less costly than extensions – and do not take up garden space!

Insulation

Q Will the converted loft have to be insulated?

A Yes. Loft conversions are treated as 'material alterations', and building regulations specify minimum insulation standards for exposed walls, roofs and new windows.

Q How much insulation should be included?

A Adopt the Best Practice insulation standards set out in Table 1. This will reduce heat losses, and so reduce fuel use, energy costs and carbon emissions. The cost of the extra insulation can be recovered through savings on the price of a smaller heating system. It may even be possible to retain the existing boiler.

Q Will I be able to insert enough insulation into the existing pitched roof construction?

A Yes, if you use the right insulating materials, and insulate both between and beneath the existing rafters.

Q Is there a risk of condensation with an insulated pitched roof?

A The risk of condensation is effectively eliminated if a vapour barrier is included on the warmer side of the insulation (before the linings are fixed) and a 50mm wide ventilated gap is maintained above the insulation (beneath the tiles and felt).

Q What about 'breathing roof' construction?

A This is really 'vapour balanced' construction; it is vapour permeable and so does not need to be ventilated. The existing roofing felt is replaced by a waterproof but vapour-permeable 'breather membrane' (note that the tiles and the existing felt have to be removed, and the tiles re-fixed). The vapour barrier and the 50mm ventilation gap may then be omitted, leaving more space for insulation.

Q Is it necessary to insulate the gable end walls?

A Yes, gable walls should be insulated to the Best Practice standards set out in Table 1. This can usually be achieved internally by means of insulated 'dry-lining'. Chimney breasts and piers should also be insulated, to eliminate thermal bridges.

Q Is insulation effective?

A Yes, if it is properly installed. Architects and builders should understand the need to eliminate 'thermal bridges' and to achieve a good standard of airtightness. There should be no gaps in the insulation at the junctions of walls and roofs, or around openings. All windows, including rooflights, should be properly sealed into the walls or roofs, and the places where services (pipes and wires) penetrate through walls and floors should also be sealed.

Glazed openings

Q Can I have the roof extensively glazed?

A No. Windows are a major contributor to heat loss, and therefore to energy consumption, fuel costs and carbon emissions. An extensively glazed loft conversion is likely to be difficult and expensive to heat. Windows should only be large enough to admit adequate daylight, and the area of north-facing glazing should be minimised. The building regulations specify the maximum ratio of window area to new floor area (25 per cent).

Q What about south-facing roof windows?

A South-facing roof windows do trap useful solar gains, but contribute to summer overheating. South-facing glazing should include blinds to provide shading from high-angle summer sun. Highly-glazed south-facing rooms must be well ventilated.

Q Should I specify high-performance glazing?

A Yes, if possible. Double- or triple-glazing with wide gaps, a low emissivity coating and gas filling will reduce heat losses, and thus reduce energy consumption, fuel costs and carbon emissions. Comfort will improve through reduced down-draughts and decreased risk of internal surface condensation.

Ventilation

Q Does the converted loft have to be ventilated?

A Yes. There must be provision for background, rapid and (in 'wet areas') extract ventilation. Trickle ventilators and opening windows meet most of this requirement. For wet areas, there are several controlled ventilation options, including energy efficient extract fans, heat-recovery room ventilators and passive stack ventilation.

Heating

Q Will the existing heating boiler have to be replaced?

A Not necessarily. If the converted loft is well insulated and airtight, there may be little or no overall increase in heating demand, and the spare capacity in the existing boiler may be sufficient. This can be confirmed by calculation.

Q What if the existing boiler is not adequate?

A If possible, the existing boiler should be replaced by a new condensing boiler, of appropriate output and with a seasonal efficiency not lower than grade B (86 per cent). A condensing boiler will offset additional heat demand, so fuel costs will not necessarily increase significantly.

Q Are condensing boilers expensive?

A Condensing boilers are a little more expensive than conventional boilers of equivalent output, but they are much more efficient. The additional cost is usually recovered through reduced heating and hotwater bills within 2-3 years, and the boiler should go on saving money for at least another eight years. The carbon emissions from condensing boilers are also much less than those from conventional boilers.

Q Will I have to upgrade the heating controls?

A If good controls are not already installed and the boiler is replaced, then they will have to be upgraded. The final system must be fully-pumped, and include a programmer, room thermostat and hot water cylinder thermostat. The room thermostat must be interlocked to the boiler so that the boiler does not fire when there is no demand for heat.

Q Should I include a room heater in the loft conversion?

A An efficient gas-fired room heater is sometimes a good alternative, or supplement, to central heating. Electric room heaters are efficient, but they are also expensive to run and have high carbon emissions.

Lighting

Q What type of lighting should I install?

A Energy efficient lighting with compact fluorescent lamps (CFLs) is much less expensive (over the life of the lamps) than conventional tungsten lighting, even though more expensive initially. Energy efficient lighting significantly reduces electricity use and associated carbon emissions. The Energy Saving Trust (EST) manages a labelling scheme for products of proven energy efficiency. The scheme currently covers a range of lighting fixtures and fittings. These products carry the Energy Efficiency Recommended label. Currently endorsed products can be found at www.est.org.uk/myhome.

Q How can I achieve the desired lighting effect with CFLs?

A A large range of CFL lamp types can be obtained, including spot lamps, candle lamps, and coloured lamps of every description. Multi-tube lamps light up instantly and quickly reach their full brightness. Special dimmer switches are available for use with CFLs.

Professional assistance

Q Who can help me with all this?

A Choose an architect and builder carefully. Ask them if they know how to design energy efficient roofspace conversions, and whether they have completed any. Ask them if they are familiar with this guide, and with the other guides listed below. If in doubt, contact the local Energy Efficiency Advice Centre (EEAC) via the Energy Saving Trust's **Energy Efficiency Helpline** on **0845 727 7200**.

Further information

Energy Efficiency Best Practice in Housing

The following Energy Efficiency Best Practice in Housing publications are available free by telephoning the Helpline on **0845 120 7799** or by visiting the website at: **www.est.org.uk/bestpractice**.

Energy efficient garage conversions (CE121)
Energy efficient domestic extensions (CE122)

General

Energy efficiency primer (CE101)
Achieving Best Practice in new housing: a practical guide (CE95)
Building your own energy efficient house (CE123 / GPG 194)
Energy efficiency in new housing: England Wales and Scotland (CE12)
Energy efficiency in new housing: Northern Ireland (CE24)
Energy efficient refurbishment of existing housing (CE83)
The effect of the Building Regulations (Part L1 2002) on existing dwellings – information for installers and builders for extensions and alterations in England and Wales (CE53)

Insulation

External insulation systems for walls of dwellings (GPG293)
Cavity wall insulation in existing housing (CE16)
Effective use of insulation in dwellings: a guide for specifiers and contractors (CE23)
Insulation materials chart: thermal properties and environmental ratings (CE71)

Windows

Windows for New and Existing Housing: a summary of Best Practice (CE66)

Airtightness

Improving airtightness in existing housing (GPG224)

Ventilation

Energy efficient ventilation in housing: a guide for specifiers on the requirements and options for ventilation (GPG268)

Heating

Domestic heating by gas: boiler systems guidance for installers and specifiers (CE30)
Domestic heating by oil: boiler systems guidance for installers and specifiers (CE29)
Domestic heating: solid fuel systems guidance for installers and specifiers (CE47)
Central heating system specifications (CHeSS) year 2005 (CE51)

Lighting

Low energy domestic lighting – looking for less (CE81)
Low energy lighting – a summary guide (GIL20)

Other publications

The Building Regulations 2000, Approved Document L1, Conservation of Fuel and Power, The Stationery Office, London, 2001.

The Building Standards (Scotland) Regulations 1990, 6th amendment: Technical Standards to Part J, Conservation of Fuel and Power.

The Building Regulations (Northern Ireland) 1994, Technical Booklet part F, Conservation of Fuel and Power (1998).

Limiting thermal bridging and air leakage: robust construction details for dwellings and similar buildings, DEFRA and DTLR, The Stationery Office, London, 2002.

CIBSE Domestic Heating – Design Guide, Chartered Institute of Building Services Engineers, London 2003.

Anderson J and Howard N The Green Guide to Housing Specification, published for the Building Research Establishment by Construction Research Communications Ltd, London, 2000.

CE120

Energy Efficiency Best Practice in Housing

Energy efficient loft extensions

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