



Refurbishing dwellings – a
summary of best practice



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Refurbishing dwellings

Introduction

Home energy use is responsible for 27 per cent of UK carbon dioxide (CO₂) emissions which contribute to climate change. By following the Energy Saving Trust's best practice standards, new build and refurbished housing will be more energy efficient: this will reduce emissions and cut energy consumption, helping to save money and safeguard the environment.

This guide offers advice to those specifying refurbishment work in homes and provides information on best practice standards for typical dwellings in the UK. A summary of the main construction elements and building services are covered here. More detailed guidance is available from the sources listed at the end of this publication.

Existing housing stock is made up of a variety of wall constructions, but there are three forms which are seen most frequently: solid wall, cavity wall, and timber frame. Each of these is described briefly below.

Typical wall constructions

Solid wall

Approximately one out of every five homes in the UK today has traditional nine-inch solid brick walls. This was the main form of construction until the 1930s. Other types of solid wall construction can be found, such as systems using no-fines concrete or pre-cast concrete panels. These buildings suffer high fabric heat loss which leads to high fuel bills. Unfortunately, they are often occupied by those least able to pay higher energy bills.

Refurbishing solid wall buildings in an energy-efficient way raises particular problems for specifiers. The first of these is deciding whether to use internal or external wall insulation. Both options offer advantages and

disadvantages and the final decision often depends upon the scope of the work being planned. If walls are to be re-rendered, for example, it clearly makes sense to add external insulation while this is being done – the work can be carried out while the buildings are occupied (although those living in the property may have to suffer some disruption). On the other hand, if major work is being carried out inside the building (which has to be vacant for this process) then internal insulation may be the better choice.

Cavity wall

Since the late 1920s masonry cavity walls have been used in house construction throughout most of the UK (see Table 1) – although this is a technique which has been in use for more than 100 years. Cavity-walled houses are amongst the easiest to refurbish in an energy-efficient way, as the cavity can be filled with insulation. In cases where such treatment is not appropriate, they can be treated in the same way as solid walls.

Timber-frame

Over the past 25 years, timber-frame homes built in the UK have been constructed with insulation filling the studwork frames. Those built before this – up to 100,000 dwellings – may have little or no insulation. These would have been built in the period between 1920, when 'modern' timber-frame construction was introduced in the UK, and 1976 (1977 in Northern Ireland), when changes to the building regulations first required a wall U-value of 1.0W/m²K.

Between 1966 and 1976, over 80,000 timber-frame dwellings were constructed, mainly for the public sector. Despite increasing standardisation, over 43 different design systems have been catalogued for this period.

Table 1 The rise of cavity walls in new housing

Decade	Development	Cavity width (mm)
1920s	Cavity walls start to grow in popularity	variable
1930s	Cavity walls become main form of construction	variable
1940s	Cavity width becomes standardised	50
1950s	Concrete blocks are used for inner leaf	50
1960s	Lightweight 'aircrete' blocks are introduced	50
1970s	Cavity width is increased	60-70
1980s onwards	Cavity wall insulation (partial or full-fill) starts to be 'built-in'	60-70

The construction system used in a particular property should be identified before refurbishment starts. While it is easy to recognise many of the early examples of timber frame housing, particularly those built before the Second World War (1939-1945), many later designs, especially those built in the 1960s and 70s, look very similar to buildings of conventional masonry construction.

In cases where insulation has been built into the timber-frame walls, it is likely that it was very thin (25-50mm) when it was put in place and it may now be in poor condition. This can cause high heat loss and condensation leading to a lack of comfort for the occupants. It is certainly true that insulation can be added to timber-frame walls without difficulty, but the process can be very disruptive to householders and it is best carried out during major refurbishment programmes, while the properties are unoccupied.

Cost-effectiveness or convenience?

When a house is being completely refurbished, all energy efficiency improvements can be incorporated in one go – but this occurs relatively rarely. Usually, different parts of a home are improved at different times, as repair or replacement is needed, and improvements are seldom carried out in order of

cost-effectiveness. In line with this practice, each measure outlined in the Energy Saving Trust's best practice refurbishment specification should be carried out as and when the opportunity arises, and not prioritised according to cost-effectiveness criteria. For example, insulating a masonry cavity and topping up the loft insulation are tasks which can be carried out at any time and should be completed as soon as possible.

A summary of best practice

In situations where it is possible to exceed the best practice specification – and achieve even better levels of energy efficiency – this is to be recommended.

Occasionally, however, constraints (such as lack of space in sloping ceilings) may make it impossible to meet best practice. In such cases the highest practical levels of performance should be specified and additional energy efficiency measures applied elsewhere.

The specification outlined here is applicable to the vast majority of properties in the UK. There are, however, other factors which may sometimes influence the choice of measures for a refurbishment project: for example, if the dwelling has an unusual form of construction or if it is of particular historical value. Table 2 summarises the key points of the best practice refurbishment specification.

Table 2 Best practice refurbishment specification

Walls	Where possible, walls should be insulated to achieve a maximum U-value of 0.30W/m ² K.
Roofs	Pitched roofs should be insulated at ceiling level to a maximum U-value of 0.16W/m ² K and draught sealing applied to the services penetrations. Roofs insulated at rafters level and flat roofs should achieve a maximum U-value of 0.20W/m ² K.
Ground floors	Floors should be insulated to achieve a maximum U-value of 0.20-0.25W/m ² K (depending on floor geometry).
Windows	Replacement windows Should have a BFRC Rating in band C or above. Existing windows All existing windows should be draughtstripped.
Doors	Replacement doors Solid insulated doors should have a maximum U-value of 1.0W/m ² K. Half glazed insulated doors should have a maximum U-value of 1.5W/m ² K. Existing doors All existing doors should be draughtstripped.
Airtightness	Air leakage paths should be identified and improved using a pressure test. The best practice recommendation is to aim for an air permeability of 5m ³ /h/m ² at 50Pa.
Ventilation	Purpose-provided ventilation systems should be installed.
Heating* and hot water	Heating and hot water systems should meet 'Central Heating System Specifications (CHeSS) – Year 2005' (CE51/GIL59) ¹ best practice standard HR6 or HC6.
*Electric heating should only be used where all insulation measures have already been adopted.	

Building control

Where refurbishment is subject to building regulations^{2,3,4}, proposals should be notified to the building control body before starting work.

Saving fuel and reducing emissions

Refurbishment which meets the specifications outlined here will result in lower greenhouse gas emissions and in lower fuel bills for the occupier. Savings that might typically be expected, compared with a 'base case', are shown here.

The seven most common types of dwelling were assessed (see Table 3) and the results are shown in Tables 4 and 5 – Table 4 relates to gas heated properties and Table 5 applies to electrically heated dwellings. Typical energy use for each dwelling type was calculated using the BRE Domestic Energy Model (BREDEM-12), not only for the 'base case', but also for fully refurbished properties.

Associated fuel costs were calculated using the Standard Assessment Procedure (SAP 2005)⁵. SAP is the UK Government's approved procedure for calculating home energy ratings and is a reliable way of determining the energy efficiency of dwellings.

Table 3 Floor areas for typical dwelling types

Dwelling type	Floor area (m ²)
Flat	61
Detached bungalow	67
Semi-detached bungalow	64
Mid-terrace house	79
End-terrace house	79
Semi-detached house	89
Detached house	104

The SAP rating is based on the calculated cost of space and water heating, adjusted according to floor area (which allows properties of different sizes to be compared). This rating is expressed on a scale which reflects the running costs of a home (where 1 is extremely poor and 100 is zero fuel cost). The SAP calculation process also provides a formula for quantifying CO₂ emissions.



The 'base case'

Each of the seven types of dwelling considered is assumed to meet the same insulation standard, regardless of the heating fuel used.

This consists of:

- An uninsulated solid floor (U-value varies depending on dimensions).
- 100mm of loft insulation (U-value of 0.40W/m²K).
- Unfilled cavity walls (U-value 1.45W/m²K), timber-frame walls (U-value 1.2W/m²K) or solid nine-inch brick walls (U-value 2.1W/m²K), as appropriate.
- Partially double glazed (average U-value 3.5W/m²K).
- Solid wooden floors (U-value 3.0W/m²K).

It is assumed that the living area of each dwelling is heated to 21°C during the morning and evening of each weekday, and throughout the day at weekends.

In the case of natural gas heating the main features of the system are:

- The gas boiler has a SEDBUK efficiency of 70 per cent.
- A cylinder thermostat is used (not applicable for the flat where it is assumed that a combination (combi) boiler will be used).
- Uninsulated primary pipework is used (not relevant for the flat with a combi).
- Cylinder insulation matches the UK stock average, equivalent to a 55mm insulating jacket on a 120 litre cylinder (again, not applicable to the flat).
- There is a room thermostat and programmer, but no thermostatic radiator valves (TRVs).

The main features of the electric heating system are:

- Slimline storage heaters with manual charge control.
- Secondary heating from on-peak panel radiators.
- Cylinder insulation equivalent to a 55mm insulating jacket on a 120 litre cylinder (UK stock average).

The impact of changing the insulation and the building services in order to comply with the best practice refurbishment specification has been calculated for each dwelling type.

U-values, R-values and conductivities

Best practice insulation specifications are generally expressed in terms of a U-value. This is the overall rate of energy transfer through 1m² of a particular building element when the air temperatures on either side differ by 1°C. It is measured in W/m²K.

For some refurbishment situations, it is more useful to quote thermal resistances, or R-values. Thermal resistance depends on thermal conductivity (λ) and thickness (d): $R = d / \lambda$ and is measured in m²K/W. Thermal conductivities of insulating materials are published by manufacturers.

The resistances of each component (as well as the resistances of cavities and surfaces) are used to calculate the overall thermal resistance or R-value for the structural element. The U-value is the reciprocal of this figure.

Typical savings

Table 4 Typical savings in dwellings with natural gas heating

Solid wall								
Dwelling type	Base case				Best practice			
	Energy use (kWh/yr)	Fuel cost (£/yr)	Carbon emissions (kgCO ₂ /yr)	SAP 2005 rating	Energy use (kWh/yr)	Fuel cost (£/yr)	Carbon emissions (kgCO ₂ /yr)	SAP 2005 rating
Flat	15,100	361	3,400	58	6,900	203	1,710	80
Detached bungalow	25,600	539	5,470	42	9,300	245	2,190	76
Semi-detached bungalow	22,900	491	4,930	45	8,800	235	2,080	77
Mid-terraced	20,800	494	4,680	56	9,600	278	2,370	80
End terraced	27,100	598	5,910	45	10,200	288	2,480	78
Semi-detached	30,000	656	6,510	44	11,000	310	2,680	78
Detached	39,700	833	8,480	36	12,600	347	3,030	76

Cavity wall								
Dwelling type	Base case				Best practice			
	Energy use (kWh/yr)	Fuel cost (£/yr)	Carbon emissions (kgCO ₂ /yr)	SAP 2005 rating	Energy use (kWh/yr)	Fuel cost (£/yr)	Carbon emissions (kgCO ₂ /yr)	SAP 2005 rating
Flat	13,300	332	3,060	62	7,300	210	1,790	79
Detached bungalow	22,400	485	4,840	47	10,000	258	2,340	74
Semi-detached bungalow	20,200	446	4,400	50	9,300	244	2,190	75
Mid-terraced	18,700	460	4,270	61	10,000	285	2,450	79
End terraced	23,100	533	5,130	52	11,000	300	2,630	76
Semi-detached	25,600	585	5,660	50	11,900	323	2,840	76
Detached	33,200	725	7,200	43	14,100	371	3,320	73

Timber frame								
Dwelling type	Base case				Best practice			
	Energy use (kWh/yr)	Fuel cost (£/yr)	Carbon emissions (kgCO ₂ /yr)	SAP 2005 rating	Energy use (kWh/yr)	Fuel cost (£/yr)	Carbon emissions (kgCO ₂ /yr)	SAP 2005 rating
Flat	12,500	319	2,900	64	7,200	208	1,770	79
Detached bungalow	20,900	460	4,550	49	9,800	253	2,290	75
Semi-detached bungalow	18,900	426	4,160	52	9,100	241	2,150	76
Mid-terraced	17,700	443	4,070	62	9,900	283	2,420	80
End terraced	21,300	503	4,780	54	10,700	296	2,580	77
Semi-detached	23,700	552	5,280	53	11,600	318	2,780	77
Detached	30,300	677	6,640	46	13,600	363	3,220	74

Table 5 Typical savings in dwellings with electric heating

Solid wall								
Dwelling type	Base case				Best practice			
	Energy use (kWh/yr)	Fuel cost (£/yr)	Carbon emissions (kgCO ₂ /yr)	SAP 2005 rating	Energy use (kWh/yr)	Fuel cost (£/yr)	Carbon emissions (kgCO ₂ /yr)	SAP 2005 rating
Flat	12,600	538	5,320	44	6,200	305	2,640	70
Detached bungalow	20,800	820	8,770	26	7,900	365	3,350	64
Semi-detached bungalow	18,400	737	7,760	30	7,400	345	3,130	66
Mid-terraced	16,400	701	6,930	43	8,000	391	3,370	72
End terraced	21,900	888	9,240	30	8,600	412	3,640	68
Semi-detached	24,200	973	10,210	28	9,400	445	3,980	67
Detached	32,800	1,277	13,840	19	11,100	509	4,670	62

Cavity wall								
Dwelling type	Base case				Best practice			
	Energy use (kWh/yr)	Fuel cost (£/yr)	Carbon emissions (kgCO ₂ /yr)	SAP 2005 rating	Energy use (kWh/yr)	Fuel cost (£/yr)	Carbon emissions (kgCO ₂ /yr)	SAP 2005 rating
Flat	11,200	489	4,700	44	6,600	318	2,800	70
Detached bungalow	17,800	719	7,520	26	8,700	390	3,660	64
Semi-detached bungalow	16,000	654	6,740	30	8,000	366	3,380	66
Mid-terraced	14,500	636	6,130	43	8,400	405	3,560	72
End terraced	18,400	767	7,750	30	9,400	439	3,970	68
Semi-detached	20,500	845	8,630	28	10,400	476	4,370	67
Detached	26,800	1,074	11,320	19	12,500	559	5,290	62

Timber frame								
Dwelling type	Base case				Best practice			
	Energy use (kWh/yr)	Fuel cost (£/yr)	Carbon emissions (kgCO ₂ /yr)	SAP 2005 rating	Energy use (kWh/yr)	Fuel cost (£/yr)	Carbon emissions (kgCO ₂ /yr)	SAP 2005 rating
Flat	10,600	469	4,460	44	6,500	314	2,750	70
Detached bungalow	16,700	679	7,030	26	8,400	382	3,560	64
Semi-detached bungalow	15,000	622	6,340	30	7,800	359	3,300	66
Mid-terraced	13,800	611	5,820	43	8,300	400	3,500	72
End terraced	17,000	720	7,160	30	9,100	429	3,850	68
Semi-detached	19,000	795	8,010	28	10,000	466	4,240	67
Detached	24,500	995	10,350	19	12,000	542	5,080	62

Energy efficient building fabric

The following tables give examples of improvements which, when using appropriate levels of insulation, will meet the best practice refurbishment specification.

The amount of insulation actually needed in individual cases may be affected by the thermal properties of the original structure. It can also be affected by other refurbishment measures being installed in the part of the building under consideration. The insulation requirement will need to be re-calculated if the situation differs from that given in the tables shown here.

Table 6 Thermal conductivities of common insulation products

Insulation type	Typical thermal conductivity (W/mK)
Phenolic	0.022
PIR/PUR	0.023
Extruded polystyrene	0.030
Expanded polystyrene and mineral wool (slab)	0.038
Cellular glass	0.040

Insulating walls

Solid walls

A conventional 220mm solid brick wall with internal plaster will have a U-value of 2.1W/m²K.

External wall insulation

Applying external wall insulation with an R-value of 2.9m²K/W, together with a protective render, can give a U-value of 0.30W/m²K. The exact thickness of insulation needed to achieve this will depend on the conductivity of the material used.

Table 7 Insulation thicknesses for solid wall insulation

Achieving the required R-value ($R = d/\lambda$) For both external and internal insulation	
Insulation conductivity (λ) W/mK	Thickness (d) required (mm)
0.020	57
0.025	71
0.030	86
0.035	100
0.040	114

Internal wall insulation

Applying a plasterboard/insulation laminate with an insulation R-value of 2.9m²K/W will give a U-value of 0.30W/m²K.

The exact thickness of insulation needed to achieve this will depend on the conductivity of the material used.

Cavity walls

Filling the cavity will improve thermal performance. For example:

- 1 A typical pre-1976 cavity wall with 65mm unfilled cavity and plaster facing would have a typical U-value of 1.4W/m²K. With a filled cavity the U-value would be 0.48W/m²K.
- 2 A typical post-1976 cavity wall with 65mm unfilled cavity and plaster facing, would have a typical U-value of 1.0W/m²K. With a filled cavity it would have a U-value of 0.42W/m²K.

Timber frame walls

A typical timber-framed wall might comprise: 105mm external brick, a 50mm cavity, plywood sheathing, and 89mm timber stud framing faced with plasterboard. This would have a U-value of about 1.2W/m²K (with 25mm insulation in between the studs, the U-value would be 0.73W/m²K).

Filling the stud frame with mineral fibre or cellulose insulation will improve the insulation performance. The plasterboard lining will also need to be replaced (a vapour control layer is required). The final U-value will depend on the conductivity of the new insulation.

Table 8 U-values from insulated existing timber frame walls

Insulation conductivity (λ) (W/mK)	U-value achieved (W/m ² K)
0.035	0.39
0.040	0.42

* The U-values given assume that any existing insulation is replaced with new material of known conductivity.

Insulating roofs

Pitched roofs

Lofts: An uninsulated loft space would have a U-value in the region of 2.5W/m²K. With 100mm of insulation ($\lambda = 0.040\text{W/mK}$) this would reduce to 0.40W/m²K.

Two layers of insulation, covering the joists, will achieve a U-value of 0.16W/m²K.

Table 9 Insulation thickness for pitched roofs

Achieving the required U-value	
Insulation conductivity (λ) W/mK	Thickness required (mm)
0.035	100 + 124
0.040	100 + 150
0.045	100 + 180

Given that the conductivity of any existing insulation may not be known, the thicknesses given above are based on new insulation of known conductivity.

Sloping ceilings: Insulate between and under the rafters where possible to achieve a U-value of 0.16W/m²K. If space is limited, the best practicable level of insulation should be installed. A U-value of 0.20W/m²K is usually achievable.

Flat roofs

An uninsulated roof, consisting of a weatherproof membrane over a timber deck, would have a U-value of about 2.6W/m²K. Applying insulation with an R-value of about 4.6m²K/W over the deck would give a final U-value of 0.20W/m²K.

Table 10 Insulation thickness for flat roofs

Achieving the required R-value ($R=d/\lambda$)	
Insulation conductivity (λ) W/mK	Thickness (d) required (mm)
0.020	92
0.025	115
0.030	138
0.035	161
0.040	184

Insulating ground floors

Solid floors

A solid concrete floor slab has a U-value of between 0.45W/m²K and 0.70W/m²K.

Applying insulation with an R-value of 2.5m²K/W under or over new concrete slab, can improve this to between 0.20W/m²K and 0.25W/m²K (depending on floor geometry).

Suspended floors

A floor composed of timber floorboards on joists will have a U-value between 0.45W/m²K and 0.70W/m²K.

Insulation with an R-value of 3.75m²K/W applied between the joists – tight against the underside of the floor deck – will give a final U-value of between 0.20W/m²K and 0.25W/m²K, (depending on floor geometry).

Table 11 Insulation thickness for suspended floors

Achieving the required R-value ($R = d/\lambda$)		
Insulation conductivity (λ) (W/mK)	Thickness (d) required (mm)	
0.020	50	75
0.025	63	94
0.030	75	115
0.035	88	133
0.040	100	150

Flexible thermal linings and insulating renders

In addition to the materials discussed here there are a selection of products, such as flexible thermal linings or insulating render, that can be used to achieve more modest thermal improvements. Although applying these materials alone will not achieve best practice standards, they should be considered for difficult areas such as window reveals where wall thickness and avoidance of mould growth are important. Alternatively, they can be used in situations where only cosmetic refurbishment work was originally planned.

Windows

Single glazed windows of all frame materials will have very high heat loss. These should be replaced with windows having a BFRC Rating in band C or above. This compares with a requirement in England and Wales 2006 revisions to the building regulations for band E or better for replacement windows.

Note that in Scotland a U-value of 2.0W/m²K or 1.8W/m²K is required for replacement windows depending on the type of heating system being used. If in doubt, seek guidance from the building control department at the relevant local authority. Window frames should also be fully draught-stripped.

Doors

A solid timber door will have a U-value of 3.0W/m²K. A new, and insulated, solid door will improve this to below 1.0W/m²K.

A half-glazed door will typically have a U-value of 3.7W/m²K. An insulated half glazed door will improve this to below 1.5W/m²K.

Table 12 BFRC Ratings and U-values for a range of window types

Frame type	Glass layers	Glass type	Air gap (mm)	Gas fill	Spacer	BFRC Rating	Band	U-value
PVC-U (5 chamber)	3	2 x low iron 1x hard coat	16 x 2	Argon	Warm edge hybrid	+4	A	1.3
PVC-U (5 chamber)	2	Soft coat	16	Argon	Silicone rubber	-8	B	1.4
PVC-U (3 chamber)	2	Soft coat	16	Argon	Silicone rubber	-13	C	1.5
Timber	2	Soft coat	16	Argon	Corrugated metal strip	-16	C	1.5
PVC-U (5 chamber)	2	Soft coat	16	Argon	Hard polyurethane	-18	C	1.5
Timber	2	Soft coat	16	Air	Silicone rubber	-22	D	1.6
PVC-U (5 chamber)	2	Soft coat	16	Argon	Aluminium	-23	D	1.6
Aluminium (23mm polyamide breaks)	2	Soft coat	16	Argon	Silicone rubber	-26	D	1.8
Timber	2	Hard coat	16	Air	Silicone rubber	-27	D	1.8
PVC-U (3 chamber)	2	Hard coat	16	Air	Aluminium	-38	E	2.0

Energy efficient services

While work on building services normally takes place as part of planned maintenance, there are situations (such as boiler breakdown) where immediate action is required.

Specifications should be prepared in advance so that opportunities for improving energy efficiency are not lost. The heating system is responsible for the greatest energy use in a dwelling, but the high cost of electricity and its greater contribution to CO₂ emissions, means that specifying energy efficient lighting and appliances is increasingly important.

Ventilation is not, in itself, considered an energy efficiency measure, but it does have an impact on both comfort levels and energy consumption. If there is too much ventilation, whether from draughts or from uncontrolled vents, this will cause discomfort to occupants and result in excessive energy use. Too little ventilation, on the other hand, may lead to a build-up of moisture which can, in turn, result in condensation and mould growth.

Table 13 shows the improvements that should be made in order to achieve the standards set by the best practice refurbishment specification.

Table 13 Improvements to services

Service	Improvement
Heating systems	<p>The following applies to domestic wet central heating systems.</p> <p>Boiler The boiler should have a minimum SEDBUK rating of 90 per cent if fuelled by natural gas, LPG or oil (band A), but 86 per cent for an oil fired combi or a combined primary storage unit (CPSU) (band A or B). These levels can only be achieved with condensing versions.</p> <p>Hot water store In the case of systems with combi or CPSU boilers, there is no separate store. Systems with regular boilers will have either a high-performance hot water cylinder, exceeding the requirements of BS 1566 and BS 7206, or a high performance thermal (primary) storage system. In the latter case, the insulation properties must exceed the requirements of the Waterheater Manufacturers' Association (WMA) Performance Specification for Thermal Stores⁷ by 15 per cent and satisfy its other requirements.</p> <p>Controls These should consist of:</p> <ul style="list-style-type: none"> • A programmable room thermostat – in Scotland these must have a 7-day function. • A boiler interlock. • Thermostatic radiator valves (TRVs) on all radiators, except in areas with a room thermostat. • An automatic bypass valve. <p>For systems with a separate storage cylinder, a cylinder thermostat is required and the programmable room thermostat must have an additional hot water timing capability. Installation should be carried out to current best practice requirements, see CHeSS for full details⁴.</p> <p>Non-centrally heated systems Time and temperature controls should be equivalent to CHeSS HC6/HR6. Off-peak electric storage heaters should have automatic charge control and fan-assisted models are recommended. Heaters using peak-period electricity should have controls for individual room temperature and operating times. Hot water cylinders should be large enough to supply most of the hot water demand between off-peak charging periods. They should be insulated to a high performance specification such as 'Maxistore'.</p>

Service	Improvement
Lighting	<p>Use dedicated energy efficient lights when replacing fittings. These can have a major impact in high usage areas such as living rooms, study bedrooms, hallways and landings. They should also be used in communal areas and for security lighting.</p> <p>However, they should not generally be used where lighting systems are push-button operated, or controlled by passive infra-red (PIR) detectors, although special lamps are available for such applications.</p>
Ventilation	<p>Provide controlled ventilation in order to prevent condensation. Whole-house mechanical ventilation systems should only be used in conjunction with a package of measures to reduce air leakage.</p>
Electrical appliances	<p>The European Union Energy Label shows how much energy an appliance uses (on a scale from A to G).</p> <p>The Energy Saving Trust endorses the most energy efficient appliances through its 'energy saving recommended' certification scheme.</p> <p>Electrical appliances, where fitted, should be energy saving recommended models, as they meet strict criteria for energy efficiency and so are guaranteed to use less energy. A full list is available at www.est.org.uk/recommended</p> <div data-bbox="336 1070 651 1361" style="text-align: center;">  </div> <p data-bbox="416 1373 571 1395">Certification mark</p>

Embodied energy

There is a growing urgency to reduce the environmental impacts of human activities.

Energy efficiency initiatives over the last 40 years have reduced the energy consumption of buildings considerably, but action to minimize the impact from construction materials has been relatively slow.

There are two key elements to the energy use of a building. Energy used by occupants to run the building during its lifespan – known as operational energy; and energy used during the manufacture, maintenance and replacement of the components that constitute the building during its lifespan. This is known as embodied energy.

In older buildings operational energy has traditionally represented the major impact. As the energy efficiency

standards of modern buildings have been raised the importance of embodied energy has increased.

Where the selection of products and materials directly affect the operational energy, the most efficient option should be selected.

For those looking to maximise environmental benefit, or where products are very similar in terms of operational performance, then embodied energy aspects should also be taken into consideration.

Further reading

The Green Guide to Housing Specification, Anderson and Howard, BRE, 2000.

Insulation Materials Chart – thermal properties and environmental ratings (CE71)

References

- 1 Central Heating System Specifications (CHeSS)
– year 2005 (CE51).
- 2 The Building Regulations 2000, Conservation of fuel
and power, Approved Document L1B – Work in
existing dwellings (2006 Edition).
- 3 Section 6: Energy, of the Domestic Technical
Handbook on possible ways of complying with the
Building (Scotland) Regulations 2004.
- 4 Building Regulations (Northern Ireland) 1994,
Technical booklet F, Conservation of fuel and power
(December 1998) – Currently under revision.
- 5 The Government's Standard Assessment Procedure
for Energy Ratings of Dwellings. SAP 2005.
- 6 Waterheater Manufacturers' Association
Performance Specification for Thermal Stores, 1999.
- 7 BR390 The Green Guide to Housing Specification,
Anderson and Howard, BRE, 2000.

Further information

The Energy Saving Trust sets energy efficiency standards that go beyond building regulations, for use in the design, construction and refurbishment of homes. These standards provide an integrated package of measures covering fabric, ventilation, heating, lighting and hot water systems for all aspects of new build and renovation. Free resources including best practice guides, training seminars, technical advice and online tools are available to help meet these standards.

The following publications may also be of interest:

Whole house

- Domestic Energy Efficiency Primer (CE101/GPG171)
- Energy efficient refurbishment of existing housing (CE83/GPG55)
- Energy efficient refurbishment of existing housing – case studies (CE104/GPCS418)
- Energy efficient historic homes – case studies (CE138)

Fabric

- Cavity wall insulation in existing housing (CE16/GPG26)
- Internal wall insulation in existing housing (CE17/GPG138)
- Cavity wall insulation: unlocking potential in existing dwellings (GIL23)
- Effective use of insulation in dwellings (CE23)
- Windows for new and existing housing (CE66)
- Improving air tightness in dwellings (CE137/GPG224)
- External insulation for dwellings (CE118/GPG293)
- Advanced insulation in housing refurbishment (CE97)
- Refurbishment site guidance for solid-walled houses (CE184)

Services

- Central Heating System Specifications (CHeSS) – Year 2005 (CE51)
- Domestic heating by oil: boiler systems (CE29)
- Domestic heating by gas: boiler systems (CE30)
- Energy efficient lighting – a guide for installers and specifiers (CE61)
- Low energy domestic lighting (CE188/GIL20)
- Energy efficient ventilation in housing – a guide for specifiers on the requirements and options for ventilation (CE124/GPG268)
- New and renewable energy technologies for existing housing (CE102)

To obtain these free publications or for more information, call 0845 120 7799, email bestpractice@est.org.uk or visit www.est.org.uk/housingbuildings



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