Zero carbon homes – an introductory guide for housebuilders

NHBC Foundation
Housing research & development in partnership with BRE Trust

ZERO CARBON HUB

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February 2009

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FOREWORD

Tackling climate change is now widely acknowledged as one of the highest priorities for our society. The homes we live in are responsible for 27% of the UK's CO_2 emissions, and so it is right that attention should focus on how new homes can be designed and constructed to minimise emissions.

Since the launch of the first government consultation on zero carbon housing at the end of 2006 I have seen a variety of encouraging initiatives such as the construction of the Barratt Green House on BRE's Innovation Park in Watford. Builders large and small are increasingly engaging with the challenge of building to world-leading environmental standards.

But if we are to implement successfully the zero carbon standard across all new homes built in the UK it is imperative that we have a definition which is realistic, practical and sufficiently flexible to be achievable on all kinds of developments, with all kinds of homes.

The government consultation, *Definition of zero carbon homes and non-domestic buildings*, issued on 17 December 2008[1] marks a critical stage in our transition towards zero carbon. Its significance was noted by Mark Clare, Group Chief Executive of Barratt Developments Plc, who said:

> *A workable definition of zero carbon is critical if we are to deliver environmental ambitions in an affordable way – particularly in the hostile economic environment that we face today.*

The importance of this consultation cannot be under-estimated as the final definition of zero carbon will, quite literally, shape the future of housebuilding. It is important that builders, developers and all organisations in the supply chain are fully aware of the implications.

This guide, produced in association with the Zero Carbon Hub, is designed to help builders understand the issues associated with the definition of zero carbon and help them engage in the consultation process. I hope that it will prove a valuable reference source and a stimulus to active engagement throughout the industry in this hugely important agenda.

Rt. Hon. Nick Raynsford MP

Chairman, NHBC Foundation

ABOUT THE NHBC FOUNDATION AND THE ZERO CARBON HUB

The NHBC Foundation was established in 2006 by NHBC in partnership with the BRE Trust. Its purpose is to deliver high-quality research and practical guidance to help the industry meet its considerable challenges.

Since its inception, the NHBC Foundation's work has focused primarily on the sustainability agenda and the challenges of the government's 2016 zero carbon homes target. Research has included a review of microgeneration and renewable energy techniques and the groundbreaking research on zero carbon and what it means to homeowners and housebuilders.

The NHBC Foundation is also involved in a programme of positive engagement with government, development agencies, academics and other key stakeholders, focusing on current and pressing issues relevant to the industry.

Further details on the latest output from the NHBC Foundation can be found at www.nhbcfoundation.org.

NHBC Foundation Advisory Board

The work of the NHBC Foundation is guided by the NHBC Foundation Advisory Board, which comprises:

Rt. Hon. Nick Raynsford MP, Chairman

Dr Peter Bonfield, Chief Executive of BRE

Professor John Burland CBE, BRE Trust

Imtiaz Farookhi, Chief Executive of NHBC

Rod MacEachrane, NHBC Director (retired)

Geoff Pearce, Group Director of Development and Asset Management at East Thames Group

David Pretty CBE, Chairman of the New Homes Marketing Board

Richard Simmons, Chief Executive of CABE

Professor Steve Wilcox, Centre for Housing Policy, University of York

The Zero Carbon Hub

Established in 2008, the Zero Carbon Hub supports and reports to the 2016 Taskforce which is chaired by the Housing Minister and the Executive Chairman of the Home Builders Federation. It is a public/private partnership established to take day-to-day operational responsibility for co-ordinating delivery of low and zero carbon new homes. This purpose will be fulfilled by monitoring, co-ordinating and guiding the zero carbon programme and engaging organisations active in low and zero carbon homes. To do this the Zero Carbon Hub is developing five integrated workstreams – energy efficiency, energy supply, examples and scale up, skills and training and consumer engagement. For more information visit www.zerocarbonhub.org.

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1 Introduction

Little more than two years ago, few of us had considered the possibility of the zero carbon home. The concept of modern homes that were self-sufficient in terms of their energy use had been limited to a handful of 'autonomous houses', not connected to mains services, designed, built and occupied by enthusiasts.

That all changed in December 2006, with the launch of a government consultation which proposed that from 2016 all new homes should be built to a zero carbon standard. The policy statement which followed in July 2007, *Building a greener future: policy statement*[2] confirmed the policy and its timetable. The extent of change required to deliver zero carbon homes cannot be overstated.

Critical to achieving zero carbon homes is having a definition that is realistic, workable and has sufficient flexibility to enable compliance on all developments and for all kinds of homes. Clearly, the challenge of developing a cramped urban infill site, where there may be less opportunity to exploit renewable energy resources is quite different from that of building a single detached home on a large south-facing plot where there is scope for using a variety of renewable technologies.

The consequence of an inflexible definition of zero carbon, which did not recognise these limitations and allowed no scope for the use of renewable energy produced offsite, would be to prevent the development of a significant proportion of sites. Clearly that would run counter to government policy of improving the supply of new homes in the UK.

On 17 December 2008, following on from work done by the UK Green Building Council earlier in the year[3] the government launched a second consultation which deals specifically with the definition of zero carbon and how it is assessed. The final definition that emerges from this consultation has huge significance for the housebuilding industry, its supply chains and clients. These parties now have the opportunity to be engaged closely in the development of the definition and, through greater awareness of the issues, be instrumental in the generation of informed, practical solutions.

This guide has been prepared by the NHBC Foundation in association with the Zero Carbon Hub, the public and private partnership responsible for making zero carbon homes a reality from 2016.[4] It helps explain the concept of zero carbon and initially provides useful information for those wishing to respond to the consultation, which closes on 18 March 2009. In the longer term it will continue to provide a useful starting point for small and medium sized builders who have not yet faced the challenge of building above the current Building Regulation standards.

The specific focus of the guide is England and Wales because (depending on decisions to be taken regarding devolution of Building Regulations to Wales) that is the scope of the present consultation. However, Appendix A briefly summarises the present position with regard to zero carbon in Scotland and Northern Ireland.

2 How is energy used in homes?

The amount of energy used in homes varies widely depending on the size and type of home (eg detached, terraced or ground floor flat). Clearly the number of people living in the home, their occupation pattern and their use of hot water and appliances† will also affect the overall energy use. Figure 1 gives an idea of CO_2 emissions from a typical new home built to current Building Regulations standards Approved Document (AD) L1A, 2006.[5,6]

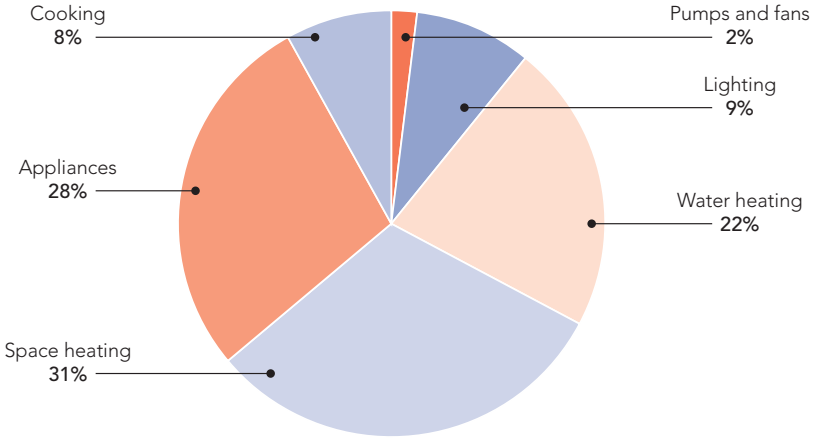

Figure 1 Typical annual CO_2 emissions from a semi-detached house constructed to current AD L1A.

A typical new home built to current standards uses considerably less energy than a typical existing home. This is because it is likely to have more thermal insulation in the external walls, ground floor and roof, and more thermally efficient windows and doors. It is also likely to have a more efficient heating system and will have been constructed to achieve a better standard of airtightness to control heat leaking out.

† Appliances are electrical devices whose function is not primarily for space or water heating, ventilation, lighting or cooking (for example, television, washing machine).

Where fossil fuels (such as gas and oil and electricity supplied through the National Grid) are used to provide that energy, CO_2 is produced. As shown by Table 1 the amount of CO_2 produced per unit of energy depends on the type of fuel used.

TABLE 1

Fuel emissions per unit energy as currently used in SAP 2005

Fuel		Emissions kg CO_2 per kWh
Gas	mains gas	0.194
	LPG	0.234
Oil	heating oil	0.265
Solid fuel	house coal	0.291
	anthracite	0.317
	manufactured smokeless fuel	0.392
	wood logs/pellets/chips	0.025
	dual fuel appliance (mineral and wood)	0.187
Electricity	from the National Grid	0.422
Community heating schemes	heat from boilers – gas, oil, solid fuel	Depends on fuel used*
	heat from heat pump	Depends on fuel used*
	heat from boilers – waste combustion	0.057
	heat from boilers – biomass	0.025
	heat from boilers – biogas	0.025
	waste heat from power stations	0.018
	geothermal heat source	0.018
	heat from combined heat and power	Depends on fuel used*
	electricity generated by combined heat and power	0.568

* For example, if mains gas is used the factor is 0.194.

Annual CO_2 emissions from a new typical semi-detached house with a gas fired central heating system (excluding emissions due to appliances and cooking) will be around 2.0 tonnes.

3 Why reduce energy use in new housing?

The UK's housing stock is responsible for 30% of primary energy use in the UK and, as shown in Figure 2, 27% of the UK's CO_2 emissions.

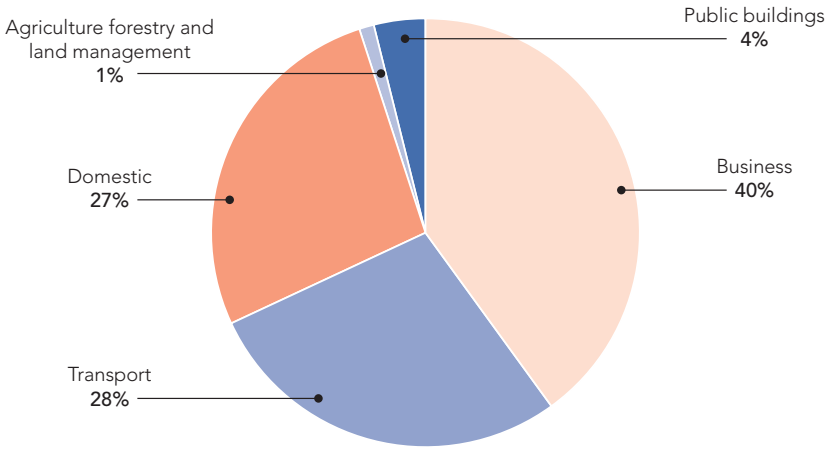

Figure 2 CO_2 emissions by end user.[7]

There are many reasons why it is important to reduce energy use in the UK's housing stock, but probably the three most important are listed under the following headings.

3.1 Climate change

It is now generally accepted that man-made CO_2 emissions are the main cause of climate change.[7] CO_2, and to a lesser extent other gases such as methane and nitrous oxide, in the atmosphere create a greenhouse effect. Most scientists now agree that there is a direct correlation between higher CO_2 concentrations in the atmosphere and increasing global temperature and that to restore balance, man-made emissions of CO_2 must be reduced as a matter of urgency.

3.2 Fuel poverty

Fuel poverty occurs where a household cannot afford to keep warm – this can compromise the health of those living in cold homes (sometimes fatally) and affects their quality of life. Fuel poverty in the UK is caused by a combination of poor energy efficiency in homes, low incomes and high energy prices.

3.3 Energy security

The UK's reserves of oil and gas are declining. While significant amounts still remain in the North Sea, production has hit its peak and is now falling. We are increasingly dependent on imports in a world where supplies are concentrated in potentially less stable regions.

4 Controlling energy use and CO_2 emissions

Measures to improve the energy efficiency of new homes were first introduced into the Building Regulations in 1965 with the introduction of a requirement for loft insulation and this was followed by changes in 1971 to limit condensation. In 1981 the Building Regulations sought to further reduce heat loss through the fabric although at the time the aim was to cut energy costs. Since then they have been subject to regular review and update, the last change taking effect in April 2006.

AD L1A[6] requires close attention to be paid to the specification and construction of the building fabric, the design, installation and commissioning of the services, and installation of some fixed lighting. These measures control the amount of energy that will be needed for space and hot water heating and lighting. But, importantly, AD L1A does not currently make reference to CO_2 emitted by appliances and cooking within the home, although as can be seen from Figure 1 for a semi-detached house this may typically account for about 36% of the overall CO_2 emissions.

It is important to note that, even if it were possible to improve the performance of the fabric and the services to perfect levels, the appliances used in the home would still consume energy and CO_2 would still be emitted. This may amount to about 1.12 tonnes per year for the typical semi-detached house.

5 Why aim for zero carbon?

It is estimated that the new homes built between now and 2050 could account for up to one third of the total stock of housing in 2050. Logic dictates, therefore, that if those new homes are built to high standards of energy efficiency, the amount of CO_2 they will emit will add less to total housing emissions than if they are built to lower standards. And so it follows that, if homes can be built to zero carbon design standards, then (in use) they will not in theory add to overall emissions at all.

Importantly the zero carbon target provides certainty to the industry on what is needed and when, allowing time for progressive up-skilling and development of the new approaches required.

Homes built to zero carbon standards should be relatively future-proof:

- they will not contribute towards climate change during their operation
- their occupants will be unlikely to suffer fuel poverty
- their occupants will be well cushioned from the effects of international fuel markets.

The commitment to build zero carbon homes is one of several government strategies and initiatives which aim to reduce the causes, and adapt to the effects, of climate change as a whole. On 3 October 2008 the government announced the creation of a new Department of Energy and Climate Change as part of its commitment to a wide range of strategies to reduce energy consumption, conserve water, reduce waste, manage flood risk, provide renewable energy sources, reduce risk of overheating, reduce fuel poverty and so on.

It is likely that housing (both existing and new build) will need to contribute more to the overall strategy to reduce CO_2 emissions in the future. The UK's independent climate change committee recommended last year that the proposed legally binding target of a 60% cut in CO_2 emissions should be increased to an 80% cut in greenhouse gas emissions. This advice was accepted by the government and incorporated into the Climate Change Act 2008.[8] If CO_2 cannot be cut sufficiently from other sectors, such as shipping and aviation, then higher standards will be required elsewhere to make up the shortfall.

6 How will zero carbon homes be required/encouraged?

The three mechanisms currently in place for requiring or encouraging zero carbon standards for new homes are Building Regulations, the Code for Sustainable Homes and stamp duty land tax relief.

6.1 Building Regulations

The concept of zero carbon was first introduced in the *Building a greener future: towards zero carbon development* consultation document,[9] published by Communities and Local Government (CLG) in December 2006. It laid out a proposed timetable for changes to Building Regulations for all new homes to achieve zero carbon by 2016, and defined zero carbon as follows:

> *For a new home to be genuinely zero carbon it will need to deliver zero carbon (net over the year) for all energy use in the home – cooking, washing and electronic entertainment appliances as well as space heating, cooling, ventilation, lighting and hot water.*

This consultation marked a turning point because it was the first time that it was suggested that the CO_2 emissions from appliances and cooking, and cooling within the home, might be brought under control using the Building Regulations.

A policy statement was issued by CLG in July 2007,[2] which confirmed the government's intention to press ahead with the policy to the following timetable in England and Wales (Table 2).

Figure 3 represents Table 2 graphically. Note that zero carbon represents an improvement in the order of 150% over AD L1A.

Work is currently underway to make the 2010 amendments to AD L1A and CLG is expected to issue a consultation on the revised Approved Document early in 2009. Building Regulations apply to all new dwellings, regardless of whether they are private or affordable homes and whether or not they are built on public land.

TABLE 2

Proposed future changes to AD L1A

Year	Improvement over AD L1A 2006 (%)
2010	25
2013	44
2016	Zero carbon

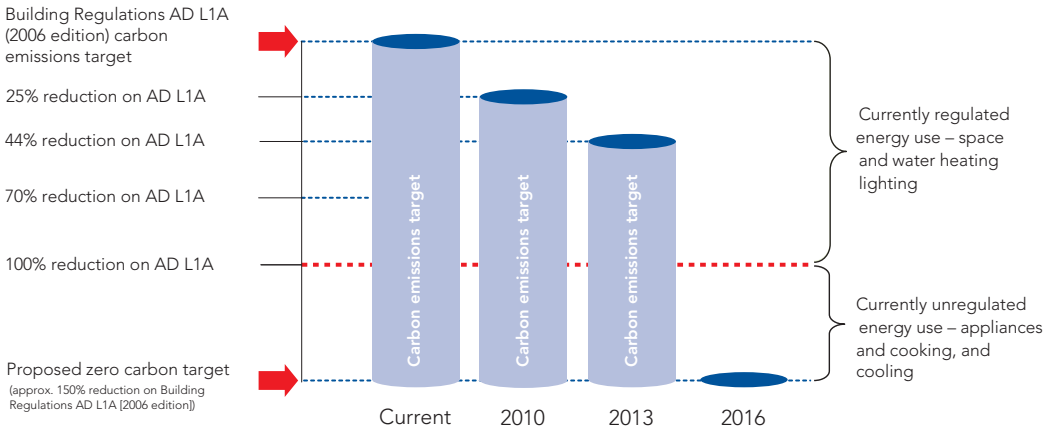

Figure 3 Reduction of CO_2 emissions from new housing – proposed transition to zero carbon by 2016. *Source: Zero Carbon Hub 2009*. (Note that even a 100% reduction over today's Building Regulations emissions standards takes us only part way to the proposed zero carbon target.)

6.2 Code for Sustainable Homes

Launched in December 2006, the Code for Sustainable Homes (the Code) is an environmental assessment method for rating and certifying the performance of new homes. The Code has nine categories of sustainable design and credits are earned under these categories if specified performance targets are reached. Based on the number of credits achieved an overall rating is awarded, ranging from Level one (1-star) to Level six (6-star).

Amongst the nine categories of sustainable design is 'energy and emissions'. Due to the importance of this category, mandatory levels of performance for energy and emissions are prescribed for each level of the Code. Again, these are expressed as a percentage improvement in CO_2 emissions over the current level of performance required by AD L1A (Table 3).

TABLE 3

Code for Sustainable Homes mandatory energy and emissions performance levels

Code level	Improvement over AD L1A 2006 (%)
Level 1	10
Level 2	18
Level 3	25
Level 4	44
Level 5	100
Level 6	Zero carbon

The definition of zero carbon that the Code uses is essentially the same as that used in the 2006 CLG consultation document[2] (ie it includes all emissions [net over the year], including appliances), but two additional criteria are set:

- to ensure homes are built to excellent standards of fabric energy efficiency – this prevents homes heated using fuels with low or zero CO_2 emissions from being built with poor fabric performance
- to allow the use of renewable energy generated offsite to be counted, only where it is directly connected by means of a 'private wire' – this prevents the developer from simply paying towards a wind turbine away from the site that would have been constructed in any case.

(The full definition of zero carbon is on page 46 of the Code for Sustainable Homes Guide, October 2008.[10])

From 1 May 2008 it has been mandatory for a Code rating certificate to be provided for all new homes built in England. For most housing no minimum Code rating is required and a 'nil rated certificate' may be included within the home information pack where the developer does not wish to undertake a full assessment against the Code. However, at present for publicly-funded new homes and those built on public land, achievement of Code Level 3 is the minimum requirement.

The Housing Corporation announced its intention that new homes funded under the National Affordable Housing Programme should meet zero carbon standards and Level 6 of the Code for Sustainable Homes by 2015 if the technology needed to achieve this cost-effectively is available.[11] The new Homes and Communities Agency is currently considering how to harmonise the standards and commitments made by English Partnerships and the Housing Corporation and will, subject to a cost-benefit analysis, confirm the timetable for building to higher levels of the Code for Sustainable Homes in due course.

6.3 Stamp duty land tax relief

A relief from stamp duty land tax (SDLT) for most new zero carbon homes built in the UK was announced in the 2006 pre-Budget report. To establish eligibility for this relief HM Revenue and Customs (HMRC) needed to adopt a definition of zero carbon.

Like the Code, the HMRC definition follows that in the 2006 CLG consultation document[2] but, again requires in addition, excellent standards of fabric energy efficiency and stipulating that a 'private wire' shall be used to connect offsite renewable energy sources.

The full definition is available from the HMRC website.[12]

It is understood that, to date, only a very small number of homes have qualified for relief from SDLT.

7 The CLG zero carbon consultation

On 17 December 2008 CLG launched a consultation document entitled *Definition of zero carbon homes and non-domestic buildings*.[1] It proposes "an approach to zero carbon homes that will:

- achieve large reductions in carbon emissions from all new homes compared to current Building Regulations; and
- allow a range of solutions for dealing with the remaining carbon emissions that will be workable for the full range of housing developments that will be needed to meet our housing targets".

The consultation is relevant for England and Wales currently, although the anticipated devolution of Building Regulations could affect its future applicability in Wales.

7.1 The definition

Closely following the definition proposed in the previous CLG consultation, the December 2008 consultation defines zero carbon homes as those built "in such a way that, after taking account of:

- emissions from space heating, ventilation, hot water and fixed lighting
- expected energy use from appliances
- exports and imports of energy from the development (and directly connected energy installations) to and from centralised energy networks,

the building will have net zero carbon emissions over the course of a year".[1]

The consultation proposes the following 'hierarchical framework' (Fig. 4).

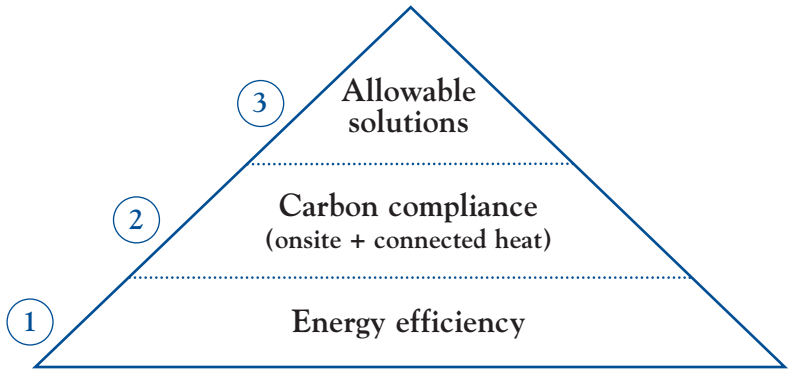

Figure 4 Zero carbon hierarchical framework.

1 Energy efficiency

The first issue that needs to be addressed is energy efficiency.

All new homes will have to be built to very high standards of energy efficiency because these measures are likely to be the most cost-effective and deliver their benefits over the lifetime of the homes. Energy efficiency is achieved by having an appropriate building form, good fabric insulation (well insulated walls, floor, roof, windows, doors, no thermal bridging etc.), achieving good airtightness standards and installing efficient heating and ventilation systems. Benefit may also be gained from passive solar design – orienting the homes to optimise heat from the sun.

2 Carbon compliance (onsite and connected heat)

This is the minimum level of reduction in CO_2 emissions that is required to be achieved onsite and/or through direct connection to a district heating system that produces little or no CO_2.

Onsite technologies include microgeneration (solar water heating, solar electric, wind turbines, etc.) and the capacity to install these will depend on the site size and the types of home – clearly the opportunities for urban flats are restricted compared with sites with houses at low density.

As can be seen from other countries such as Sweden, district heating systems can make a useful contribution to minimising CO_2 emissions (particularly where they are supplied by a combined heat and power system). The proposals allow for a heating system located either onsite or offsite to count towards 'carbon compliance'.

As noted in section 2, it has been already proposed that AD L1A is changed to require a reduction in emissions (beyond the 2006 edition) of 25% in 2010 and 44% in 2013 and work to achieve this is underway. The December 2008 consultation document proposes that for 2016 and beyond, energy efficiency and compliance measures, should, combined, achieve a reduction of 44%, 70% or 100%.

Achieving even 44% presents a major challenge and it is around the PassivHaus level of energy efficiency.[13] Going beyond 44% will become extremely challenging for many developments because meeting the target will be entirely reliant upon the incorporation of low carbon and renewable technologies. The consultation specifically invites views on whether 44%, 70% or 100% is the appropriate level.

3 Allowable solutions

It is unlikely that a combination of energy efficiency and carbon compliance, alone, will be sufficient to achieve zero carbon. A range of 'allowable solutions' is therefore proposed to deal with the remaining ('residual') emissions.[12] These are:

- additional measures installed on site (microgeneration, etc.)
- credit for energy efficient appliances or advanced forms of building control system (eg 'smart' systems that sense occupancy)

- export of low carbon/renewable heat (or cooling) to other properties nearby
- a Section 106 contribution towards a low or zero carbon infrastructure
- retrofitting energy efficiency measures to existing buildings near to the development
- investment in low or zero carbon infrastructure (such as a wind turbine sited away from the development) where the benefits of ownership of that investment (eg shares and dividends) are passed to the homeowner
- offsite renewable energy capacity connected by 'private wire' (ie a direct connection as opposed to connection through the National Grid)
- 'any other measures that government might in future announce as being eligible'.

7.2 Capped cost

Clearly, not all renewable sources will be available for use on every development. For example, a small urban infill development may be unsuited to the use of microgeneration technologies due to a relatively small roof area or insufficient wind to utilise a wind turbine.

Equally, on some developments the costs of those solutions which are available could be very high and may not be easy for developers to predict at this stage. In order to provide certainty and predictability, the consultation document proposes a review of allowable solutions in 2012 to ensure that the allowable solutions can be implemented on a sufficient scale at a cost (per tonne of CO_2 saved) below a level to be set via the consultation. The consultation seeks views on what that cost level should be.

7.3 Summary

The three-month consultation period will end on 18 March 2009 and readers are encouraged to submit responses. Following a review of the responses to the December 2008 consultation, a policy statement is due to be issued in Summer 2009.

Assuming the definition proposed in the consultation is adopted then it is likely that the design of future housing developments will need to follow the process outlined in Appendix B.

APPENDIX A

Zero carbon in Scotland and Northern Ireland

Scotland

In Scotland the report entitled *A low carbon building standards strategy for Scotland* (the 'Sullivan Report')[14] makes 56 recommendations to the Scottish government for challenging but realistic targets for housing and non-domestic buildings. The majority of the recommendations are within the remit of the Scottish government's Building Standards Division, which has responsibility for setting Building Regulations within Scotland.

The report recommends that 'net zero carbon' buildings (ie space and water heating, lighting and ventilation) are made a requirement by 2016/2017, if practical. This definition of 'net zero carbon' is equivalent to 100% improvement over AD L1A 2006 and Code Level 5. There is a further recommendation for buildings to be 'total life zero carbon' by 2030. This is described as the building's total carbon emissions including those from construction and demolition as well as in use.

The Code for Sustainable Homes has not been adopted in Scotland where EcoHomes 2006 is still being used, although some housing schemes are adopting the Code's energy requirements on a trial basis.

Northern Ireland

Northern Ireland is seeking to promote the UK government's goal that all new homes should reach a zero carbon standard by 2016, and their intended future improvements to Building Regulations presently match the timetable for England (25% reduction in CO_2 emissions by 2010, and 44% by 2013 then moving towards zero carbon).

There is currently discussion[15] on domestic rating rebates for privately built new zero carbon homes built in Northern Ireland to help stimulate the demand and supply of such houses. To qualify for the rate rebates it is likely that the definition and assessment of a zero carbon home will be based around the guidance contained within the Code for Sustainable Homes, although it is recognised that further work is necessary for the current zero carbon definition to be accepted in Northern Ireland.

All new publicly funded social housing schemes have been required to achieve Code level 3 since 1 April 2008, however it is not yet a requirement to have a rating against the Code for private housing.

APPENDIX B

Designing for zero carbon

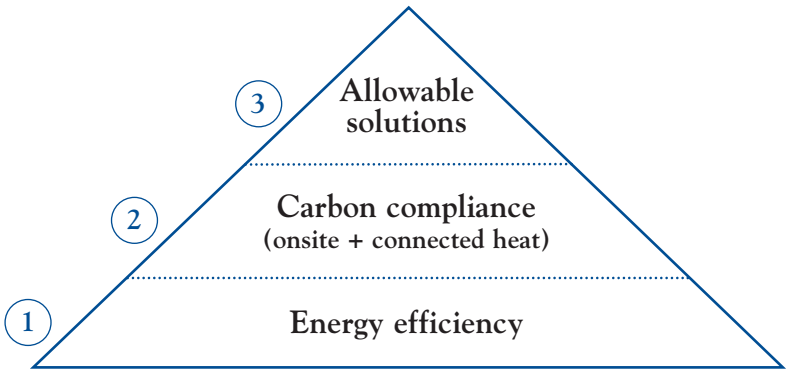

Figure A1 Zero carbon hierarchical framework.

Assuming the definition proposed in *Definition of zero carbon homes and non-domestic buildings*, December 2008 CLG consultation is adopted[1] (Fig. A1) the design of future housing developments will need to follow the stages listed below:

Stage 1 Energy efficiency

Within the zero carbon hierarchy, minimum levels of energy efficiency for the building envelope will be required. At present Code level 6 requires a heat loss parameter of 0.8 W/m^{2}K to be achieved, which is comparable to the building fabric and airtightness requirement of the PassivHaus standard.[16] To achieve the current standard, excellent U-values for all of the fabric elements, levels of airtightness and, in most instances a heat recovery ventilation system are typically needed. The building form should also be taken into account. The current CLG consultation[1] on zero carbon is seeking industry views on what a suitable level of energy efficiency might be.

Experience has shown that improvements in energy efficiency may reduce the CO_2 emissions by up to 44% compared to a house presently built according to the requirements of AD L1A. Therefore energy efficiency has an important role to play, potentially reducing the amount of low and zero carbon technologies which are needed to achieve zero carbon (see *Stage 2 Carbon compliance (onsite and connected heat)* below).

Stage 2 Carbon compliance (onsite and connected heat)

Additional low and zero carbon technologies are then specified to achieve the required level of 'carbon compliance', which for zero carbon take account of the emissions due to using appliances and cooking. These could include roof-mounted solar panels[17] and connection to heat schemes such as community heating and power schemes.

The minimum carbon compliance level required for a zero carbon building at the second stage is likely to require a reduction in CO_2 emissions over AD L1A 2006 of either 44%, 70% or 100% (Code level 5). In the December 2008 consultation document the government has indicated a reduction in CO_2 emissions of 70% may be the appropriate level, which would leave residual CO_2 emissions per home of 1.5 tonnes of CO_2 per year which can be addressed at the third stage to meet the zero carbon standard.

Stage 3 Allowable solutions

To achieve zero carbon the residual emissions (which remain after energy efficiency and carbon compliance measures have been accounted for) may be mitigated using one or more of the following allowable solutions:

- additional measures installed on site (microgeneration, etc.)
- credit for energy efficient appliances or advanced forms of building control system (eg 'smart' systems that sense occupancy)
- export of low carbon/renewable heat (or cooling) to other properties nearby
- a Section 106 contribution towards a low or zero carbon infrastructure
- retrofitting energy efficiency measures to existing buildings near to the development
- investment in low or zero carbon infrastructure (such as a wind turbine sited away from the development) where the benefits of ownership of that investment (eg shares and dividends) are passed to the homeowner
- offsite renewable energy capacity connected by 'private wire' (ie a direct connection as opposed to connection through the National Grid).

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4 www.zerocarbonhub.org.

5 The data in Figure 1 are based on typical occupancy assumptions used within SAP 2005 regarding occupancy patterns for heating and also for the use of appliances, cooking and hot water.

Where fossil fuels (such as gas and oil and electricity supplied through the National Grid) are used to provide that energy, CO_2 is produced. The amount of CO_2 produced per unit of energy depends on the type of fuel used.

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14 www.sbsa.gov.uk/sullivanreport.htm.

15 www.ratingreviewni.gov.uk/green_rebates.pdf.

16 See www.passivhaus.org.uk for a outline specification.

17 Further information on this and other technologies available please see the NHBC Guide to renewable energy, 2007 and NHBC Foundation A review of microgeneration and renewable energy technologies (NF7), 2008.

NHBC Foundation publications

A guide to modern methods of construction — NF1, December 2006

Conserving energy and water, and minimising waste
A review of drivers and impacts on house building — NF2, March 2007

Climate change and innovation in house building
Designing out risk — NF3, August 2007

Risks in domestic basement construction — NF4, October 2007

Ground source heat pump systems
Benefits, drivers and barriers in residential developments — NF5, October 2007

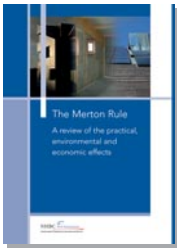
Modern housing
Households' views of their new homes — NF6, November 2007

A review of microgeneration and renewable energy technologies — NF7, January 2008

Site waste management
Guidance and templates for effective site waste management plans — NF8, July 2008

Zero carbon: what does it mean to homeowners and housebuilders? — NF9, April 2008

Learning the lessons from systemic building failures — NF10, August 2008



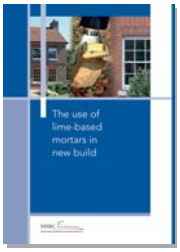
The Merton Rule

A review of the practical, environmental and economic effects

Since its introduction in 2003, the Merton Rule has been a focus of controversy. While some call it 'ground-breaking', and view it as having a positive impact on the renewables industry, others believe that it encourages a 'bolt-on' approach to energy efficiency and can be a financial burden on developers.

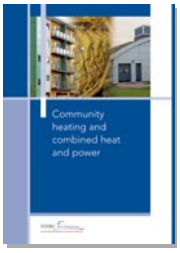
The review also looks at how the Merton Rule has been interpreted, the effect it has had on reductions in CO_2 emissions and how developers have been impacted financially in complying with its requirements. NF11, January 2009

The use of lime-based mortars in new build



This guide provides a general introduction to using lime-based mortars and is aimed at those who may have little knowledge of this material but who want to apply best practice when used in new build construction projects. It describes a range of mortar types concentrating on natural hydraulic limes.

A Draft for Development Standard is also included which provides replacement and new clauses for incorporation into BS 5628-1:2005 *Code of practice for the use of masonry – Part 1: Structural use of unreinforced masonry.* NF12, December 2008



Community heating and combined heat and power

The advent of the Code for Sustainable Homes means that low carbon solutions, such as community heating, are a key consideration for new developments. There are powerful environmental drivers for this approach principally because it enables the integration of combined heat and power and renewables.

This guide aims to introduce the reader to the concept of community heating and combined heat and power and how they can be applied. The focus is principally on new housing developments, but the possibilities for serving a mixture of both new and existing buildings, as well as mixed use developments, is also described. NF13, February 2009

NHBC Foundation publications in preparation

- Code for Sustainable Homes – simply explained
- Water efficiency guidelines
- Sustainable drainage systems for housing

NHBC FOUNDATION

Housing research & development in partnership with BRE Trust

www.nhbcfoundation.org

Zero carbon homes – an introductory guide for housebuilders

This guide has been written in response to the government's *Definition of zero carbon homes and non-domestic buildings* consultation published in December 2008. The guide is intended to help explain the concept of zero carbon and provides useful information for those wishing to respond to the consultation, which closes on 18 March 2009. The importance of the consultation cannot be under-estimated – the final definition of zero carbon will, quite literally, shape the future of housebuilding.

The guide is designed to help builders understand the issues associated with the definition of zero carbon and help them engage in the consultation process. It provides an overview of CO_2 emissions from homes, how these can be reduced and how zero carbon standards can be set through the Building Regulations, the Code for Sustainable Homes and stamp duty tax relief.

NHBC Foundation
Housing research & development in partnership with BRE Trust

The NHBC Foundation has been established by NHBC in partnership with the BRE Trust. It facilitates research and development, technology and knowledge sharing, and the capture of industry best practice. The NHBC Foundation promotes best practice to help builders, developers and the industry as it responds to the country's wider housing needs. The NHBC Foundation carries out practical, high quality research where it is needed most, particularly in areas such as building standards and processes. It also supports house builders in developing strong relationships with their customers.

NF14
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