Energy Efficiency Best Practice in Housing

Energy efficiency in new housing

Summary of Specifications for Northern Ireland

- this guide explains how to improve energy efficiency in new dwellings
- better energy efficiency is a means of tackling fuel poverty
- better energy efficiency reduces the emissions associated with global warming
- lower atmospheric emissions mean lower environmental impact and better air quality

Why worry about energy efficiency?

Reducing the consumption of fossil fuels is becoming a Government priority. The UK has international obligations and domestic targets which require a reduction in emissions of carbon dioxide in particular; and fossil fuels are a major cause of these emissions. Energy efficiency requirements for new housing are therefore likely to rise significantly over the coming years.

The specifications outlined here allow architects, specifiers, installers and others involved in design and construction to produce new dwellings that anticipate some of the likely upgrading of standards.

In addition, better energy efficiency has immediate benefits. It reduces energy bills for the occupants, which is particularly important where housing is being provided for vulnerable groups.

Improved insulation levels mean less energy consumption and lower emissions. This improves air quality (less CO_2, SO_x and NO_x) and reduces the environmental impact of the building.

A choice of specifications

The Building Regulations (Northern Ireland) 1994: Technical Booklet F, Conservation of Fuel and Power, as revised in 1998, sets down the minimum standards of energy efficiency required for new dwellings.

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The specifications outlined in this document set out a series of options for constructing dwellings with better levels of energy efficiency than this minimum.

The specifications are:

- **Good Practice** – this incorporates a package of measures that will ensure the legal requirements are met and in addition includes some additional energy efficiency measures
- **Best Practice** – this involves the adoption of technically proven, cost effective techniques and products. These are already in the marketplace and involve no undue risk
- **Advanced** – this specification is aimed at those who want to minimise the environmental impact of the building and who wish to address sustainability issues

Typical energy and carbon dioxide savings for each strategy – compared with the statutory minimum – are also shown in this document.

As energy efficiency technologies develop and, in parallel, statutory requirements are tightened, so the three specifications will also evolve. Forthcoming editions of this publication will provide further information on how to design homes where energy efficiency is better than average.

Targets

All three specifications set maximum U-values for exposed construction elements (i.e. minimum thermal insulation requirements).

The Good Practice and Best Practice guidelines also make use of a Carbon Index (CI) target. The Index number, essentially, is a measure of the carbon emissions due to space heating and hot water. It varies according to fuel and boiler efficiency. Based on the Government's Standard Assessment Procedure (SAP), the Index is measured on a scale of 0-10: the higher the number, the better the energy performance. This allows a certain flexibility of design, albeit within the insulation constraints imposed on the walls, floors, roofs and glazed areas.

In the Advanced specification the Carbon Index is not used. In a building where environmental impact (and therefore fuel used for heating) has been minimised, the main energy requirements are for lighting and appliances. However, the SAP – and hence the Carbon Index – does not measure this consumption. Therefore, the Index is not an appropriate target for this method.

Reducing consumption and cutting emissions

Building dwellings to higher standards will both cut energy bills and lessen associated environmental emissions. The tables below attempt to quantify energy and emissions savings for seven typical types of dwelling. In each case, the comparison is made against buildings constructed to meet only the legal minimum standards set down in the Building Regulations.

Annual energy consumption for each building type and fuel was calculated using the BRE Domestic Energy Model (BREDEM-12). These values were converted into costs by using the conversion factors given in the SAP, 2001 edition. CO_2 emissions are also assessed using a standard calculation set out in the SAP.

The process was then repeated for the same buildings, but with the energy efficiency enhancements laid out in the three specifications.

In the companion document covering England, Wales and Scotland, it was assumed that houses would be heated by natural gas. However, the fuel supply mix is different in Northern Ireland and this has required calculations to be made for both gas and oil.

Table 1: Savings on fuel and emissions for dwellings using natural gas as heating fuel

Dwelling Type	Minimum Standard		Good Practice			Best Practice			Advanced		
	Energy Cost (£/yr)	SAP	Cost Saving (£/yr)	CO_2 Saving (kg CO_2/yr)	SAP	Cost Saving (£/yr)	CO_2 Saving (kg CO_2/yr)	SAP	Cost Saving (£/yr)	CO_2 Saving (kg CO_2/yr)	SAP
Flats	260	94	41	359	102	64	640	108	80	834	118
Bungalows											
- semi-detached	299	82	74	823	100	90	1009	106	107	1225	114
- detached	314	81	80	904	100	99	1128	106	117	1356	114
Houses											
- mid-terrace	346	90	62	584	102	91	924	108	112	1192	118
- end-terrace	362	86	75	802	100	101	1112	107	124	1393	117
- semi-detached	397	84	91	966	100	115	1249	107	139	1545	116
- detached	448	81	112	1241	101	139	1551	107	164	1865	115

Table 2: Savings on fuel and emissions for dwellings using oil as heating fuel

Dwelling Type	Minimum Standard		Good Practice			Best Practice			Advanced		
	Energy Cost (£/yr)	SAP	Cost Saving (£/yr)	CO_2 Saving (kg CO_2/yr)	SAP	Cost Saving (£/yr)	CO_2 Saving (kg CO_2/yr)	SAP	Cost Saving (£/yr)	CO_2 Saving (kg CO_2/yr)	SAP
Flats	282	96	39	295	104	73	667	115	89	834	120
Bungalows											
- semi-detached	329	81	83	816	103	103	1021	112	122	1225	120
- detached	347	80	92	922	103	113	1137	112	134	1356	120
Houses											
- mid-terrace	375	90	65	551	103	103	959	112	125	1192	120
- end-terrace	395	85	84	817	103	116	1149	111	139	1393	120
- semi-detached	434	82	102	970	102	133	1291	110	157	1545	120
- detached	492	78	118	1143	101	158	1566	109	187	1865	119

Good Practice Specification
Requirements

Energy rating

The dwelling must have a minimum Carbon Index of:

- 8.0 where the heating fuel is gas, biomass, CHP, LPG, or a renewable source
- 6.8 if oil is the heating fuel
- 6.2 if electricity is used for heating purposes

Note: no allowance can be claimed for use of 'green' electricity tariffs

Maximum permissible U-values (W/m^2K) for exposed elements	
For buildings with SAP rating of more than 60 (for those lower than 60, see the Building Regulations Technical Booklet F)	
Pitched roofs	0.25
Flat roofs (or the sloped ceiling of a room-in-the-roof)	0.35
Exposed walls	0.45
Semi-exposed walls and floors	0.6
Exposed floors and ground floors	0.45
Windows, doors, rooflights	3.3

Heating Systems

For more details on this topic, refer to the Central Heating System Specifications (CHeSS), published by Energy Efficiency Best Practice in Housing as General Information Leaflet (GIL) 59.

Domestic wet central heating systems

Boiler

This should have a minimum SEDBUK (Seasonal Efficiency of Domestic Boilers in the UK) rating of:

- 78% if fuelled by natural gas (bands A to D)
- 80% if LPG fuelled (A to C, and some from band D)
- 85% if an oil-fired regular boiler (A and B, and some from C). In the case of a combination (combi) or a Combined Primary Storage Unit (CPSU) boiler, the requirement is 82%.

Hot water store

In the case of systems with combi or CPSU boilers, there is no separate store.

For systems with regular boilers, the requirement is for: either a hot water cylinder whose heat exchanger and insulation properties meet the relevant British Standards (in particular BS 1566 and BS 7206) or a thermal primary storage system satisfying the requirements of the Waterheater Manufacturers' Association (WMA) Performance Specification for Thermal Stores (1999).

Controls
These should comprise:

- a time switch for combi or CPSU boilers; otherwise a full programmer
- a room thermostat
- a boiler interlock
- Thermostatic Radiator Valves (TRVs) on all radiators, except in areas with a room thermostat
- automatic bypass valve

For systems with a separate storage cylinder, a cylinder thermostat is also required.

Installation should be carried out to current Best Practice requirements – see CHeSS for full details.

Non-centrally heated systems

Time and temperature controls should be equivalent to CHeSS HC3/HR3. (See also note on back page.)

Lighting
Use energy efficient lights in at least half of the rooms.

Good Practice Specification Recommendations

The following recommendations will improve efficiency further.

Ventilation
Passive Stack Ventilation (PSV), assisted Passive Stack Ventilation (aPSV) or Heat Recovery Ventilation (HRV) systems should be installed. These will provide a continuous, controlled supply of fresh air. If fans are used in the ventilation system, total fan power should be less than 2 W per litre per second of extract air. If heat recovery is used, heat exchanger efficiency should be greater than 70%. In the cases of PSV and aPSV systems, the supply and exhaust vents should have humidity control.

Pressure testing
A pressure test (carried out to the procedure in CIBSE TM23 Testing Buildings for Air Leakage) should achieve an air permeability of less than:

- 4 $m^3/h/m^2$ at 50 Pa for dwellings with HRV
- 7 $m^3/h/m^2$ at 50 Pa for dwellings with other ventilation systems

Electrical appliances
Fit Energy Efficiency Recommended (EER) electrical appliances wherever possible.

Best Practice Specification Requirements

Energy rating
The dwelling must have a minimum Carbon Index of:

- 8.6 where the heating fuel is gas, biomass, CHP, LPG, or a renewable source
- 7.4 if oil is the heating fuel
- 6.8 if electricity is used for heating purposes

Note: no allowance can be claimed for use of 'green' electricity tariffs

Maximum permissible U-values (W/m^2K) for exposed elements	
Roofs	0.13
Walls	0.25
Floors	0.20
Windows, doors, rooflights (area weighted average)	1.8

Heating Systems
For more details, refer to the Central Heating System Specifications (CHeSS), published by Energy Efficiency Best Practice in Housing as General Information Leaflet (GIL) 59.

Domestic wet central heating systems

Boiler
This should have a minimum SEDBUK (Seasonal Efficiency of Domestic Boilers in the UK) rating of:

- 86% if fuelled by natural gas (bands A and B)
- 88% if LPG fuelled (A and some from band B)
- 89% if an oil-fired regular boiler (A and some from B). In the case of a combi or CPSU boiler, the requirement is 86%.

These levels of efficiency can only be obtained with condensing boilers.

Hot water store
In the case of systems with combi or CPSU boilers, there is no separate store.

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 WMA Performance Specification for Thermal Stores (1999) by 15% and satisfy its other requirements.

Controls
These should comprise:

- a programmable room thermostat
- a boiler interlock
- Thermostatic Radiator Valves (TRVs) on all radiators, except in areas with a room thermostat
- automatic bypass valve

For systems with a separate storage system, a cylinder thermostat is also required. In addition, 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 details.

Non-centrally heated systems

Time and temperature controls should be equivalent to CHeSS HC4/HR4. (See also note on back page.)

Lighting
Use dedicated energy efficient light fittings in at least 80% of the rooms.

Ventilation
Passive Stack Ventilation (PSV), assisted Passive Stack Ventilation (aPSV) or Heat Recovery Ventilation (HRV) systems should be installed. These will provide a continuous, controlled supply of fresh air. If fans are used in the ventilation system, total fan power should be less than 2 W per litre per second of extract air. If heat recovery is used, then heat exchanger efficiency should be greater than 70%. In the cases of PSV and aPSV systems, the supply and exhaust vents should have humidity control.

Pressure testing
A pressure test (carried out to the procedure in CIBSE TM23 Testing Buildings for Air Leakage) should achieve an air permeability of less than:

- 3 $m^3/h/m^2$ at 50 Pa

Electrical appliances
Energy Efficiency Recommended (EER) electrical appliances are to be fitted.

Drying space
A ventilated space for drying clothes should be provided within the house.

Best Practice Specification
Recommendations

The following recommendations will further improve the efficiency of the dwelling.

Water usage
Use appliances with low water consumption

- WCs should consume a maximum of 4 litres
- showers should not deliver more than 8 litres/min
- any specified washing machines should use less than 50 litres per wash
- dishwashers should use less than 16 litres per wash

Avoid 'dead legs' in piping where possible.

Where 'dead legs' occur, they should not contain more than 1.5 litres of water (that equates to a maximum run of 10 metres of 15 mm copper pipe).

In systems using mains pressure hot and cold water, outlets should be fitted with dynamic flow regulators.

Assess heat loss
Post construction, carry out a thermographic survey of the property to search for missing insulation (see Relevant Publications section at the end of this document).

Advanced Design Specification Requirements

Energy Rating

Emissions due to space and water heating will be minimised in this Specification. Lighting and appliance loads (which the Carbon Index does not take into account) will be the predominant causes of emissions. So the CI is an inappropriate measure in this case.

Maximum permissible U-values (W/m^2K) for exposed elements	
Roofs	0.08
Walls	0.15
Floors	0.10
Windows, doors, rooflights (area weighted average)	1.5

Average daylight factor	
Based on BS 8206: Part 2 Code of Practice for Daylighting, the minimum levels should be:	
Living rooms, dining rooms, studies	1.5%
Kitchen	2.0%
Bedrooms	1.0%

Heating Systems

For more details, refer to the Central Heating System Specifications (CHeSS), published by Energy Efficiency Best Practice in Housing as General Information Leaflet (GIL) 59.

Domestic wet central heating systems

Boiler

This should have a minimum SEDBUK (Seasonal Efficiency of Domestic Boilers in the UK) rating of:

- 86% if fuelled by natural gas (bands A and B)
- 88% if LPG fuelled (A and some from band B)
- 89% if an oil-fired regular boiler (A and some from B). In the case of a combi or CPSU boiler, the requirement is 86%.

These levels of efficiency can only be obtained with condensing boilers.

Hot water store

In the case of systems with combi or CPSU boilers, there is no separate store.

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 WMA Performance Specification for Thermal Stores by 15% and satisfy its other requirements.

Controls

These should comprise:

- a programmable room thermostat
- a boiler interlock
- Thermostatic Radiator Valves (TRVs) on all radiators, except in areas with a room thermostat
- automatic bypass valve

For systems with a separate storage system, a cylinder thermostat is also required. In addition, the programmable room thermostat must have a hot water timing capability.

Installation should be carried out to current Best Practice requirements – see CHeSS for full details.

Non-centrally heated systems

Time and temperature controls should be equivalent to CHeSS HC4/HR4. (See also note on back page.)

Lighting

Use dedicated energy efficient light fittings throughout the building.

Ventilation

Passive Stack Ventilation (PSV), assisted Passive Stack Ventilation (aPSV) or Heat Recovery Ventilation (HRV) systems should be installed. These systems will provide a continuous, controlled supply of fresh air. If fans are used in the ventilation system, total fan power should be less than 1 W per litre per second of extract air. If heat recovery is used, then heat exchanger efficiency should be greater than 85%. In the cases of PSV and aPSV systems, the supply and exhaust vents should have humidity control.

Pressure testing
A pressure test (carried out to the procedure in CIBSE TM23 Testing Buildings for Air Leakage) should achieve air permeability of less than:

- 1 $m^3/h/m^2$ at 50 Pa

Electrical appliances
Energy Efficiency Recommended (EER) electrical appliances are to be fitted.

Drying space
A ventilated space for drying clothes should be provided within the house.

Water usage
Only use appliances with low water consumption

- WCs should consume a maximum of 4 litres
- showers should not deliver more than 6 litres/min
- any specified washing machines should use less than 50 litres per wash
- dishwashers should use less than 16 litres per wash

Avoid 'dead legs' in piping where possible.

Where 'dead legs' occur, they should not contain more than 1.5 litres of water (that equates to a maximum run of 10 metres of 15 mm copper pipe).

In systems using mains pressure hot and cold water, outlets should be fitted with dynamic flow regulators.

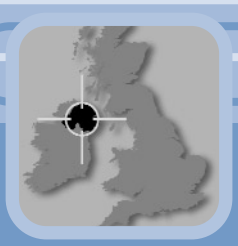
Advanced Design Specification Recommendations

The following recommendations will further improve the efficiency of the dwelling and reduce environmental impact.

Assess heat loss
Post construction, carry out a thermographic survey of the property to search for missing insulation.

Consider alternative energy sources
Renewable energy technologies can reduce the emissions attributable to fossil fuel use.

Consider creating an "Autonomous dwelling" which would utilise on-site renewable energy generation and avoid connections to mains services other than electricity (see Relevant Publications at the end of this document).



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Relevant Publications

Energy Efficiency Best Practice in Housing publications
These are available free from the website: www.est.co.uk/bestpractice or by phoning the helpline 0845 120 7799.

Building a sustainable future – homes for an autonomous community (GIR53), October 1998

Central Heating System Specifications (CHeSS) (GIL59), July 2002

Energy efficiency standards for new and existing dwellings (GIL72), September 2002

Post-construction testing – a professional's guide to testing housing for energy efficiency (GIR64), August 2000

Other publications
Building Regulations (Northern Ireland) 1994, Technical booklet Part F, Conservation of fuel and power (December 1998)

BS 1566: 2002, Copper indirect cylinders for domestic purposes

BS 7206: 1990, Specification for unvented hot water storage units and packages

BS 8206: Part 2, 1992, Code of Practice for Daylighting

BS EN 613: Independent gas-fired convector heaters

BS EN 13141/7/8: (CEN TC 156/WG2/AH7) Component/products for residential ventilation

CIBSE TM23 Testing Buildings for Air Leakage

The Government's Standard Assessment Procedure for Energy Rating of Dwellings, 2001 Edition

Waterheater Manufacturers' Association Performance Specification for Thermal Stores, 1999

Note
For Non-Centrally Heated Systems

If gas room heaters are used, their efficiency should not be less than the standard set down in BS EN 613 'Independent gas-fired convector heaters'. The heaters should have individual room temperature control. If hot water storage is used, for the Good Practice specification it should be insulated to CHeSS HR3, and have time and temperature control. For Best Practice, it should be insulated to CHeSS HR4, and have time and temperature control.

For electric systems

Storage heaters should have automatic charge control. Fan-assisted storage heaters are recommended. On-peak heaters should have time and individual room temperature controls. Hot water systems should have cylinder losses less than 1.33*(0.02 + 0.051*V2/3) as measured by BS 1566 'Copper indirect cylinders for domestic purposes'. This equates to a heat loss of 24kWh over 24 hours for a 210 litre cylinder, or 1.7kWh over 24 hours for a 120 litre cylinder. BS 1566 requires these heat loss figures to be marked on cylinders.

Energy Efficiency Best Practice in Housing

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