CE292

Energy efficiency and the Code for Sustainable Homes

Levels 5 & 6

Also available:

Energy efficiency guidance for level 3

Energy efficiency guidance for level 4

energy saving trust®

Contents

Acknowledgement

Cover: The Kingspan LightHouse, BRE Innovation Park, the first house to meet Level 6 of the Code for Sustainable Homes

1. Introduction

1.1 Energy Saving Trust guidance

Home energy use is responsible for over a quarter of the UK's carbon dioxide (CO_2) emissions which contribute to climate change. To help mitigate the effects of climate change, the Energy Saving Trust has developed a range of guidance to help housing professionals meet the energy performance requirements of the Code for Sustainable Homes[1].

This guide[2] outlines recommendations for housing professionals to meet, and in some cases, exceed energy efficiency requirements of levels 5 and 6 of the Code for Sustainable Homes.

This publication is the third in a suite of Energy Saving Trust guidance, designed to achieve step-change energy performance improvements over national building regulations[3]. It provides guidance on designing and building new homes that achieve 100% and zero carbon reductions over the minimum levels required by building regulations, and meet the mandatory (ENE1) energy requirements of the Code for Sustainable Homes levels 5 and 6.

Constructing dwellings that achieve these heightened levels of energy performance currently presents a significant challenge to industry, and research on compliance is still at a pioneering stage. Cost-effective alternative solutions and strategies to meet the required energy performance may emerge in the short to medium term. Therefore, please note that the scenarios suggested in this guide are offered for demonstration and learning purposes only, and should not be regarded as definitive.

Other guides in this series cover 25% and 44%, and will help housing professionals to meet levels 3 and 4 of the Code for Sustainable Homes respectively.

For more information on the other Energy Saving Trust guidance go to www.energysavingtrust.org.uk/housing or contact the free helpline on 0845 120 77 99.

1.2 Who the guides are for

Energy Saving Trust guides will help:

- Anyone wanting to build a low or zero carbon dwelling (whether developer, designer or builder, etc).
- Developers and specifiers needing to formulate robust energy specifications to demonstrate performance beyond the requirements of current building regulations.
- Policy makers in local government wanting to refer to recognised standards in local development frameworks.
- Builders required to meet an energy performance standard – referring to Energy Saving Trust guidance reduces technical risks whilst maintaining a good level of flexibility.
- Housing professionals required to meet a percentage target for the use of renewable energy – the fabric-first measures recommended in the guidance make hitting this target percentage easier, because overall dwelling energy demand is reduced.

1. The Code for Sustainable Homes has only been adopted for use in England and Wales
   See www.planningportal.gov.uk/uploads/code_for_sustainable_homes_techguide.pdf
2. This guide relates to the April 2008 Code for Sustainable Homes Technical guide.
3. England and Wales: The Building Regulations 2000, Conservation of fuel and power, are detailed in Approved Document L1A (2006 Edition).
   See www.planningportal.gov.uk
   Northern Ireland: Building Regulations (Northern Ireland) 2000, are detailed in Technical booklet F1 2006, Conservation of fuel and power in dwellings. See www.dfpni.gov.uk
   Scotland: Section 6: Energy, of the Domestic Technical Handbook outlines possible ways of complying with the Building (Scotland) Regulations 2007. See www.sbsa.gov.uk

Introduction

1.3 Outline of the guidance

This guide presents the required criteria and a set of scenarios for applying the Energy Saving Trust 100% and zero carbon guidance.

The guidance is based on energy efficient products and technologies that combine to give very well insulated, airtight dwellings with appropriate and efficient building services. It emphasises the importance of maximising long-lasting energy performance improvements to the fabric of a dwelling, before adding the optimum renewables solution if required.

Due to the multitude of potential configurations it has not been possible to present every combination of fabric and renewables strategy. The scenarios have been modelled using four standard housing types:

- Detached house – 104m^2 (page 15)
- Semi-detached house – 89m^2 (page 16)
- Mid-terrace house – 79m^2 (page 17)
- Four storey flats – 61m^2 (page 18)

1.4 Key features

Key features of the Energy Saving Trust guidance include:

An integrated design-led approach

The guidance provides an integrated design-led approach so that insulation, heating and ventilation systems work together to maximise cost-effectiveness in construction, and minimise occupant fuel costs. Carbon reduction targets are combined with minimum 'backstop' design performance requirements based on practical insulation levels and appropriate dwelling airtightness.

Flexibility

Beyond these backstop requirements, the method of achieving the desired CO_2 reduction is flexible – insulation can be increased, renewables can be added, and thermal bridging or airtightness can be improved. Builders are free to innovate and use newly available products, or to minimise technical risks by using only tried and tested solutions.

Proven solutions

All of the aspects, strategies, and components required by the guidance have been successfully built on developments in the UK. The guidance brings these together to form a rounded approach that is achievable using proven and available products and technologies. If availability or skills are limited, industry should consider taking the lead in developing stronger manufacturing capability via their supply chains, and increasing on-site skills through training.

Compatibility across the UK

This guidance has been structured to ensure alignment with the building regulations in England and Wales, and has been reviewed to ensure continuing compatibility with subsequent changes in Scotland and Northern Ireland, as well as the Code for Sustainable Homes.

A familiar format

The guidance has been specifically designed to adopt the existing building regulations compliance methodology, ensuring a familiar format for builders and designers that will help to speed up the design process.

More help available

The Energy Saving Trust provides a specifiers' technical helpline and a range of publications for support and assistance (see page 19 for details).

Achieving Levels 5 and 6 of the Code for Sustainable Homes

As with previous versions of Energy Saving Trust guidance, this document focuses on achieving CO_2 emissions that are significantly lower than current national building regulations. The solutions described in this guide are illustrative only, and are offered to help designers achieve ENE1 at levels 5 and 6 of the Code for Sustainable Homes.

Level 5 of the Code is scheduled to become mandatory in Wales by 2013, with level 6 being likely to be incorporated into the new national building regulations in England and Wales by 2016.

Please note that this document is specifically targeted at meeting ENE1 and is not intended to provide a complete guide to meeting the whole of Code levels 5 and 6.

2. Reaching 100% and zero carbon – basic principles

2.1 100% reduction in CO_2

To reach a 100% cut in CO_2 (Code for Sustainable Homes level 5), all emissions that are accounted for under the SAP 2005 methodology (space heating, water heating and lighting) must be zero or negative.

To achieve this, a highly insulated building fabric is necessary, and some form of microgeneration or other onsite energy generation will be required.

2.2 Zero carbon – Code for Sustainable Homes level 6

To reach zero carbon, all emissions that are accounted for under the SAP 2005 methodology (space heating, water heating and lighting) must be zero or negative.

In addition to this, all CO_2 emissions from cooking and domestic appliances must be offset. The required offset is based on floor area. This offset can be achieved with microgeneration, other onsite generation or offsite generation provided that this is connected directly to the development via a private wire arrangement.

Please note that the use of any commercial carbon offsetting scheme is not an acceptable way to achieve the requirements of the Code for Sustainable Homes.

Additionally, a heat loss parameter of 0.8 W/m^{2}K or less is required. This typically requires a highly insulated building fabric, combined with excellent dwelling airtightness and, depending on available solar gains, the avoidance of high glazing to floor area ratios.

2.3 Delivering reductions in CO_2 to reach 100% and zero carbon

Fundamental to achieving these challenging reductions in CO_2 is a highly insulated building fabric, coupled with an efficient heating system. To reduce emissions further, heat and/or electricity may be generated either:

- Within the dwelling via the use of microgeneration.
- Within the boundaries of the development via the use of, for example, combined heat and power. This kind of community level strategy is discussed further below.
- Outside the boundaries of the development via the use of, for example, large scale wind turbines.

Please note that currently such an arrangement is only acceptable under the Code for Sustainable Homes if the external generation source is connected to the development via a private wire network.

Dwelling scale solutions

At the level of individual dwellings, microgeneration techniques, such as photovoltaic panels, solar thermal water heating, mini wind turbines or micro combined heat and power, help to reduce dwelling CO_2 emissions.

For solar technologies, factors such as dwelling orientation and overshading are critical in achieving good performance. In addition, physical roof space should be carefully assessed to ensure the necessary microgeneration can be accommodated. The use of certain design features, for example mono pitched roofs, can help increase the available mounting area. For micro wind turbines, local conditions should be checked in detail to ensure a suitable wind resource is available.

Development scale solutions

When aiming to achieve zero carbon dwellings, certain constraints such as cost or physical space on the dwelling may preclude the exclusive use of microgeneration alone. In such cases, development scale solutions should be sought.

Community heating

A community heating scheme delivers heat from a centralised boiler to multiple dwellings via a network of heat mains. Boilers can be fuelled using fossil fuels or low carbon fuels such as biomass. Community heating can operate most efficiently and cost effectively in relatively dense housing (low rise or high rise blocks) where pipe runs and thermal losses can be minimised. Community heating is particularly appropriate where electric heating can be displaced.

'Community Heating – a guide' (CE55), provides more information. See www.energysavingtrust.org.uk/housing

Reaching 100% and zero carbon – basic principles

Combined heat and power

Combined heat and power (CHP) is the simultaneous generation of usable heat and power (usually electricity) in a single process. CHP is a highly efficient way to use both fossil and renewable fuels and can be run using gas, biomass or waste (or a combination of these). Through the use of an absorption cooling cycle, combined cooling heat and power (CCHP, also known as trigeneration) schemes can also be developed.

For more information on combined heat and power, please contact the Combined Heat and Power Association. See www.chpa.co.uk

Medium/large scale wind turbines

Medium and large scale wind turbines harness the energy in wind to produce electricity. They offer an alternative to multiple dwelling based photovoltaic arrays, and their use may simplify the design process by reducing issues of overshading and dwelling orientation. If located on site they must be sited in an appropriate area of the development, or if located remotely they must be connected directly to the development by a private wire network.

For more information on wind energy, please contact the British Wind Energy Association. See www.bwea.com

Legal frameworks for suppliers

The developer must put arrangements in place to ensure occupiers do not switch their electricity connection to any other supplier, as switching to a non-renewable source would effectively preclude the development from being zero carbon. This is usually easiest to achieve by setting up an ESCO.

Energy Services Companies (ESCOs)

ESCOs are private companies whose services can be used to deliver varying levels of input to community heat and power schemes and other types of energy service contracts. Typically, these services include project design, capital finance, construction, management, fuel purchasing, billing, plant operation, maintenance, long term replacement and risk management. ESCOs typically provide capital finance to projects on the basis of bankable long-term energy supply contracts with their customers.

For more information on ESCOs, please see: London Energy Partnership – 'Making ESCOs work: Guidance and Advice on Setting Up and Delivering an ESCO'. See www.london.gov.uk/mayor/environment/energy/partnership-steering-group/

Carbon Trust – GPG377 'Guidance on procuring energy services to deliver community heat and power schemes'. See www.carbontrust.co.uk

Energy Saving Trust Energy Services Toolkit. See www.energysavingtrust.org.uk/housingbuildings/servicepackages

3. How the Energy Saving Trust 100% and zero carbon guidance works

The process is summarised in figure 1, and consists of two key stages:

1. Establishing minimum backstop design performance requirements for practical insulation levels (see page 10) and appropriate dwelling airtightness (see page 12). It is up to design teams to determine how best to meet the specified U-values, airtightness and other parameters, as exact specifications may vary depending on individual dwelling design.
2. Once the backstop values have been adopted, fabric, service or renewable options (pages 15-18) are then used to gain the 100% or zero carbon reduction. This gives guidance users flexibility in choosing whether to increase insulation, improve thermal bridging, improve airtightness, or add renewables.

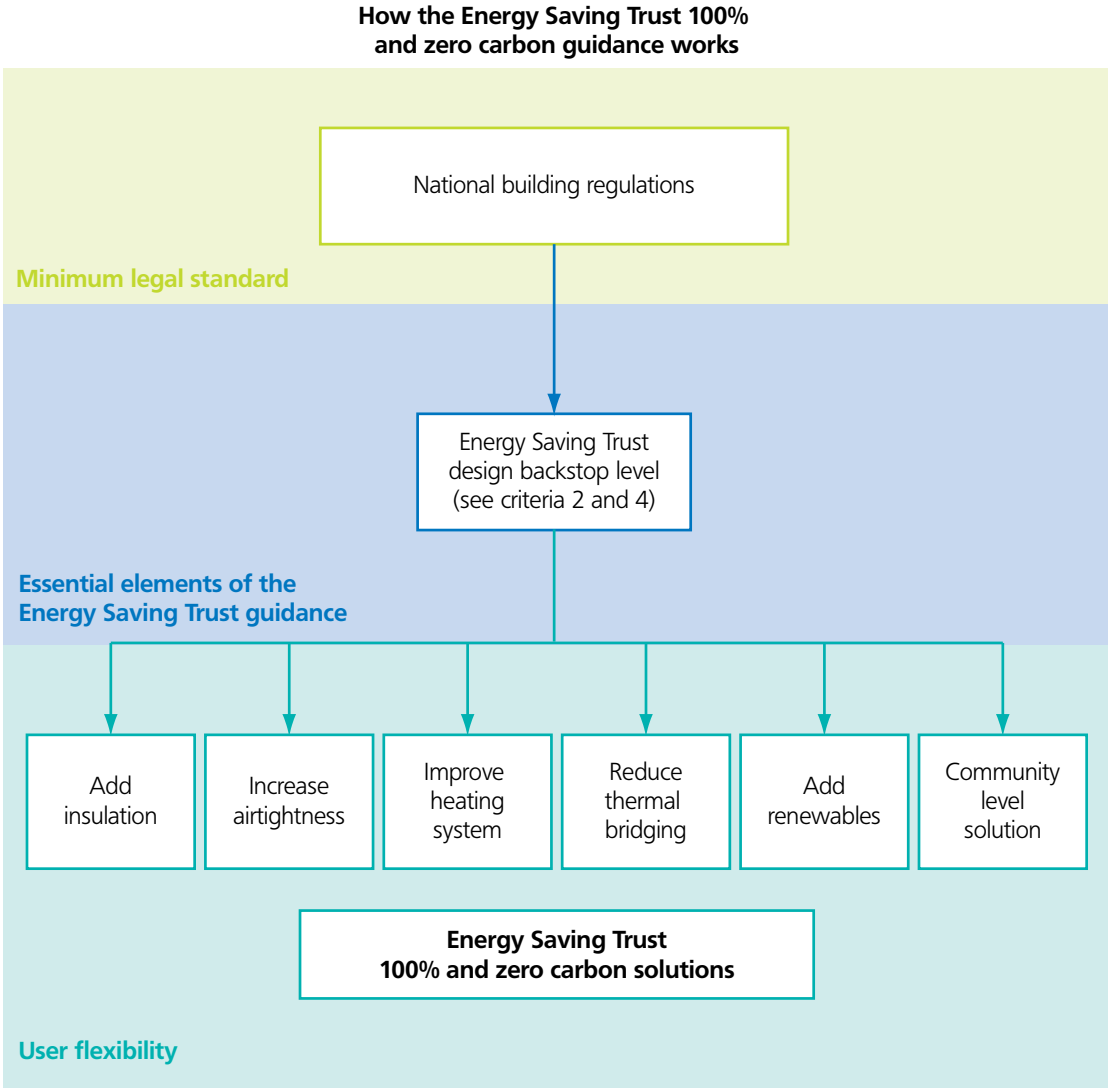

Figure 1: Summary of how the Energy Saving Trust 100% and zero carbon guidance works

4. Achieving the Energy Saving Trust 100% and zero carbon solutions

Achieving 100% and zero carbon solutions using the Energy Saving Trust guidance can be demonstrated by complying with all of the five criteria listed below, and detailed on the following pages.

Criterion 1
The predicted CO_2 emissions from the dwelling (the Dwelling Emission Rate, DER) should be no worse than the Energy Saving Trust Target Emission Rate ($TER_{(Energy\ Saving\ Trust\ 100\%\ solution)}$) – see page 9 for explanation.

Criterion 2
All relevant areas of the dwelling should comply with the design backstops as set out in the table on page 10.

Criterion 3
Provision should be made to limit the effects of internal temperature rises in the summer due to excessive solar gains, as set out on page 12.

Criterion 4
Quality of construction and commissioning should meet the requirements as set out in the table on page 12.

Criterion 5
Requirements for provision of information and future proofing should be adhered to, as set out on page 13.

Achieving the Energy Saving Trust 100% and zero carbon solutions

Criterion 1: Predicted CO_2 emissions from the dwelling: reaching 100% and zero carbon

Criterion 1a: Code for Sustainable Homes Level 5

To assess whether a dwelling design achieves the 100% CO_2 reduction, the target emission rate (TER) methodology should be used (as defined in national building regulations). The TER is expressed in terms of the annual CO_2 emissions, in kg per m^2 of floor area.

Different dwellings will have different emissions targets, because the TER is based on floor area, dwelling shape and other factors, such as the heating fuel used.

Under national building regulations, the dwelling's DER (dwelling emissions as designed) should be equal or less than its TER to pass.

A similar method is adopted here to assess compliance, but in order to give the desired CO_2 savings, the DER has to be equal to or less than 0kg $CO_2/m^2.yr.$, i.e.:

DER=0

Criterion 1b: Code for Sustainable Homes Level 6 only

To achieve Code for Sustainable Homes level 6, true zero carbon status must be attained. This means that, in addition to negating CO_2 from space and water heating, and lighting (as per level 5), all CO_2 emissions from cooking and other domestic appliances must also be accounted for.

These additional emissions should be calculated using the methodology within the Code for Sustainable Homes technical guidance. The calculated emissions for cooking and appliances should then be subtracted from the actual CO_2 emissions to find the final DER which is required to achieve true zero carbon.

1. Calculate the TER for level 5 as above.
2. Calculate offset using Code for Sustainable Homes technical guidance - please see the Code for Sustainable Homes technical guidance document for the appropriate methodology.
   See www.planningportal.gov.uk/uploads/code_for_sustainable_homes_techguide.pdf
3. Subtract offset from code 5 TER to find code 6 TER.
4. Ensure DER meets code level 6 TER.

At code levels 1 through to 5 of the Code for Sustainable Homes, standard SAP compliance methodology must be adhered to i.e. only 30% of low energy lighting may be claimed, and a secondary heating system has to be assumed. However at code level 6, the actual CO_2 emissions should be used, as these take into account the true level of low energy lighting installed, as well as relaxing the need to include a secondary heating system when none is installed.

Achieving the Energy Saving Trust 100% and zero carbon solutions

Criterion 2: Design backstops

Aspect		National building regulations[1]	Energy Saving Trust 100% and zero carbon solutions
Opaque elements W/m^2.K (area weighted average)	roof	0.25	0.13
	walls	0.35	0.15
	exposed floors	0.25	
Windows and doors W/m^2.K (area weighted average) For further guidance see 'Windows for new and existing housing' (CE66)[2].		2.2 (area weighted average)	Windows must achieve a BFRC (British Fenestration Rating Council) rating in band A or better. Doors should achieve U-values better than 1.5 if glazed, or 1.0 if solid.
Space and hot water heating For further guidance see 'Central heating system specifications (CHeSS)' (CE51/GIL59).		Services must comply with the limits set out in the 'Domestic Heating Compliance Guide'[3].	Where gas, LPG or oil central heating systems are specified they should conform to CHeSS HR5 or HC5. Communal boilers, communal heat pumps and combined heat and power may also be used.
Ventilation For further guidance see 'Energy efficient ventilation in dwellings – a guide for specifiers' (GPG268).		Purpose provided ventilation should be provided by way of methods accepted in national building regulations.	Mechanical extract ventilation (MEV) • The whole system must have a specific fan power (SFP) of 0.6 Watts per litre per second or less; or • Whole house mechanical ventilation with heat recovery (MVHR). • The whole system must have a specific fan power of 1 Watt per litre per second or less; and • The heat recovery efficiency must be 85% or better. The performance of an MEV or MVHR unit should be assessed using SAP Appendix Q test methodologies[4].
Lighting (internal) Percentage of all fixed lighting to be dedicated low energy (i.e. fittings will only accept low energy lamps with luminous efficacy of greater than 40 lumens per circuit Watt). For further guidance see 'Energy efficient lighting – guidance for installers and specifiers' (CE61).		1. One per 25m^2 of dwelling floor area (excluding garages) or part thereof; or 2. One per four fixed lighting fittings.	100%. The lamp fitting may contain one or more lamps and should include the ballast, appropriate housing, reflector, shade or diffuser or other appropriate device for controlling the output of light. If tubular fluorescent lamps are used, T8 (26mm tube diameter) lamps, or preferably T5 (16mm diameter) lamps should be specified.

Achieving the Energy Saving Trust 100% and zero carbon solutions

Aspect	National building regulations[1]	Energy Saving Trust 100% and zero carbon solutions
Lighting (external)	Maximum lamp capacity of 150 Watts per fitting with controls that automatically switch off: 1. When there is enough daylight; and 2. When it is not required at night, or only energy efficient light fittings greater than 40 lumens per circuit Watt.	Maximum lamp capacity of 150 Watts per fitting with controls that automatically switch off: 1. When there is enough daylight; and 2. When it is not required at night; or 3. Only energy efficient light fittings greater than 40 lumens per circuit Watt and compatible photocell or timer.
White goods (where specified) energy saving recommended Certification mark For guidance, see www.energysavingtrust.org.uk/compare	n/a	All major electrical appliances (i.e. refrigerators, freezers, washing machines, tumble dryers, washer-dryers and dishwashers) supplied with the dwelling must be Energy Saving Recommended.
Air permeability	See Criterion 4	
Drying space	n/a	A ventilated space for drying clothes should be provided within the house. This could be either an unheated space with good ventilation, or a heated space with adequate, controlled ventilation.

Notes

1. This column gives a summary of the national building regulations in England and Wales and Northern Ireland, but the official documents should be referred to for detailed guidance.
2. Please note that all documents referenced beginning with CE, GIL and GPG can be downloaded from the Energy Saving Trust's website – please visit http://www.energysavingtrust.org.uk/housing
3. Please see http://www.planningportal.gov.uk/uploads/br/BR_PDF_PTL_DOMHEAT.pdf
4. Please see http://www.sap-appendixq.org.uk

Criterion 3: Provisions to limit the effects of solar gains

In order to comply with the Energy Saving Trust 100% and zero carbon guidance and to achieve the Code for Sustainable Homes levels 5 and 6, care must be taken to use appropriate steps to avoid summer overheating. 'Reducing overheating – a designers guide' (CE129) gives information on avoiding overheating by reducing heat gains, solar shading, incorporating thermal mass and providing secure night ventilation.

SAP2005 Appendix P contains a procedure to enable designers to check whether predicted solar gains are excessive. Reasonable provision would be achieved if the SAP assessment indicates that the dwelling will not have a high risk of high internal temperatures.

In order to comply with the Energy Saving Trust 100% and zero carbon guidance, the use of mechanical cooling (air conditioning) is not permitted.

Criterion 4: Quality of construction and commissioning

Aspect	National building regulations	Energy Saving Trust 100% and zero carbon solutions
Maximum permissible air permeability $m^3/(hr.m^2)$@50Pa Confirmed after construction (but prior to completion) by a pressure test carried out in accordance with the procedure set out in the ATTMA publication 'Measuring air permeability of building envelopes'.[1] For further guidance see 'Improving airtightness in dwellings' (CE137/GPG224) and 'Achieving airtightness in new dwellings: case studies' (CE248)	10[2]	3
Limiting thermal bridging Repeating thermal bridges within the planes of the construction will be accounted for within the U-value calculations, however junctions between elements (non-repeating thermal bridges) need special consideration. For further guidance see 'Accredited Construction Details'[3] and BRE information paper IP1/06 'Assessing the effect of thermal bridging at junctions and around openings'.[4]	It is acceptable to use the Energy Saving Trust's Enhanced Construction Details, or alternatively the assessment of bespoke constructions to a similar or better standard using IP1/06 is acceptable. For further information on Enhanced Construction Details, please see the Energy Saving Trust website.	

1. Please see http://www.attma.org/ATTMA_TS1_Issue2_July07.pdf
2. Different requirements apply across Scotland with regard to testing
3. Please see http://www.planningportal.gov.uk/england/professionals/en/1115314255826.html
4. Please see http://www.brebookshop.com

Criterion 5: Provision of information and future proofing

Householders should be provided with clear and simple operating and maintenance instructions for both fixed building services and the dwelling as a whole, to help ensure the energy efficient running of the dwelling. Examples of the kind of information to include are:

- How to adjust the time and temperature settings of heating controls.
- How to maintain services and any equipment included with the home at optimum energy efficiency.
- The energy rating of the home.

The Energy Saving Trust produces a number of technical publications on energy efficiency and renewable energy which may be of assistance. These can be found at www.energysavingtrust.org.uk/housing

If renewable energy technologies are not initially installed, dwellings should be designed and constructed to facilitate the installation of renewable energy technologies at some point in the future. This requirement will depend on the renewable energy technologies appropriate to the particular dwelling, for example:

- Roof structure with suitable fixing locations for PV or solar hot water panels.
- Space for enlarged hot water cylinder (solar hot water).
- Roof orientated to face between south-east and south-west with minimal overshading, to maximise PV and solar hot water panel efficiency.
- Provision of identified and accessible electrical cable ductwork between the electrical consumer unit and proposed location of generating equipment (small scale wind and PV).

5. Scenarios for achieving the Energy Saving Trust 100% and zero carbon emission solutions

The following scenarios show various ways that Energy Saving Trust solutions can help achieve 100% and zero carbon CO_2 reductions over national building regulations, in line with levels 5 and 6 of the Code for Sustainable Homes.

5.1 Achieving robust CO_2 savings

Certain options may show variances that are in excess of the required of levels 5 and 6, but it is still important to ensure that the fundamental thermal performance of the building fabric is of a suitably high standard. This is because the lifespan of the dwelling may be up to 100 years, and heating and renewables systems may be changed during this time. Therefore, even with the inclusion of low or zero-carbon heating technology, best practice backstop U-values, airtightness, etc should be adhered to.

5.2 Correct use of MVHR

When installed correctly, mechanical ventilation heat recovery (MVHR) systems will maintain healthy, fresh air. Studies have shown that they can provide further health benefits through the reduction of dust mites (a potential cause of asthma, etc). MVHR is most effective in highly airtight dwellings. When planning to incorporate an MVHR system it is essential to design the airtightness and ventilation strategies to work in harmony.

MVHR is a low maintenance technology which typically requires little user intervention. However, it may not be familiar to all householders so it is important that occupants receive an information sheet detailing maintenance regimes and other checks (in addition to the full manufacturer's instructions). This should be posted next to the MVHR unit itself, with a duplicate copy included in the home buyer's pack. Manual switches, automatic humidity or other sensors should be clearly marked and located in accessible locations in or near the wet rooms.

5.3 Regional variations

Please note that due to minor regional variations the scenarios shown are for England and Wales only, but suitable specifications for Scotland and Northern Ireland will in most cases be very similar. In all cases, the relevant requirements of current building regulations should always be checked to ensure that they are satisfied.

5.4 Data source

All of the fuel costs and carbon intensities are taken from SAP 2005. Please note, due to SAP compliance methodology, the CO_2 emissions shown for the 100% (Code level 5) solutions do not reflect low energy lighting savings beyond building regulations levels (30%). The true zero carbon (Code level 6) solutions show the full benefit of 100% low energy lighting, as well as zero secondary heating (see page 9 for details).

5.5 Flats

Figures for the flats are the aggregate of ground, middle and top-floor dwellings in a four-storey building. Note that the Code for Sustainable Homes does not deal with hallways, but for the purposes of modelling thermal performance, hallways have been treated as unheated.

As previously stated, constructing dwellings that achieve these heightened levels of energy performance currently presents a significant challenge to industry, and research on compliance is still at a pioneering stage. Cost-effective alternative solutions and strategies to meet the required energy performance may emerge in the short to medium term. Therefore, please note that the scenarios suggested in this guide are offered for demonstration and learning purposes only, and should not be regarded as definitive.

Scenarios for achieving the Energy Saving Trust 100% and zero carbon emission solutions

Detached house (104m^2) scenarios

			Typical building regulations scenario	Energy Saving Trust 100% and zero carbon solutions							
				Gas boiler with solar water heating		Biomass boiler		Heat pump		Communal gas CHP	
				100%	Zero carbon	100%	Zero carbon	100%	Zero carbon	100%	Zero carbon
Fabric U-values W/m^2.K		Roof	0.15	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
		Walls	0.30	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
		Ground floor	0.20	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
		Windows	1.90	0.80	0.70	0.80	0.70	0.80	0.70	0.80	0.70
		Doors	2.00	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
		y-value	0.08 (accredited)	0.04		0.04		0.04		0.04	
Ventilation		Airtightness m^3/(hr.m^2)	7.0	3.0		3.0		3.0		3.0	
		Mechanical Ventilation	Extractor fans	MVHR 85% efficiency, 1W /(l.s) specific fan power		MVHR 85% efficiency, 1W /(l.s) specific fan power		MVHR 85% efficiency, 1W /(l.s) specific fan power		MVHR 85% efficiency, 1W /(l.s) specific fan power	
Heating		Boiler	Gas condensing 90%, boiler interlock	Gas condensing 90%, boiler interlock		Wood pellet, independent boiler 86%		Electric ground to water heat pump		Gas CHP, 75%	
		Controls	Programmer, room thermostat, thermostatic radiator valves	Programmer, room thermostat, thermostatic radiator valves, weather or load compensator		Programmer, room thermostat, thermostatic radiator valves		Programmer and at least 2 room thermostats		Flat rate charging, programmer, room thermostat and thermostatic radiator valves	
		Water heating	160 litre cylinder, 50mm insulation	160 litre cylinder, 80mm insulation		160 litre cylinder, 80mm insulation		160 litre cylinder, 80mm insulation		160 litre cylinder, 80mm insulation	
		Secondary heating	Electric heaters	Electric	n/a	Electric	n/a	Electric	n/a	Electric	n/a
Renewables		Solar water heating	n/a	Solar water heating 4m^2		n/a		n/a		Solar water heating 4m^2	
		Photovoltaic (kWp)	n/a	2.90	5.30	1.75	3.95	3.60	5.95	2.90	5.35
Lighting			30%	100%		100%		100%		100%	
CO_2	100% (Level 5)	TER	23.76	23.76		23.76		33.73*		23.76	
		DER	23.46	-0.12		-0.20		-0.10		-0.19	
		Improvement	**1.3%**	**100.00%**		**101.00%**		**100.00%**		**101.00%**	
	Level 6 only	**Actual emissions**		-1.65		-2.22		-1.82		-1.42	
		Level 6 offset		12.24		12.24		12.24		12.24	
		Final DER		-10.59		-10.02		-10.42		-10.82	
Energy efficiency rating			80 (C)	97 (A)	112 (A)	85 (B)	95 (A)	102 (A)	114 (A)	101 (A)	112 (A)
Environmental impact rating			79 (C)	99 (A)	112 (A)	102 (B)	112 (A)	102 (A)	112 (A)	101 (A)	112 (A)
Running costs (£/yr)			263	69	-107	210	98	4	-124	27	-108

*Here the TER has changed because the heating fuel for this option has different fuel factor in the building regulations

Scenarios for achieving the Energy Saving Trust 100% and zero carbon emission solutions

Semi-detached house (89m²) scenarios

		Typical building regulations scenario	Energy Saving Trust 100% and zero carbon solutions							
			Gas boiler with solar water heating		Biomass boiler		Heat pump		Communal gas CHP	
			100%	Zero carbon	100%	Zero carbon	100%	Zero carbon	100%	Zero carbon
Fabric U-values W/m².K	Roof	0.15	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
	Walls	0.25	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
	Ground floor	0.25	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
	Windows	1.90	0.80	0.70	0.80	0.70	0.80	0.70	0.80	0.70
	Doors	2.00	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
	y-value	0.08 (accredited)	0.04		0.04		0.04		0.04	
Ventilation	Airtightness m³/(hr.m²)	7.0	3.0		3.0		3.0		3.0	
	Mechanical Ventilation	Extractor fans	MVHR 85% efficiency, 1W /(l.s) specific fan power		MVHR 85% efficiency, 1W /(l.s) specific fan power		MVHR 85% efficiency, 1W /(l.s) specific fan power		MVHR 85% efficiency, 1W /(l.s) specific fan power	
Heating	Boiler	Gas condensing 90%, boiler interlock	Gas condensing 90%, boiler interlock		Wood pellet, independent boiler 86%		Electric ground to water heat pump		Gas CHP, 75%	
	Controls	Programmer, room thermostat, thermostatic radiator valves	Programmer, room thermostat, thermostatic radiator valves, weather or load compensator		Programmer, room thermostat, thermostatic radiator valves		Programmer and at least 2 room thermostats		Flat rate charging, programmer, room thermostat and thermostatic radiator valves	
	Water heating	160 litre cylinder, 50mm insulation	160 litre cylinder, 80mm insulation		160 litre cylinder, 80mm insulation		160 litre cylinder, 80mm insulation		160 litre cylinder, 80mm insulation	
	Secondary heating	Electric heaters	Electric	n/a	Electric	n/a	Electric	n/a	Electric	n/a
Renewables	Solar water heating	n/a	Solar water heating 4m²		n/a		n/a		Solar water heating 4m²	
	Photovoltaic (kWp)	n/a	2.75	5.25	1.60	4.20	2.40	5.00	2.50	5.10
Lighting		30%	100%		100%		100%		100%	
CO_2	100% (Level 5) TER	23.00	23.00		23.00		32.60*		23.00	
	100% (Level 5) DER	22.69	-0.19		-0.01		-0.03		-0.17	
	100% (Level 5) Improvement	**1.3%**	**101.00%**		**100.00%**		**101.00%**		**101.00%**	
	Level 6 only **Actual emissions**		-1.68		-1.31		-1.28		-1.38	
	Level 6 only **Level 6 offset**		13.46		13.46		13.46		13.46	
	Level 6 only **Final DER**		-11.78		-12.15		-12.18		-12.08	
Energy efficiency rating			101 (A)	113	94 (A)	106	97 (A)	109	100 (A)	112
Environmental impact rating			102 (A)	112	101 (A)	112	101 (A)	112	101 (A)	112
Running costs (£/yr)			21	-98	99	-23	60	-64	32	-89

*Here the TER has changed because the heating fuel for this option has different fuel factor in the building regulations

Scenarios for achieving the Energy Saving Trust 100% and zero carbon emission solutions

Mid-terrace house (79m²) scenarios

			Typical building regulations scenario	Energy Saving Trust 100% and zero carbon solutions							
				Gas boiler with solar water heating		Biomass boiler		Heat pump		Communal gas CHP	
				100%	Zero carbon	100%	Zero carbon	100%	Zero carbon	100%	Zero carbon
Fabric U-values W/m².K		Roof	0.15	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
		Walls	0.30	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
		Ground floor	0.20	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
		Windows	1.90	0.80	0.70	0.80	0.70	0.80	0.70	0.80	0.70
		Doors	2.00	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
		y-value	0.08 (accredited)	0.04		0.04		0.04		0.04	
Ventilation		Airtightness m³/(hr.m²)	7.0	3.0		3.0		3.0		3.0	
		Mechanical Ventilation	Extractor fans	MVHR 85% efficiency, 1W /(l.s) specific fan power		MVHR 85% efficiency, 1W /(l.s) specific fan power		MVHR 85% efficiency, 1W /(l.s) specific fan power		MVHR 85% efficiency, 1W /(l.s) specific fan power	
Heating		Boiler	Gas condensing 90%, boiler interlock	Gas condensing 90%, boiler interlock		Wood pellet, independent boiler 86%		Electric ground to water heat pump		Gas CHP, 75%	
		Controls	Programmer, room thermostat, thermostatic radiator valves	Programmer, room thermostat, thermostatic radiator valves, weather or load compensator		Programmer, room thermostat, thermostatic radiator valves		Programmer and at least 2 room thermostats		Flat rate charging, programmer, room thermostat and thermostatic radiator valves	
		Water heating	140 litre cylinder, 50mm insulation	160 litre cylinder, 80mm insulation		160 litre cylinder, 80mm insulation		160 litre cylinder, 80mm insulation		160 litre cylinder, 80mm insulation	
		Secondary heating	Electric heaters	Electric	n/a	Electric	n/a	Electric	n/a	Electric	n/a
Renewables		Solar water heating	n/a	4m²		n/a		n/a		4m²	
		Photovoltaic (kWp)	n/a	2.35	4.75	1.45	3.75	2.25	4.65	2.25	4.65
Lighting			30%	100%		100%		100%		100%	
CO_2	100% (Level 5)	TER	21.32	21.32		21.32		30.13*		21.32	
		DER	21.04	-0.18		-0.18		-0.16		-0.19	
		Improvement	**1.3%**	**101.00%**		**101.00%**		**101.00%**		**101.00%**	
	Level 6 only	**Actual emissions**		-1.66		-1.97		-1.47		-1.47	
		Level 6 offset		14.28		14.28		14.28		14.28	
		Final DER		-12.62		-12.31		-12.81		-12.81	
Energy efficiency rating				101 (A)	113 (A)	88 (B)	99 (A)	97 (A)	109 (A)	101 (A)	113 (A)
Environmental impact rating				101 (A)	113 (A)	102	112 (A)	101 (A)	112 (A)	101 (A)	113 (A)
Running costs (£/yr)				24	-87	163	53	58	-57	28	-87

*Here the TER has changed because the heating fuel for this option has different fuel factor in the building regulations

Scenarios for achieving the Energy Saving Trust 100% and zero carbon emission solutions

Four-storey flats (61m²) scenarios

			Typical building regulations scenario	Energy Saving Trust 100% and zero carbon solutions							
				Electric		Communal biomass boiler		Communal heat pump		Communal gas CHP	
				100%	Zero carbon	100%	Zero carbon	100%	Zero carbon	100%	Zero carbon
Fabric U-values W/m².K		Roof	0.15	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
		Walls	0.25	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
		Ground floor	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
		Windows	1.20	0.80	0.70	0.80	0.70	0.80	0.70	0.80	0.70
		Doors	1.00	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
		y-value	0.08 (accredited)	0.04		0.04		0.04		0.04	
Ventilation		Airtightness m³/(hr.m²)	7.0	3.0		3.0		3.0		3.0	
		Mechanical Ventilation	Extractor fans	MVHR 85% efficiency, 1W /(l.s) specific fan power		MVHR 85% efficiency, 1W /(l.s) specific fan power		MVHR 85% efficiency, 1W /(l.s) specific fan power		MVHR 85% efficiency, 1W /(l.s) specific fan power	
Heating		Boiler	Electric storage heaters, integrated storage/direct acting	Electric storage heaters		Communal wood pellet boiler 86%		Electric ground to water heat pump		Gas CHP, 75%	
		Controls	Automatic charge control	Programmer, room thermostat		Programmer, room thermostat, thermostatic radiator valves		Programmer and at least 2 room thermostats		Flat rate charging, programmer, room thermostat and thermostatic radiator valves	
		Water heating	Electric immersion	140 litre cylinder, 80mm insulation		140 litre cylinder, 80mm insulation		140 litre cylinder, 80mm insulation		140 litre cylinder, 80mm insulation	
		Secondary heating	Electric heaters	Electric	n/a	Electric	n/a	Electric	n/a	Electric	n/a
Renewables		Solar water heating	n/a	Solar water heating 4m²		n/a		n/a		Solar water heating 4m²	
		Photovoltaic (kWp)	n/a	3.35	5.25	1.10	3.10	1.90	3.90	1.30	3.35
Lighting			30%	100%		100%		100%		100%	
CO_2	100% (Level 5)	Aggregate TER	31.75	31.75		22.42		31.74*		22.42	
		Aggregate DER	31.21	-0.25		-0.12		-0.11		-0.06	
		Aggregate % improvement	**1.70**	**100.80%**		**100.55%**		**100.35%**		**100.30%**	
	Level 6 only	**Actual emissions**		-1.55		-1.59		-1.64		-1.52	
		Level 6 offset		15.50		15.50		15.50		15.50	
		Final DER		-13.95		-13.91		-13.86		-13.98	
Energy efficiency rating				**85**	**108**	**87**	**104**	**87**	**109**	**88**	**106**
Environmental impact rating				**90**	**112**	**94**	**112**	**91**	**112**	**96**	**112**
Running costs (£/yr)				**160**	**-31**	**142**	**58**	**142**	**-45**	**136**	**-13**

*Here the TER has changed because the heating fuel for this option has different fuel factor in the building regulations

6. Further information

The Energy Saving Trust provides free technical guidance and solutions to help UK housing professionals design, build and refurbish to high levels of energy performance. These cover all aspects of energy performance in domestic new build and renovation. They are made available through the provision of training seminars, downloadable guides, online tools and a dedicated helpline.

A complete list of guidance categorised by subject area can be found in 'Energy Efficiency is best practice' (CE279). To download this, and to browse all available Energy Saving Trust best practice publications, please visit www.energysavingtrust.org.uk/housing

The following publications may also be of interest:

General

- Energy efficiency frequently asked questions (CE126)

For a variety of shorter introductory guides, visit www.energysavingtrust.org.uk/resources

Insulation

- Insulation materials chart – thermal properties and environmental ratings (CE71)

Lighting

- Cost benefit of lighting (CE56)
- Daylighting in urban areas: a guide for designers (CE257)
- Low energy domestic lighting (GIL20)

Windows

- Windows for new and existing housing (CE66)

To view a list of the most efficient windows currently available, please visit www.bfrc.org

Community Heating

- Community heating serves luxury private apartments (CE103)

Heating system

- Domestic heating by oil (CE29)
- Domestic heating by gas (inc. LPG) (CE30)
- Domestic heating by solid fuel (CE47)
- Domestic Heating by electricity (CE185)

To view a list of the most efficient boilers currently available, please visit www.boilers.org.uk

Airtightness and efficient ventilation

- Improving airtightness in dwellings (CE137)
- Achieving airtightness in new dwellings: case studies (CE248)
- Energy efficient ventilation in housing (GPG 268)

Renewables

- Renewable energy sources for homes in urban environments (CE69)
- Renewable energy sources for homes in rural environments (CE70)
- Domestic ground source heat pumps (CE82)
- Solar water heating systems (CE131)

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

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