Communities and Local Government

Building Regulations
Energy efficiency requirements for new dwellings

A forward look at what standards may be in 2010 and 2013

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July 2007
Department for Communities and Local Government: London

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July 2007

Product Code: 07 HC 04748/f

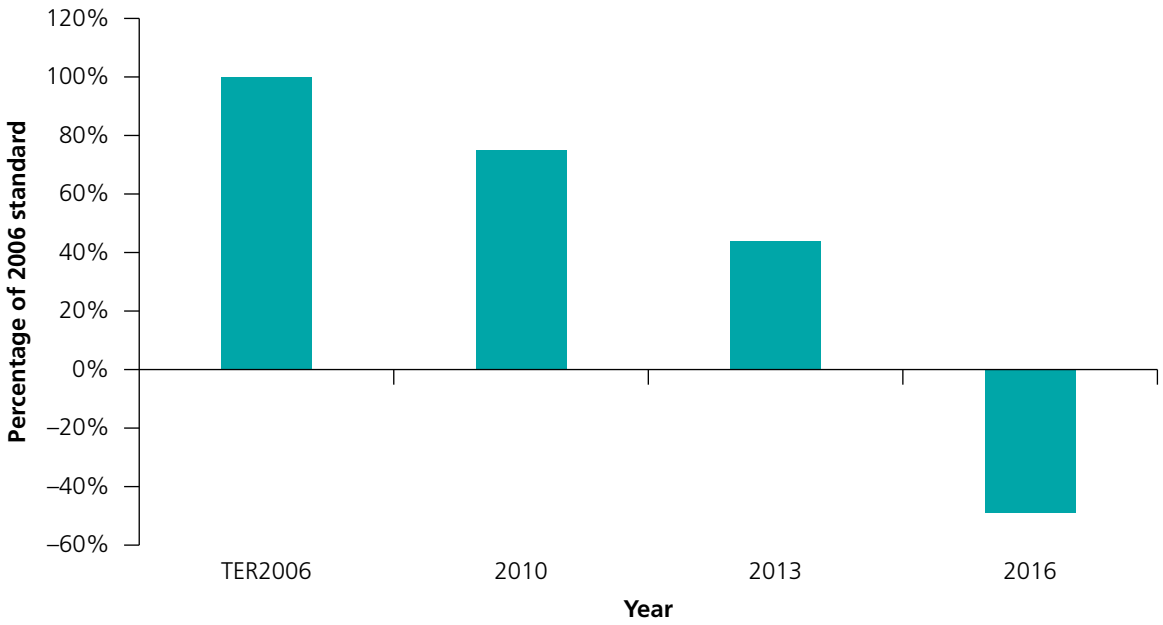
Contents

Introduction

1. In the recent Energy White Paper the Government signalled its intention to significantly reduce energy use in buildings as an important element in its climate change strategy, and its approach to securing energy supplies in the future. The minimum energy efficiency requirements in Part L of the Building Regulations are one of the mechanisms through which these reductions are to be achieved. The latest revision of Part L came into effect in April 2006. The Government is proposing a series of further amendments in its Green Paper *Homes for the future: more affordable more sustainable*.[1]

2. Figure 1 sets out, with respect to carbon emissions, the improvements over the 2006 standards that are proposed for implementation in 2010, 2013 and 2016[2]. These equate to the energy performance standards in the *Code for Sustainable Homes*[3] Levels 3, 4 and 6 respectively.

Figure 1: Percentage reduction in target carbon emissions (TER) required by each standard (base = 2006 standard)



3. Until 2013 the standard is likely to continue to be set with reference to those sources of emission (space, water heating and lighting) that are contained in the 2006 regulations and to offer the *option* of adopting Low and Zero Carbon (LZC) technologies. The step to zero carbon in 2016 is likely to include emissions from other sources (principally electrical appliances), which would result in the need for significant renewable generation capacity as well as other LZC systems.

[1] *Homes for the future: more affordable, more sustainable*. Department for Communities and Local Government, July 2007.

[2] The figure of 149 per cent for 2016 is an approximation because it depends on assumptions made about consumer electrical appliances energy consumption which are currently outside the scope of the energy calculation procedure.

[3] *Code for Sustainable Homes*, December 2006. Department for Communities and Local Government www.planningportal.gov.uk/england/professionals/en/1115314116927.html

4. This paper is intended to update the forward look at prospective Building Regulations energy efficiency standards **for new dwellings** as previously published in the 2004 Part L consultation document[4] and should be read in conjunction with the Green Paper. It gives illustrations of the physical provisions that could be necessary to meet the standards in 2010 and 2013 so far as this can be forecast at the time of publication.

5. The paper is intended to provide an early indication of the changes that *seem likely* to be needed to meet future targets for energy efficiency. Its content may change significantly before formal changes to the building regulations are made as technologies and approaches to achieving energy efficiency improvements evolve, and views expressed in formal consultation procedures are taken into account. As required by the Building Act 1984 there will be full consultations before any changes are actually made to the Building Regulations requirements.

6. Further forward look papers will be published in due course providing similar updates for new buildings that are not dwellings and for the provisions that apply when carrying out work on existing buildings.

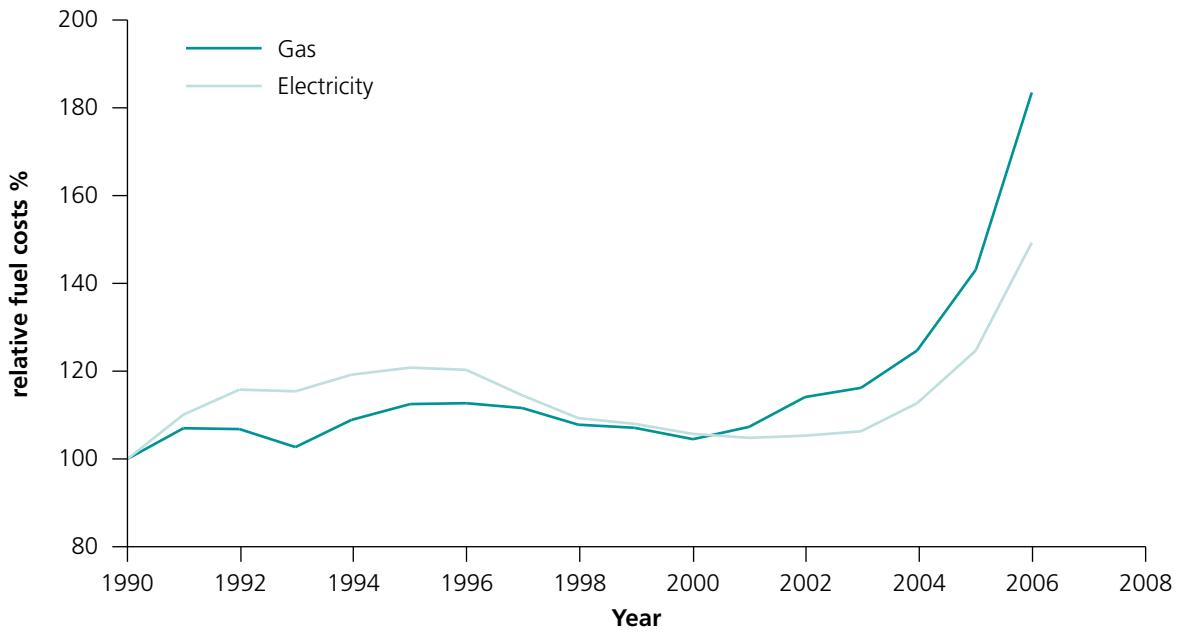
[4] *Section 6: Possible future performance standards for Part L – Proposals for amending Part L: A consultation document*, ODPM, July 2004. www.communities.gov.uk/index.asp?id=1131459

Cost-effectiveness considerations

7. The standards in the Building Regulations are predicated on cost effectiveness and there will be a full Regulatory Impact Assessment (RIA) before any changes are made. Since the 2006 standards were consulted on in 2004, there has been a substantial increase in energy prices, making further improvements in energy efficiency standards possible whilst still remaining cost effective. This is indicated in Figure 2 below, which shows how the real cost of gas and electricity has changed over the years to 2005[5]. Since the standards were set for the last review of Part L, gas prices have increased by nearly 50 per cent and electricity prices by nearly 30 per cent although they have been falling back again during 2007. This illustrates the uncertainties surrounding fuel price forecasting but an underlying upward trend is expected. We will need to revisit this in the coming review and it could have a significant impact on the way we proceed.

8. It will also be necessary to take into account carbon trading and the possible post-Kyoto agreements that will impact on the social cost of carbon.

Figure 2: Changes in the real cost of gas and electricity over the 15 years to 2005



Planning considerations

9. Planning legislation has a significant role to play in the achievement of low carbon developments. There are changes in prospect, through the Climate Change Planning Policy Statement (PPS), to improve the contribution that, for instance, site layout, building orientation, shading etc can make in reducing demand on mechanical heating, cooling and ventilation systems. The formal review in advance of the 2010 amendment will also have to take these contributions into account.

[5] *Quarterly energy prices: tables* (Ref URN No: 07/276a/tab), Department for Business, Enterprise and Regulatory Reform. www.dti.gov.uk/energy/statistics/publications/prices/tables/page18125.html

Standards for new dwellings

Basis for setting the standards

10. In line with the requirements of Article 3 on the Energy Performance of Buildings Directive (EPBD), the 2006 revision of Part L moved the basis of compliance from standards given for each construction element and building service to an overall CO_2 emissions target, the Target Emissions Rate (TER) for the whole building. This target is based on a notional dwelling defined in terms of the elemental standards (U-values, area allowances, boiler efficiencies etc) that prevailed in the 2002 edition of Approved Document L1. The 2002 Approved Document was chosen as the datum because it gave a set of standards that the construction industry was familiar with in terms of construction specifications and real constructional products and materials. This enabled them to extrapolate the physical implications of the proposed higher standards.

11. Target CO_2 emissions for new dwellings are calculated using SAP 2005[6], using the following formula:

    TER = (C_H x fuel factor + C_L) x (1 – improvement factor)

    Where: C_H is the emissions calculated using SAP 2005 that would arise from the provision of heating and hot water (including fans and pumps) complying with the 2002 Approved Document standards.

    C_L is the emissions arising from internal fixed lighting as determined to comply with the 2002 Approved Document standards.

    Fuel factor is a factor depending on the primary heating fuel.

    Improvement factor is the target improvement from the 2002 base line for a *gas-heated* dwelling.

12. Current thinking is that for the 2010 and 2013 amendments, the formula for the TER will remain unchanged, but the values used will change as discussed below. The calculations will still be based on SAP, although a new version of it will be required to address a number of changing technical requirements (see paragraph 31 below).

The fuel factor

13. The fuel factor is the ratio of the CO_2 emission factor ($kgCO_2/kWh$) for the given fuel to that of mains gas, the primary heating fuel in the UK. Its purpose is to provide some relief in the target applicable to dwellings that are off the gas grid or in blocks of flats where a gas service to each apartment is not a preferred choice. The fuel factor means that if the chosen heating fuel is more carbon intensive than gas, the TER is increased (eased).

[6] *SAP 2005, The Government's Standard Assessment Procedure for Energy Rating of Dwellings*, DEFRA, 2005. BRE website: http://projects.bre.co.uk/sap2005/

14. The fuel factor equation for 2006 was chosen to strike a balance between taking no account of fuel selection (this would penalise those who must use more carbon-intensive fuels in terms of increased construction costs) and taking full account (which would mean accepting much higher emissions from buildings where gas is not used). The goal is to set a zero carbon target for 2016 and along the way to reduce the relief in stages in 2010 and 2013.

15. The fuel factors for 2006 and the current thinking for factors for 2010 are given in the following table. The values are based on the CO_2 emission factors given in SAP 2005 Table 12 (which come from the policy paper *CO_2 Emission factors for policy analysis*, BRE 2005). They are derived by indexing the ratio of carbon content of the fuel in question to that of the carbon burden of mains gas as the base. The index for 2006 was chosen as 0.5 to give some relief for higher carbon fuels such as electricity and LPG. The proposed index for 2010 is 0.4 which removes some of this relaxation and a similar reduction is proposed for 2013 along the way to no relaxation in 2016. In addition, the fuel factors themselves will be kept under review in coordination with Defra and DBERR.

Table 1: Current thinking on Fuel factors for 2010

Fuel	CO_2 emission factor $kgCO_2/kWh$	Fuel factor (2006)	Fuel factor (2010)
Mains gas	0.194	1.00	1.00
Liquid Petroleum Gas (LPG)	0.234	1.10	1.08
Oil	0.265	1.17	1.13
Grid electricity	0.422	1.47	1.36
Solid mineral fuel eg anthracite	0.317	1.28	1.22
Renewable energy	0.025	1.00	1.00
Solid multi-fuel	0.187	1.00	1.00

16. The fuel factor to be used for heat pump systems will be looked at as a separate issue. In 2006, the carbon value for grid electricity was allowed as a means of encouraging the application of this technology and the building fabric design limits meant that appropriate standards were achieved. At 2010 it may be more appropriate to set the fuel factor for mains electric heat pumps to 1.0, unless the limits on design flexibility for fabric are tightened significantly from the 2006 values.

Limits on design flexibility

17. These are currently set by considerations of buildability, the avoidance of risks of condensation and the overall aim of providing reasonable minimum standards for the fabric and services. They will need to be reviewed for 2010 and 2013. Current thinking is that they will need to be tightened to follow the higher standards that are to be set in 2010 and 2013 but it will still be necessary to leave margins for design flexibility. The limits could continue to be set by reference to individual building fabric elements but an alternative overall approach of limiting the permissible heat loss parameter might be more versatile. Values might be set for 2010 and 2013 in a practical trajectory leading the way to a value of say 0.8 W/m^2K (the value being incorporated into the criteria for Stamp Duty Land Tax eligibility later this year) for 2016.

Construction quality

18. Consideration will also be given as to whether an additional adjustment factor should be introduced into the calculations to reflect the confidence with which as-built performance matches the approved design intent. One of the objectives in the 2003 Energy White Paper was to reduce the gap between design and reality, although there will always be some difference arising from site circumstances. As standards rise however it becomes more important to reduce this difference. It might be possible, for example, for builders who invest in enhanced site-based quality systems and additional pre-completion testing to claim a less demanding improvement factor or to set a more demanding improvement factor that would apply unless a satisfactory quality assurance scheme and testing was in place.

CO_2 emission factors

19. The fuel factors in Table 1 are based on the CO_2 emission factors given in SAP 2005 Table 12. They spring from work carried out for Defra by the BRE as reported in *CO_2 emission factors for policy analysis, July 2005*[7]. They are nevertheless contentious:

    a) The emissions factor for mains gas may not satisfactorily account for pipeline and transit losses and the much higher global warming potential of methane leaks compared with combustion CO_2.

    b) Since the 2005 figures were finalised, the anticipated reduction in the carbon intensity of electricity has not materialised because the rising price of gas has resulted in an increased use of coal for grid power generation.

20. Developments in other fuels will also need to be monitored, such as the potential for reducing the CO_2 emission factor of heating oil by mixing conventional fuel oil with biofuel and the carbon-neutral proportion assumed for solid multi-fuel appliances.

21. Government will be working with stakeholders to investigate how best to handle these sorts of issues with the aim of publishing revised factors in time for the next round of Part L consultations.

Energy flows included in the calculation

Lighting

22. For the 2006 Part L, the calculations for compliance assume a fixed percentage of low energy lighting fittings. This approach was adopted because such light fittings are not a permanent feature of the dwelling and can be easily replaced with less efficient ones. There were also relatively few models of low-energy light fittings on the household market.

[7] *CO_2 emission figures for policy analysis*, BRE. www.bre.co.uk/filelibrary/rpts/eng_fact_file/CO2EmissionFigures2001.pdf

23. As dwellings become better insulated, lighting becomes an increasingly significant component of CO_2 emissions (typically 15 per cent for a 2006 compliant gas heated semi-detached house, when 30 per cent of the lights are low energy). This means that increased use of low energy lighting may be a significant opportunity in the drive to achieve CO_2 reductions. Since 2005 the market for low-energy light fittings has rapidly expanded and there are now more than 300 'energy recommended' models in the Domestic Energy Efficient Lighting Scheme (DEELS) scheme aimed at the household market[8]. With further innovation in light sources and lamp technology, lighting standards could improve and apply throughout new homes.

24. Communities and Local Government will be investigating the possibility of allowing the percentage lighting to be varied in the compliance calculation, and what safeguards might be required to minimise the possibility of retro-fitting of inefficient lighting. The possible EU Regulations preventing sale of low-efficiency light bulbs and the possibility that manufacturers might withdraw these bulbs from the market even sooner will have a bearing on this.

Secondary heating

25. For the 2006 Part L amendment it was assumed that householders would use some secondary heating (secondary to the central heating system such as the provision of electric, gas or solid fuel room heaters with a higher carbon burden than the main heating system. The SAP 2005 calculation assumption was that unless specific provision was made for fixed secondary heating the compliance calculation should assume 10 per cent electric secondary heating. As dwellings become better insulated, secondary heating system usage with the primary system turned off will increase.

26. Consideration will therefore be given to changing the rules on secondary heating to permit specifying a different proportion of the heating to be obtained from secondary systems. In some highly insulated dwellings that proportion could be as high as 100 per cent where the concept of 'secondary heating' no longer applies.

Other criteria

27. The 2006 Part L included three other criteria in addition to the CO_2 target and limits on design flexibility. These addressed:

    a) Passive control of overheating by, for instance, orientation, shading and landscaping. The calculation approach will be reviewed as indicated in paragraph 31 below to raise standards, taking into account climate change projections. This will include consideration of how best to model the future climate that new dwellings are likely to experience over the coming decades.

    b) Assessments of the building as constructed (eg by pressure tests). The initial feedback from implementing the sample testing system introduced in 2006 has improved confidence in the achievement of compliant air-tightness, and that has also improved confidence in compliance in general. But the sampling testing frequency might need to be tightened in the light of further experience.

[8] Source: Lighting Association

c) Provision of information. Again the guidance will be reviewed, especially in the light of the proposals in the 2007 Energy White Paper on smart metering, the availability of Energy Performance Certificates and Recommendation Reports and the probable trend to a wider adoption of low and zero carbon (LZC) systems with which users are unfamiliar. There are new safety issues that may also need to be addressed in user advice.

Approved construction details

28. These were introduced to offer builders design solutions to the problems of air leakage and insulation discontinuities at junctions. There is ongoing work with industry to:

    a) collect site experience on how robust these designs are in practice; and

    b) to add further approved construction details. Some work is already under way in each of the following areas:

        i) Dealing with less common situations; an industry consultation has been held to identify the additional details that are desirable, and plans have been put in hand to develop them during this financial year.

        ii) Achieving higher standards; the Energy Saving Trust are working on a set of enhanced details which will be assimilated into the Accredited Details set by mutual agreement. The Association for Energy Conscious Building has also been investigating model details and the results of their work will also be taken into account.

        iii) Including details that incorporate proprietary products such as insulation and air barriers (a system for approving such details would need to be developed with industry).

29. The aim is to achieve a consolidated and updated set relevant to and in time for the proposed changes in 2010 and 2013 so that builders can begin to assess the implications well in advance of the implementation deadlines. The Government will be working with industry to identify candidate details and to put in place a more robust accreditation procedure in an effort to achieve this.

Model design packages

30. Section 4 in the 2006 edition of Approved Document L1A gave an approach enabling industry consortia to offer packages of building fabric and heating etc services specifications that would collectively deliver compliance. Government will be continuing to encourage all sectors of the construction industry to consider this approach as part of their pursuit of the goals set out in the Egan Report: *Rethinking Construction*[9]. And consideration will be given to identifying model developments as examples where the higher construction standards are being achieved.

[9] *Rethinking Construction: The Report of the Construction TaskForce*, HMSO, 1998 www.constructingexcellence.org.uk/pdf/rethinking%20construction/rethinking_construction_report.pdf

Amendments to Standard Assessment Procedure (SAP)

31. SAP will need to be reviewed to determine what changes will be required to address the improvements in winter and summer performance standards required and the construction and heating, ventilation and air conditioning services systems innovations that will be needed to meet those standards. Particular issues to be addressed include:

    a) Consideration as to whether SAP should move from an annual energy calculation to a monthly one.

    b) Development of new procedures for handling the effects of thermal mass in both winter and summer performance calculations and night-cooling ventilation systems.

    c) Development of procedures for addressing embodied energy.

    d) A review of the passive solar control provisions and possible consolidation of the procedures into the main calculation.

    e) Development of new procedures for fixed air-conditioning, since many flats and larger detached dwellings are being provided with cooling.

    f) A review of the procedures for domestic hot water demand, since design changes to minimise water use (eg low flow taps[10] and limits on the capacity of shower heads) could have an impact on hot water demand. Hot water use is increasingly the dominant energy demand, especially in small sheltered dwellings where it can be around half the total. Labelling of hot water systems is under consideration within Europe, and if this work is completed in time, it may be easier to specify hot water system performance standards by reference to these labels. Following the joint Communities and Local Government/Defra consultations earlier this year, proposed new standards of water efficiency in new buildings will also impact on this review, see paragraph 62.

    g) Consolidation of the special procedures for innovative systems introduced under the SAP 2005 Appendix Q system. This would include, for example, high performance mechanical ventilation systems and LZC systems as well as the special procedures for showing eligibility for Stamp Duty Land Tax exemption.

    h) A review of the procedures for handling LZC systems since these are likely to be an increasingly important element of dwellings built to the 2010 standards and beyond. An important part of this will be to develop a consensus on determining the average-in-use energy efficiencies of these systems.

[10] The use of low flow taps with COMBI boilers does create an additional issue of the time taken to reach an acceptable delivery temperature.

Possible standards for 2010

The improvement factor

32. The aim is to set the improvement factor for 2010 to achieve a 25 per cent improvement over the 2006 standard for gas heated dwellings. The improvement in 2006 was 20 per cent better than the 2002 baseline so this means that the improvement factor over the 2002 datum would be 40 per cent[11]. This proposal was first published in the Future Thinking Section[12] of the 2004 Part L consultation paper and then again in the consultation paper *Building A Greener Future*[13], ie the Code for Sustainable Homes Energy Efficiency Level 3.

33. In the 2006 amendment, there was no prescription or specific guidance on how the overall improvement should be achieved. It could be achieved through energy efficiency measures alone, through the take-up of Low or Zero Carbon (LZC) systems, or a combination of the two. However design flexibility was limited in the Approved Documents to ensure that reasonable fabric performance was achieved and it is expected that these limits will be tightened. In addition however consideration will be given as to whether more specific guidance can be given that encourages the adoption of higher performance building fabric before selecting building services systems including LZC systems.

Impact of the proposed standards

34. Two house types with different primary heating fuels have been explored below to illustrate the possible impacts and solutions. The full impact will depend on future developments in construction systems and in building designs and how these are taken into account in the prospective revisions of SAP.

100 m^2 detached house

35. The following table gives a package of measures that would achieve compliance with the proposed standard 40 per cent above the 2002 baseline and 25 per cent better than the standard introduced in 2006.

36. This package focuses principally on envelope measures and uses a conventional condensing gas-fired hot water central heating system.

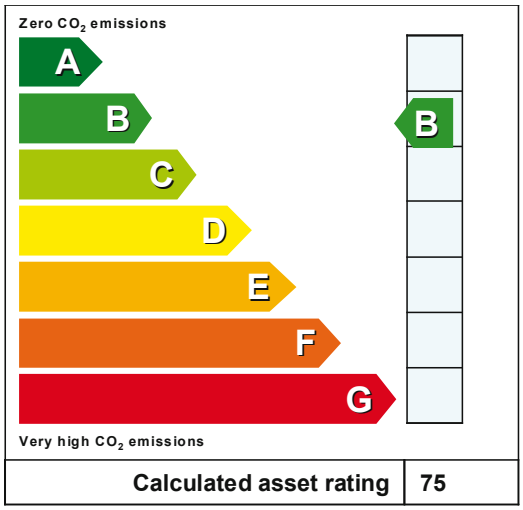
[11] [1 – (1-0.2) x (1-0.25)] = 0.4 = 40%

[12] *Section 6: Possible future performance standards for Part L – Proposals for amending Part L: A consultation document*, ODPM, July 2004. www.communities.gov.uk/index.asp?id=1131459

[13] *Homes for the future: more affordable, more sustainable*. Department for Communities and Local Government, July 2007.

Table 2: Compliance package for 2010 for 100m^2 gas heated detached house

Roof	Average U-value 0.14 W/m^{2}K, eg a fully filled 300 mm deep timber I-beam structure.
Walls	Average U-value 0.22 W/m^{2}K, eg a masonry wall with a 150 mm cavity fully filled with fibre insulation. This would give an overall wall thickness of 370mm. In timber frame, this would require 89mm studs with around 70mm external insulation, giving an overall wall thickness of around 350mm. Structural concrete block walls with external insulation and render with thicknesses of around 300mm would also be possible.
Ground floor	Average U-value 0.17 W/m^{2}K, eg 150 mm expanded polystyrene (EPS) or equivalent under slab insulation and edge insulation
Windows and doors	Average U-value 0.9 W/m^{2}K; high performance triple glazed windows, with soft-coat low-e glazing, Argon fill and warm edge technology. (Note safety glazing required by the Building regulations Part N would have to be laminated rather than toughened.)
Thermal bridging allowance	0.04 W/m^{2}K; this is a reduction (improvement) of 50% on the current default allowance, and can be achieved through improved construction details such as separate inner and outer lintels in masonry cavity walls.
Ventilation system	High performance mechanical extract ventilation, typically a specific fan power of 0.4 W/litre/s.
Air permeability (resistance to air leakage)	3 m^3/hour/m^2 at a differential pressure of 50 Pa. One way of achieving this is to parge, plaster or screed inside surfaces of walls, ceilings and floors.
Hot water central heating	Boiler 90% (SEDBUK band A) plus thermostatic controls package – SAP control type 2
Secondary heating	10% electric
Hot water storage cylinder	High recovery performance with 75 mm insulation. This sort of specification may require the labelling system referred to in paragraph 31f).
percentage of low energy light fittings	70%, to be provided in rooms with greatest lighting demand
Environmental index	75 kgCO_2/m^2.a, Band B – see graphic
Code for Sustainable Homes energy level	Level 3



37. The above compliance package contains U-values which, with the exception of the glazing, are roughly in line with the standards set out in Section 6 of the 2004 consultation package.[14] Construction systems that deliver these U-values have already been developed and published[15]. Indeed standards in advance of these are part of the Passivhaus[16] standard, which typically requires U-values for opaque elements such as walls, roofs and floors in the range 0.10 to 0.14 W/m^{2}K. For those designers who wish to pursue the advanced envelope route, this Passivhaus experience available

[14] Overall wall thickness was a big issue for the industry at the last revision. This will be a particularly important issue for discussion.
[15] AECB Silver Guidance. www.carbonlite.net.
[16] Passivhaus. www.passivhaus.org.uk

from mainland Europe will provide a useful source of experience from which the UK industry can benefit.

38. As discussed in paragraph 22, the impact of low energy lighting is significant in this case. If the percentage of low energy lights in the package changed from 70 per cent to 100 per cent, this would compensate, for example:

    a) For the adoption of natural ventilation and a reduced air permeability specification of 9 (rather than 3) $m^3/(h.m^2)$ at 50 Pa;[17]

    b) Or a combination of natural ventilation with an air permeability of 6 $m^3/(h.m^2)$ at 50 Pa and window U values of 1.1 (rather than 0.9) W/m^2K.

39. Another important issue is the secondary heating (see paragraph 25). If there was no secondary heating provision this would allow, for example, the adoption of natural ventilation with an air permeability specification of 9 $m^3/(h.m^2)$ at 50 Pa and windows with a U value of 1.1 W/m^2K.

40. Clearly, if both the percentage low energy lighting and the assumption about secondary heating were allowed to vary from the current rules, other compensatory reductions in specifications would also be possible.

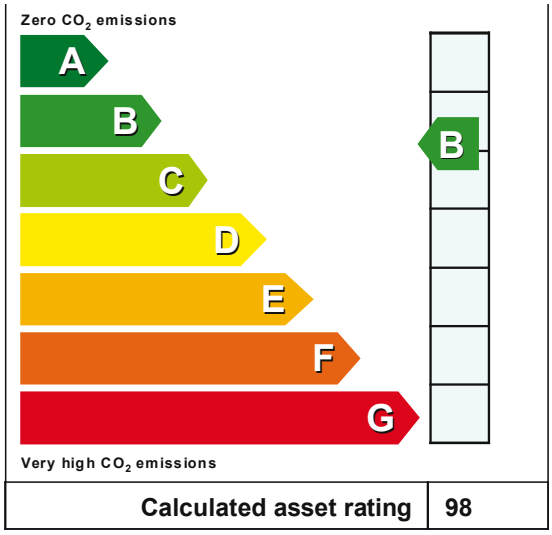
50m^2 mid-floor electrically heated flat

41. This dwelling type has been chosen as the other end of the spectrum in terms of compactness and fuel carbon burden. The following table shows one illustrative package of measures that would meet the standard.

[17] This is around the performance level builders are now achieving in response to the 2006 amendment.

Table 3: Compliance package for 2010 for 50m^2 electrically heated edge-of-mid-floor flat

Roofs	Not applicable
Walls	0.22 as table 2
Ground floor	Not applicable
Windows and doors	0.9 – as table 2
Thermal bridging allowance	0.04 – as table 2
Ventilation system	high performance mechanical ventilation with heat recovery.
Air permeability	2 m^3/hour/m^2 at 50 Pa
Hot water storage cylinder.	High recovery performance with 75 mm insulation as table 2.
Proportion of low energy lights	100%
LZCs	Air source heat pump, with a CoP of 2.5 for space heating and 1.1 for hot water heating (see paragraph 43)
Environmental Index	98kgCO_2/m^2.a, Band B
Code for Sustainable Homes energy level	Level 3



42. It can be seen that the required building fabric specification is very similar to the detached house, but the system efficiencies are much higher. This is because the opportunity for making significant improvements in performance through fabric measures is very limited in sheltered units like mid-floor flats, since space heating amounts to only about 15 per cent of total CO_2 emissions. Therefore, if design changes can deliver robust reductions in the demand for hot water (see paragraph 31f)), then significant overall reductions in emissions would be delivered. This would allow U-value specifications to be relaxed whilst still achieving compliance (for example).

43. If no reductions in hot water demand are possible, then the above package of measures indicates that LZC technology will be needed to achieve compliance. The example given is an air source heat pump serving both the space heating and the hot water. The required performance of the heat pump in the hot water mode will depend on the fuel factor eventually adopted for heat pump technology. If the fuel factor is taken as that for grid-supplied electricity (ie 0.422), the required CoP is 1.1 (this is the example shown on the energy label). If the fuel factor is taken as 1.0 for heat pumps, then the CoP will need to be 1.6.

44. It is considered likely that builders will wish to rely increasingly on LZC systems in order to reduce the impact on favoured building fabric designs and their costs. This increasing reliance makes it imperative that designers, builders and the LZC system manufacturers work together on how best to integrate systems into building designs. The Government will be encouraging this and looking to maintain the LZC Guide[18] and the *Domestic Heating Compliance Guide*[19] up to date ready for the next amendment in 2010 and beyond.

45. An important point arising from this analysis is that LZC technology is most needed in small compact building forms. Builders may well wish to explore whether individual heating systems should be the system of choice, or whether the adoption of group heating solutions based on gas or biomass boilers, heat pumps, solar panels and combined heat and power (CHP) might be more cost-effective. Promising solutions for the mid-floor flat could be electric resistance heating with a communal solar hot water system, or a gas-fired CHP scheme producing 30% of its output as electricity.

46. Achieving cost-effective group heating on an estate of large detached dwellings would be more of a challenge but the new emphasis on promoting decentralised renewable and low carbon energy generation and supporting infrastructure for example through the planning system,[20] and DTI initiatives to bring systems to the mass market, aim to facilitate such ventures[21]. Consideration will be need to be given to how the Building Regulations energy efficiency requirements take development-wide low carbon infrastructure into account.

[18] *Low or Zero Carbon Energy Sources: Strategic Guide*, ODPM, 2006. www.planningportal.gov.uk/uploads/br/BR_PDF_PTL_ZEROCARBONfinal.pdf

[19] *Domestic Heating Compliance Guide*, ODPM, 2006. www.communities.gov.uk/pub/340/DomesticHeatingComplianceGuide_id1165340.pdf

[20] *For instance Planning Policy Statement (PPS) 22* on renewable energy systems and the draft PPS: Planning and Climate Change

[21] See Energy White Paper: Meeting the Energy Challenge (May 2007).

Possible standards for 2013

Basis

47. The packages discussed in this section are based on an 80m^2 semi-detached or end-of-terrace house and consider both gas and electricity options[22]. To re-emphasise however, these packages are illustrative and developers will seek a range of approaches depending on the impact of future developments in construction systems and building designs and how these are taken into account in the prospective revisions of SAP. These options include an estimate of the emissions from appliances as well as space and water heating and lighting.

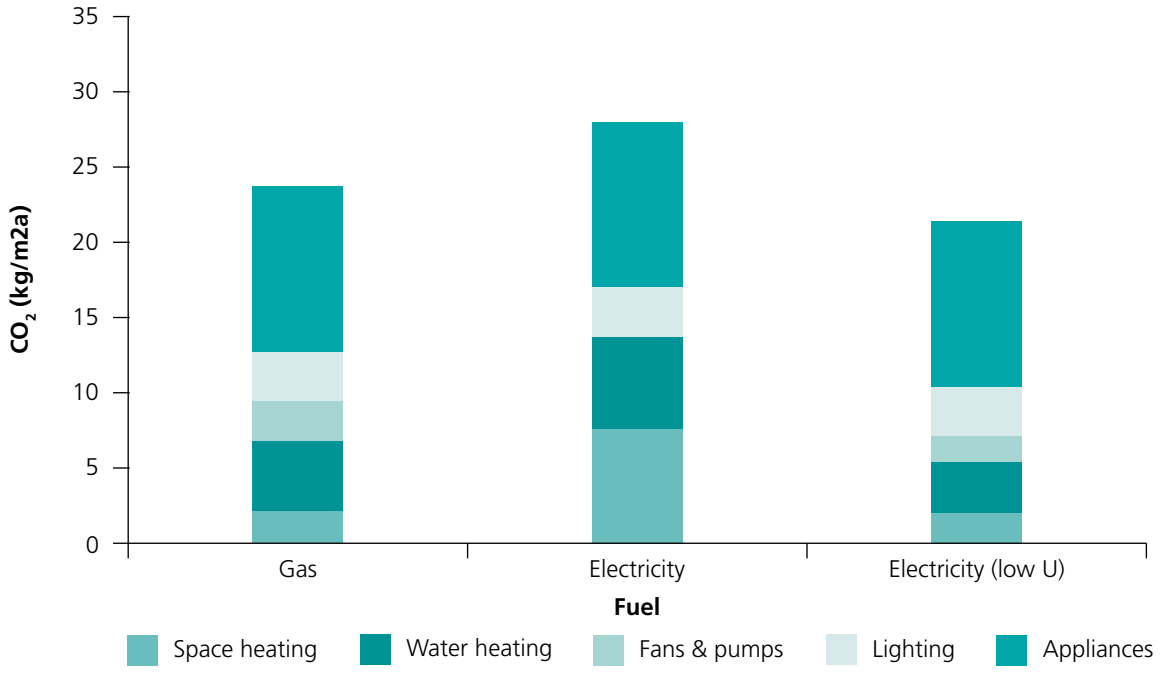
48. Three possible compliance packages and resulting emissions for gas and electricity meeting the proposed 2013 standard are set out in Table 2 and Figure 3.

Table 2: Illustrative compliance package for a 2013 80m^2 semi-detached dwelling

Element	Gas	Electricity	Electricity – low U
Roof (U – W/m^{2}K)	0.08	0.16	0.08
Wall (U – W/m^{2}K)	0.10	0.15	0.10
Ground Floor (U – W/m^{2}K)	0.09	0.15	0.09
Doors & Windows (U – W/m^{2}K)	0.70	1.2	0.70
Thermal bridging allowance (y)	0.02	0.06	0.02
Airtightness (m/h)	2	5	2
Ventilation	MVHR	Natural	MVHR
Heat loss parameter (W/K)	0.63	1.22	0.63
Space and Water	93%	GsHP* 224%	GsHP* 224%
Area of solar collector (m^2)	4	0	4
* Ground Source Heat Pump			

[22] The application of bio-fuels has not been explored in this analysis because it is considered unviable as a mainstream fuel for the foreseeable future.

Figure 3: emissions by source ($kgCO_2/m^2$ a) for a 2013 $80m^2$ semi-detached dwelling



Discussion

49. In order to enable the gas case to achieve 2013 standards, further fabric improvements have been made to achieve the U values in the PassivHaus specification, together with an improvement in air leakage to $2m^3/h.m^2$@50Pa. This results in a reduction of just under 60 per cent in the heat loss parameter (HLP) from 1.52 to 0.63 W/K and the introduction of solar water heating ($4m^2$). In practical terms the improved fabric insulation would require some 400 to 450 mm of mineral fibre equivalent in the walls, 450 to 500 mm in the roof, 250mm in the floor and high performance triple glazing in insulated frames, coupled with close attention to the avoidance of thermal bridging.

50. In the case of electricity as the primary fuel small reductions in wall, ground floor and window U values are necessary in this example (HLP reduced by about 6 per cent), requiring some 200 – 250mm of mineral fibre insulation in walls, 150mm in floors and high performance double glazing in insulated frames. However, the main change is the introduction of a ground source heat pump capable of providing domestic hot water as well as space heating. The improvement in heat efficiency is enough to avoid the need for solar water heating. It is worth noting, however, that electricity is only able to comply if the concessionary fuel factor remains in the calculation of the TER. If this concession was removed then it would be necessary to improve the fabric and, possibly, install solar water heating as well as installing a ground source heat pump. This is illustrated in Table 2 and Figure 3 with the addition of a second electricity option (electricity-low U). This option assumes the same fabric standards and solar water heating as for the gas case with the retention of the ground source heat pump.

51. The impact of the fabric improvements on space heating is marked with the gas and electricity–low-U options reducing space heating emissions to around 2 $kgCO_2/m^2$ per year and energy to some 10 kWh/m^2 per year. This is well within the PassivHaus standard of 15 kWh/m^2 per year. It is also important to realise, however, that even with PassivHaus standards the space heating requirement is unlikely to be reduced to zero.

52. The combination of a highly insulated envelope and a ground source heat pump running at an efficiency of 224 per cent (Electricity-low-U) results in total emissions just over 2 kg less than for gas. If the efficiency were around 300 per cent the reduction would be almost double at $3.7kgCO_2/m^2$ per year. Heat pump efficiency could be higher or lower than these values but the availability of reliable in-use data in the UK is sparse at present so further research will be needed to confirm real seasonal performance values.

53. The balance between the different energy requirements is now much more heavily focused on the appliance load and lighting. In the gas and electricity-low-U case these two sources account for between 60 per cent and 70 per cent of the total. The space heating load is very low leaving little room for further improvement and suggesting that the need for central heating systems will diminish and that other ways may need to be found to provide residual heating such as providing warm air heating through a mechanical ventilation system with heat recovery (MVHR).

54. It is likely that more could be done to reduce water heating demand through reduced water consumption (low flow taps, low flow showers instead of baths, cold fill appliances etc.) but it must be recognised that a residual water heating energy requirement will remain to be accommodated with energy from renewable sources beyond 2013. Following the joint Communities and Local Government/Defra consultations earlier this year proposed new standards of water efficiency in new buildings will also need to be taken into account – see paragraph 62.

Strategic implications of the proposed standards

Theoretical and realised performance

55. The analyses in this paper are based on theoretical performance being achieved in practice. Concern has been expressed by many that standards are not actually being achieved in practice. U-values, airtightness, thermal bridging allowances and the like have been shown by several studies to be degraded by construction practices and heating system performances in real use may differ from the assumed values.

56. Evidence to date suggests that the gap between theoretical and realised performance can be very large. This has considerable implications for the proposed regulatory programme since the closer standards get to zero carbon the more important (and the more noticeable) the gap will become. The implications of this for the required research effort over the coming years are considerable, since developers must not only select new technology at the design stage but also ensure that a step change in construction practices takes place. This presents a considerable challenge since it will have wide ranging implications for all parts of the industry and its supply chains.

Ventilation

57. Advanced standards of air tightness will make a significant contribution to the 2010 and 2013 performance standards, particularly when coupled with high performance mechanical ventilation systems. But this means that Part F (Ventilation) will need to be kept under review in parallel with the developments in Part L to ensure that CO_2 reductions are not achieved at the price of unsatisfactory indoor air quality.

58. A potentially greater reliance on mechanical systems in dwellings will need to be reflected in an expansion of those sectors of the industry with experience in installing and maintaining such systems, and in guiding householders in their effective use and maintenance.

Changing construction technologies

59. A 25 per cent reduction in 2010 in CO_2 emissions relative to the 2006 Part L standard and a 44 per cent reduction in 2013 will present significant challenges to the UK housing market. Although the 2006 changes were substantial at around 20 per cent, the major change was procedural because of the move from elemental standards to an overall annual CO_2 emissions target approach. The performance specifications needed to achieve compliance were an advance on previous practice but did not require major changes to new forms of masonry and timber-frame construction technology.

60. In 2010 there should be minimal procedural changes but it is likely that builders will wish to make significant construction technology changes to keep costs within bounds. For example in ordinary circumstances the proposed standards might prove difficult for conventional houses without the use of triple glazing and thicker walls if conventional technologies are retained. House builders regarded wall thickness and the consequences for land take as an important issue during the 2006 review. As indicated in Table 2, builders could achieve improved U-values within the same overall width by considering alternative forms of construction, but Government will be looking to encourage them and their suppliers to examine the design and cost-effectiveness of all options.

61. New approaches to construction could increasingly become the norm. Examples include the use of engineered timber I-beam roof constructions, masonry intermediate floors and other ways of exposing thermal mass for summer cooling purposes, greatly reduced thermal bridging, externally insulated single skin masonry constructions, and insulating sheathing in timber framed construction could increasingly become the norm.

Water efficiency regulation

62. The Government has published the analysis of the response to the joint Defra/ Communities and Local Government consultation on water efficiency conducted earlier this year and decisions will follow shortly. The purpose of any regulatory standards introduced following the consultation will be to reduce per capita water consumption in new homes by restricting the water used by bathroom fittings and water using appliances.

63. This will have a knock-on effect on the operation of certain types of combination boilers which will need to be addressed in energy efficiency calculations. Some combi-boilers require a water flow of between 2 litres and 4.5 litres per minute to cause the boiler to fire and have little buffer storage. Reduced demand from more economical water fittings may increase cycling and reduce seasonal efficiency.

64. Most boilers installed in new homes are currently not of the combination variety but the prospective changes to Part L may increase their market share. In any event energy efficiency compliance calculations will need to allow for the possibility of more installation of these boiler types.

Gaining experience

65. The house building industry and its supply chains are likely to find the scale of the innovation required to meet the proposed 2010 and 2013 standards demanding. As such, it will be necessary to take advantage of the experience of building to such standards that already exist elsewhere in the EU and overseas. Some of that experience is distilled in the advanced standards being promoted by the Energy Saving Trust (EST)[23], PassivHaus[15], and the Association for Environmentally Conscious Building (AECB)[24].

66. Builders who adopt these advanced standards in the voluntary pursuit of the higher levels in the Code for Sustainable Homes will be well placed to respond when the higher building regulations standards come into force.

[23] *Demonstrating compliance Good practice (2006 edition)*, Energy Savings Trust, 2006. www.est.org.uk/uploads/documents/housingbuildings/Demonstrating%20Compliance%20-%20Good%20practice_2.pdf df

[24] *Gold and Silver Energy Performance Standards for Buildings – Summary Guidance*, AECB. www.aecb.org.uk/PDFs/aecb_2pp_new

Government engagement

67. Less than three years remain until the proposed date of April 2010 for implementation of the next amendment. The Government published on 13 December 2006 a consultation document that looked forward to 2010 and towards standards in 2016 for new homes that on average will emit zero carbon. It is essential that the construction industry participate in the debate to ensure a practically achievable, firm programme. In any event Communities and Local Government will continue to engage with industry over the next three years to ensure the first amendment in the series contains no surprises and is practically achievable in the market by 2010.