Communities and Local Government

Definition of Zero Carbon Homes

Impact Assessment

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Impact Assessment

December 2008
Department for Communities and Local Government

Communities and Local Government
Eland House
Bressenden Place
London
SW1E 5DU
Telephone: 020 7944 4400
Website: www.communities.gov.uk

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Communities and Local Government Publications
PO Box 236
Wetherby
West Yorkshire
LS23 7NB
Tel: 0300 123 1124
Fax: 0300 123 1125
Email: communities@capita.co.uk
Online via the Communities and Local Government website: www.communities.gov.uk

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Summary: Intervention & Options

Department /Agency: Communities & Local Government	Title: Impact Assessment of the Definition of Zero Carbon Homes	
Stage: Consultation	**Version:** 1.5	**Date:** 15 December 2008

Related Publications: Building a Greener Future: Policy Statement (BAGF) and related Final Regulatory Impact Assessment (RIA) published in July 2007

Available to view or download at:
http://www.communities.gov.uk/planningandbuilding/theenvironment/zerocarbonhomes/

Contact for enquiries: Rosie Smith **Telephone:** 0207 944 4657

What is the problem under consideration? Why is government intervention necessary?

The housing stock represents 27% of UK emissions and new additions have a long lifespan so it is important to take the opportunity to reduce their environmental and carbon dioxide impact when they are first built.

The market will not deliver zero carbon homes by itself in the timescale needed, so the Government proposes regulating to achieve this. This consultation is to make clear how zero carbon is to be defined for new homes, in particular to what extent measures will need to be undertaken onsite and the allowable solutions for dealing with remaining emissions.

What are the policy objectives and the intended effects?

To set a clear, ambitious and realistic trajectory for substantially reducing carbon emissions from energy use in new homes.

The objectives are to have zero net emissions of carbon dioxide from all energy use in the home from 2016. This comes from improved energy efficiency of buildings, a renewable low carbon energy supply and other measures equivalent to the remaining emissions. Other effects include increasing the supply of renewables, effecting a transformation in the market and bringing forward low and zero carbon technologies.

What policy options have been considered? Please justify any preferred option.

1. Do nothing.
2. Twenty-five per cent reduction on 2006 Part L Building Regulations from 2010 and 44% reduction from 2013, and from 2016 increase the energy efficiency requirement (of which an example is the Advanced Practice Energy Efficiency (APEE)), with allowable solutions to cover residual emissions.
3. As Option 2 with 70% reduction on Part L in 2016 with a high energy efficiency requirement and allowable solutions for dealing with the remaining emissions).
4. As Option 2 with 100% reduction in 2016 with high energy efficiency and allowable solutions.

When will the policy be reviewed to establish the actual costs and benefits and the achievement of the desired effects?
The final Impact Assessment after the consultation will review costs and benefits. Update cost/benefit data during reviews of Building Regs in 2009/10. Revisit list of allowable solutions in 2012.

Ministerial Sign-off For consultation stage Impact Assessments:

> ***I have read the Impact Assessment and I am satisfied that, given the available evidence, it represents a reasonable view of the likely costs, benefits and impact of the leading options.***

Signed by the responsible Minister:

Date: 16 December 2008

Summary: Analysis & Evidence

Policy Option:
Reference case

Description: a 25% reduction on 2006Part L in 2010 and 44% in 2013; the two steps needed in order to apply the zero carbon homes standard from 2016

COSTS			
ANNUAL COSTS		Description and scale of **key monetised costs** by 'main affected groups' £16.15 bn to reach 25% improvement in 2010 assuming Best Practice Energy Efficiency (BPEE); £6.53 bn to reach 44% improvement in 2013 with BPEE. Upfront construction costs borne by house builders and land owners, ongoing servicing and maintenance performed by house holders or ESCOs.	
One-off (Transition)	**Yrs**		
£	57		
Average Annual Cost (excluding one-off)			
£		**Total Cost** (PV)	**£22.68 bn**
Other **key non-monetised costs** by 'main affected groups' Costs reflect capital spend of house building (from now to 2025) and ongoing repair and maintenance costs for lifetime of measures			

BENEFITS			
ANNUAL BENEFITS		Description and scale of **key monetised benefits** by 'main affected groups' £6.44 bn financial benefits via fuel bills plus £1.84 bn carbon benefits for 2010 step; £2.87 bn financial benefits via fuel bills plus £0.8 bn carbon benefits for 2013 step. Average household fuel bill savings of £149 to £256 per year.	
One-off	**Yrs**		
£	57		
Average Annual Benefit (excluding one-off)			
£		**Total Benefit** (PV)	**£9.31 bn**
Other **key non-monetised benefits** by 'main affected groups' Diversifying energy mix and helping government's targets on decarbonising energy supply; action to meet CO_2 targets – save 68.66 MtCO_2 by 2065; reducing dependence on fossil fuels; lower fuel prices for consumers; fewer EU ETS allowances required by UK generators.			

Key Assumptions/Sensitivities/Risks Central electricity price assumptions from interdepartmentally-agreed guidance (with sensitivity on high and low prices); house building projections to 2025 following government's targets; modelling done by consultants – see separate report for detail on technology costs, learning rates, etc.

Price Base Year	**Time Period Years**	**Net Benefit Range** (NPV) **£**	**NET BENEFIT** (NPV Best estimate) **–£10.77 bn**

What is the geographic coverage of the policy/option?			England	
On what date will the policy be implemented?			2010/2013	
Which organisation(s) will enforce the policy?			BCBs	
What is the total annual cost of enforcement for these organisations?			£	
Does enforcement comply with Hampton principles?			Yes	
Will implementation go beyond minimum EU requirements?			Yes/No	
What is the value of the proposed offsetting measure per year?			£	
What is the value of changes in greenhouse gas emissions?			£2.60 billion	
Will the proposal have a significant impact on competition?			Yes/No	
Annual cost (£–£) per organisation (excluding one-off)	Micro	Small	Medium	Large
Are any of these organisations exempt?	No	No	N/A	N/A

Impact on Admin Burdens Baseline (2005 Prices) (Increase – Decrease)

Increase of £ Decrease of £ **Net Impact £**

Key:	**Annual costs and benefits: Constant Prices**	**(Net) Present Value**

Summary: Analysis & Evidence

Policy Option: 2 — **Description: require Advanced Practice Energy Efficiency standard from 2016 and allowable solutions to abate residual emissions to reach zero carbon**

COSTS

ANNUAL COSTS		Description and scale of **key monetised costs** by 'main affected groups'
One-off (Transition)	**Yrs**	All costs and benefits are additional to the baseline of 25% reduction on Part L 2006 standards from 2010 and 44% from 2013 (i.e. the reference case), so represent the marginal impact of the policy. Additional construction costs caused by the policy fall mainly on the housebuilder or landowner.
£	49	
Average Annual Cost (excluding one-off)		
£316 million		**Total Cost** (PV) **£6,689 million**

Other **key non-monetised costs** by 'main affected groups'
Indirect impact on economy of either increased house prices or fewer being built; reduction of value of land caused by higher build costs; cost to society of need for 'back up' power station generation due to intermittency and unpredictability of some renewables.

BENEFITS

ANNUAL BENEFITS		Description and scale of **key monetised benefits** by 'main affected groups'
One-off	**Yrs**	Fuel bill savings accrue to the house occupier (~£213 per dwelling per annum); revenue from exporting electricity/heat may accrue to home owner or Energy Service Company; carbon savings.
£	49	
Average Annual Benefit (excluding one-off)		
£154 million		**Total Benefit** (PV) **£3,573 million**

Other **key non-monetised benefits** by 'main affected groups'
Diversifying energy mix and helping Government meet targets on decarbonising energy supply and CO_2 reductions targets; reducing dependence on fossil fuels; business and employment opportunities of developing and deploying low carbon solutions; lower fuel prices for consumers.

Key Assumptions/Sensitivities/Risks Central electricity price, SPC and EUA prices from interdepartmentally-agreed guidance (with sensitivity on high and low fuel prices); housebuilding projections following Government's targets (~1.7m of new homes built from 2016 are zero carbon). See consultants' report for detail on modelling technology costs, learning rates, etc.

Price Base	Time Period	Net Benefit Range (NPV)	NET BENEFIT (NPV Best estimate)
Year 2007	**Years** 49	**–£3.1 to –£4.1 bn**	**–£3,116 million**

What is the geographic coverage of the policy/option?			England	
On what date will the policy be implemented?			2016	
Which organisation(s) will enforce the policy?			tbd	
What is the total annual cost of enforcement for these organisations?			£	
Does enforcement comply with Hampton principles?			Yes	
Will implementation go beyond minimum EU requirements?			Yes	
What is the value of the proposed offsetting measure per year?			£	
What is the value of changes in greenhouse gas emissions?			£3.7 to £4.7 bn	
Will the proposal have a significant impact on competition?			Yes/No	
Annual cost (£–£) per organisation (excluding one-off)	Micro	Small	Medium	Large
Are any of these organisations exempt?	No	No	N/A	N/A

Impact on Admin Burdens Baseline (2005 Prices)		(Increase – Decrease)
Increase of £	Decrease of £	**Net Impact £**

Key:	**Annual costs and benefits: Constant Prices**	**(Net) Present Value**

Summary: Analysis & Evidence

Policy Option: 3

Description: 70% improvement on Part L1a Building Regulations from 2016 with Advanced Practice Energy Efficiency standards and allowable solutions

COSTS

ANNUAL COSTS		Description and scale of **key monetised costs** by 'main affected groups'	
One-off (Transition)	**Yrs**	All costs and benefits are additional to the baseline of 25% reduction on Part L 2006 standards from 2010 and 44% from 2013, so represent the marginal impact of the policy. Additional construction costs caused by the policy fall mainly on the housebuilder or landowner.	
£	49		
Average Annual Cost (excluding one-off)			
£680 million		**Total Cost** (PV)	**£15,319 million**

Other **key non-monetised costs** by 'main affected groups'
Indirect costs to economy of either increased house prices or fewer being built; reduction of value of land caused by higher build costs; cost to society of need for 'back up' power station generation due to intermittency and unpredictability of some renewables.

BENEFITS

ANNUAL BENEFITS		Description and scale of **key monetised benefits** by 'main affected groups'	
One-off	**Yrs**	Fuel bill savings accrue to the house occupier (~£397 per dwelling per annum); revenue from exporting electricity/heat may accrue to home owner or Energy Service Company; carbon savings.	
£	49		
Average Annual Benefit (excluding one-off)			
£365 million		**Total Benefit** (PV)	**£8,485 million**

Other **key non-monetised benefits** by 'main affected groups'
Diversifying energy mix and helping government meet targets on decarbonising energy supply and CO_2 reductions targets; reducing dependence on fossil fuels; business and employment opportunities of developing and deploying low carbon solutions; lower fuel prices for consumers.

Key Assumptions/Sensitivities/Risks Central electricity price, SPC and EUA prices from interdepartmentally-agreed guidance (with sensitivity on high and low fuel prices); housebuilding projections following government's targets to 2025 (~1.7m of new homes built from 2016 are zero carbon). See consultants' report for detail on modelling technology costs, learning etc.

Price Base	Time Period	Net Benefit Range	NET BENEFIT
Year 2007	**Years** 49	(NPV) **–£7.5 bn to +£5 bn**	(NPV Best estimate) **–£6,833 million**

What is the geographic coverage of the policy/option?			England	
On what date will the policy be implemented?			2016	
Which organisation(s) will enforce the policy?			tbd	
What is the total annual cost of enforcement for these organisations?			£	
Does enforcement comply with Hampton principles?			Yes	
Will implementation go beyond minimum EU requirements?			Yes	
What is the value of the proposed offsetting measure per year?			£ unknown	
What is the value of changes in greenhouse gas emissions?			£4.3 to £4.5 bn	
Will the proposal have a significant impact on competition?			Yes	
Annual cost (£–£) per organisation (excluding one-off)	Micro	Small	Medium	Large
Are any of these organisations exempt?	No	No	N/A	N/A

Impact on Admin Burdens Baseline (2005 Prices)	(Increase – Decrease)
Increase of £ Decrease of £ **Net Impact £**	

Key:	**Annual costs and benefits: Constant Prices**	**(Net) Present Value**

Summary: Analysis & Evidence

Policy Option: 4

Description: **require 100% reduction on 2006 Part L1a Building Regulations from 2016 with Advanced Practice Energy Efficiency and allowable solutions**

COSTS

ANNUAL COSTS		Description and scale of **key monetised costs** by 'main affected groups'
One-off (Transition)	**Yrs**	All costs and benefits are additional to the baseline of 25% reduction on Part L 2006 standards from 2010 and 44% from 2013, so represent the marginal impact of the policy. Additional construction costs caused by the policy fall mainly on the housebuilder or landowner.
£	49	
Average Annual Cost (excluding one-off)		
£986 million		**Total Cost** (PV) **£22,274 million**

Other **key non-monetised costs** by 'main affected groups'
Indirect impact on economy of either increased house prices or fewer being built; reduction of value of land caused by higher build costs; cost to society of need for 'back up' power station generation due to intermittency and unpredictability of some renewables.

BENEFITS

ANNUAL BENEFITS		Description and scale of **key monetised benefits** by 'main affected groups'
One-off	**Yrs**	Fuel bill savings accrue to the house occupier (~£406 per dwelling per annum); revenue from exporting electricity/heat may accrue to home owner or Energy Service Company; carbon savings.
£	49	
Average Annual Benefit (excluding one-off)		
£416 million		**Total Benefit** (PV) **£9,676 million**

Other **key non-monetised benefits** by 'main affected groups'
Diversifying energy mix and helping government meet targets on decarbonising energy supply and CO_2 reductions targets; reducing dependence on fossil fuels; business and employment opportunities of developing and deploying low carbon solutions; lower fuel prices for consumers.

Key Assumptions/Sensitivities/Risks Central electricity price, SPC and EUA prices from interdepartmentally-agreed guidance (with sensitivity on high and low fuel prices); housebuilding projections following government targets to 2025 (~1.7m of new homes built from 2016 are zero carbon). See consultants' report for detail on modelling technology costs, learning etc.

Price Base	Time Period	Net Benefit Range	NET BENEFIT
Year 2007	**Years** 49	(NPV) £	(NPV Best estimate) **–£12,599 million**

What is the geographic coverage of the policy/option?			England		
On what date will the policy be implemented?			2016		
Which organisation(s) will enforce the policy?			tbd		
What is the total annual cost of enforcement for these organisations?			£		
Does enforcement comply with Hampton principles?			Yes		
Will implementation go beyond minimum EU requirements?			Yes		
What is the value of the proposed offsetting measure per year?			£		
What is the value of changes in greenhouse gas emissions?			£3.6 bn		
Will the proposal have a significant impact on competition?			Yes		
Annual cost (£–£) per organisation (excluding one-off)	Micro	Small	Medium	Large	
Are any of these organisations exempt?	No	No	N/A	N/A	

Impact on Admin Burdens Baseline (2005 Prices) (Increase – Decrease)

Increase of £ Decrease of £ **Net Impact £**

Key:	**Annual costs and benefits: Constant Prices**	**(Net) Present Value**

Evidence Base (for summary sheets)

Background

1. In December 2006, the Department for Communities and Local Government (the Department) issued a consultation document *Building A Greener Future: Towards Zero Carbon Development*[1]. That document consulted on proposals to progressively tighten Part L of the Building Regulations so that, from 2016, new homes would emit zero net carbon. Following the consultation, the Department issued its policy statement *Building A Greener Future: policy statement*[2] confirming Government's policy decision in July 2007. The policy statement was supported by a Final Regulatory Impact Assessment.[3]

2. The July 2007 policy statement confirmed government's intention that new homes should be zero carbon from 2016, with progressive reductions in the emissions currently regulated by the Building Regulations of 25% and 44% (relative to current 2006 Part L1a regulations) in 2010 and 2013 respectively. The latter reductions are intended to continue regardless of the method chosen for reaching zero carbon homes from 2016. The details of the 2010 change will be consulted upon in early 2009.

3. *Building A Greener Future* recognised that there may be circumstances or sites where it would be difficult for developers to achieve zero carbon using the definition proposed in the July 2007 policy statement and undertook to consult again on how to reach zero carbon in such circumstances. Therefore this consultation proposes an approach which is intended to apply in all situations based on a hierarchy of energy efficiency standards, carbon compliance standards, and allowable solutions for dealing with the remaining emissions.

What is the problem and why is government intervention necessary?

4. There is an overwhelming body of scientific evidence that indicates that climate change is a serious and urgent issue and is predominantly caused by emissions of greenhouse gases from human actions, in particular carbon dioxide. The Government has agreed to an 80% reduction in such emissions by 2050 relative to 1990 levels, which is now legally binding under the Climate Change Act.

5. Emissions associated with energy use in the home account for 27% of total UK carbon emissions[4]. Substantial reductions will be needed in this sector if the UK is to meet its overall targets. At the same time, the number of homes is expected to grow over the decade ahead, to support a growing number of households.

1 www.communities.gov.uk/archived/publications/planningandbuilding/buildinggreener
2 www.communities.gov.uk/publications/planningandbuilding/building-a-greener
3 www.communities.gov.uk/publications/planningandbuilding/final-regulatory
4 Department of Energy and Climate Change (DECC)

6. Barriers and market imperfections inhibit investment in energy efficiency which is particularly relevant when thinking about housing. As noted in the Stern Review[5], regulation has an important role in product and building markets, for example to reduce uncertainty, complexity and transaction costs, and induce technological innovation.

7. By 2020, if we do nothing, then the new homes that we build between now and then will result in additional emissions of carbon and continue to do so for subsequent decades[6]. This problem of the longevity of buildings mean there is significant 'lock-in'; if we build with old (or energy inefficient) materials and methods then those buildings will remain in the building stock for a significant time, with potentially very costly retrofitting and refurbishment compared to constructing them in a low carbon way in the first place.

8. There is no evidence that emissions from new homes would reduce to the extent that is needed, in the absence of government intervention. The builder has little incentive to reduce energy bills for homeowners by building to high energy efficiency standards, and since the impacts of carbon emissions are experienced by the world as a whole rather than by the individual occupant, the occupant would not have a direct incentive to reduce emissions as much as necessary. These split incentives between the house builder, house buyer and society at large mean the house builder will only benefit from building a home to a very carbon-efficient standard if the incremental construction cost is at least offset by a premium in the price at which the home is sold and/or a reduction in the price at which land can be purchased. However, the prices of new homes are largely determined by the second hand market, and it is not yet apparent that the energy and carbon efficiency of homes has a significant effect on market prices. Companies may underinvest in innovation as the benefits do not only accrue to them, further reinforcing the case for regulation.

9. By putting further carbon reductions onto a regulatory footing and setting clear targets and milestones for achieving them, it should be possible to give confidence to all of the relevant actors in the house building process – landowners, house builders, supply chain – that carbon emissions from new homes will need to be reduced according to a clear and pre-determined trajectory.

10. Furthermore, setting a clear trajectory towards an ambitious national standard for zero carbon homes should provide a clear framework and remove the need for different standards to be established by individual local authorities, which can impact on industry confidence to invest, can confine the supply chain and reduce opportunities to achieve economies of scale.

[5] *The Stern Review into the Economics of Climate Change* (2006) www.sternreview.org.uk ch.17

[6] Other climate change and energy policies should increase uptake of renewables and work to decarbonise the grid, though this is a long-term process. Recognising this, we have assumed improvement on the current grid emissions factor. See the methodology and assumptions section for details

What are the policy objectives and the intended effects?

11. The primary objective of the policy is therefore to set a clear, ambitious and realistic trajectory for substantially reducing carbon emissions from energy use in new homes.

12. The Government set out a definition for 'zero carbon homes' in its July 2007 policy statement: that all new domestic build from 2016 must have zero net emissions from all energy use in the home over the course of a year. This includes space heating, ventilation, hot water, lighting and an estimate of energy use from cooking and appliances. This definition would allow for fossil fuels or electricity from the grid to be used, provided they are matched by an equivalent export of low or zero carbon energy, bringing net carbon to zero over the year.

13. Putting this ambition onto a regulatory footing will have the effect of:

- Reducing emissions from new buildings, reflected in lower, more predictable energy bills if less energy is used, and fewer carbon emissions if use of gas (or other fossil fuels, excluding those used to produce electricity) falls[7]
- Helping the Government meet its domestic CO_2 and greenhouse gas emissions reduction targets and show leadership internationally
- Creating a level playing field between all participants in the development process. House builders wishing to build to high carbon standards will know that they will not be outbid in their land purchase negotiations or undercut in the marketing of new homes by house builders who would otherwise choose to adopt lower standards
- Lowering costs and burdens of complying with different regulations set in different localities by having national standards, thereby supporting our national house building industry
- Driving innovation and giving confidence that economies of scale can be realised in developing and deploying the necessary technologies
- Developing a low carbon economy, with more skills and jobs needed in the construction and supporting industries
- Future-proofing new homes
- Increasing the uptake of distributed renewable energy technologies (both at a building and community scale) with a corresponding benefit for meeting overall renewable targets set out in the Renewable Energy Strategy[8] and so helping meet our energy security goals; and

[7] Rises or falls in fuel use depend on the level and type of microgeneration installed. Emissions from electricity are capped by the EU Emissions Trading Scheme; hence no carbon reductions are attributed, in this analysis, to reductions in electricity imported from the grid.

[8] www.berr.gov.uk/whatwedo/energy/sources/renewables/strategy/page43356.html

- Raising awareness among housebuyers and encouraging behavioural change to reduce energy demand, which is encouraged when onsite energy generation is used.[9]

Note that not all of these benefits can readily be monetised.

14. The policy may also bring about benefits for existing homes and communities. The use of new approaches can have a demonstrator effect, for example on integration of renewable energy technologies, which owners of existing homes may wish to incorporate into their homes. By encouraging community scale renewable energy approaches, the policy has the potential to stimulate energy solutions which can be retrofitted to existing buildings, for example by creating community heating networks.

What policy options have been considered?

15. The Final Regulatory Impact Assessment that accompanied the *Building A Greener Future* policy statement analysed a number of options for reaching zero carbon. In particular, it looked at three definitions of zero carbon (two of which allowed for offsetting net carbon emissions, the other of which did not) and two trajectories towards zero carbon (one with two steps to zero carbon, the other with three steps).

16. The option proposed in the July 2007 policy statement was for:

    - A 25% reduction in carbon emissions from space heating, hot water and fixed lighting (referred to in this document as "regulated emissions"), compared with the requirements of current building regulations (i.e. Part L 2006), from 2010
    - A 44% reduction in regulated emissions, compared with current building regulations, from 2013
    - Zero net emissions (not only regulated emissions but an allowance for cooking and appliances too), from 2016.

17. *Building A Greener Future* (BAGF) proposed that the latter step, to zero carbon, would be achieved through deployment of sufficient renewable energy technologies (whether incorporated as part of the building, part of the wider development or with a direct physical connection to the development) that, over the course of the year, the home would have zero net carbon emissions.

18. Further analysis, and a report from an expert task group organised by the UK Green Building Council[10] has identified that it is unlikely to be feasible for a number of developments types to meet the standard as defined in the July 2007 statement. In particular:

[9] www.sd-commission.org.uk/

[10] UK Green Building Council (2008): *Definition of Zero Carbon Report* www.ukgbc.org/site/resources/showResourceDetails?id=180

- Potential changes to the Standard Assessment Procedure (SAP) mean that it is likely that a higher percentage of new homes would be unable to meet the definition of zero carbon than previously anticipated
- The *Building A Greener Future* definition assumed direct physical connection of renewables which runs contrary to recent policy thinking and is made more difficult by recent European Court of Justice findings
- The UK Green Building Council raised concerns that the BAGF Option (defined in para.16) could entail a higher level of uptake of biomass CHP technology than is realistic, so options that are not heavily dependent on biomass are also being looked at.

19. Under the proposals now put forward, a zero carbon home will:

    - achieve very high standards of energy efficiency
    - achieve at least a minimum level of carbon reduction through a combination of energy efficiency, onsite low and zero carbon energy technology and supply of low carbon or renewable heat from outside the development; and
    - include a combination of predominantly offsite measures from a list of allowable solutions to deal with the remaining carbon.

20. The rationale of the above approach is that the builder has an incentive, through the allowable solutions, to install onsite measures that are reasonably practical for reducing carbon. However, the builder can use the allowable solutions if site conditions do not permit 100% onsite measures or directly connected heat, or if the builder decides that all or some of the residual emissions (beyond the minimum onsite carbon compliance) would be more cost-effective to deal with elsewhere.

21. The options are compared to the reference case, which is the announced government policy to continue the 2006 Part L Building Regulations to 2010, require a 25% improvement in regulated carbon emissions from 2010, and a 44% improvement from 2013. The reference case is shown relative to current 2006 Part L Building Regulations, which reflects the basic 'do nothing' option.

22. In arriving at the options, a number of other scenarios have been considered. These are shown (along with their costs and benefits) for the sake of completeness, in annex Tables A2-A4.

Options taken forward

23. The options are:

    1) **Option 1:** do nothing, ie continue with current Building Regulations at 2006 Part L standards;

2) **Option 2:** 25% reduction on Part L from 2010 and 44% reduction on Part L from 2013 and increase energy efficiency requirement to a higher standard broadly equivalent to the EST's Advanced Practice Energy Efficiency (APEE)[11] from 2016, with allowable solutions to cover residual emissions

3) **Option 3:** as in Option 2 but with a 70% reduction on Part L from 2016, in addition to the energy efficiency requirement and allowable solutions

4) **Option 4:** as in Option 2 but with a 100% reduction on Part L from 2016, in addition to the energy efficiency requirement and allowable solutions.

24. The key features of the above options are shown in Table A1 in the annex along with other scenarios modelled. The two steps that constitute the reference case – a 25% reduction on Part L from 2010 and a 44% reduction from 2013,– are necessary steps in order to move to zero carbon homes from 2016[12]. For this reason the costs and benefits of the Options are compared to the reference case. To see the breakdown of costs and benefits of the 2010 and 2013 steps, please see the annex Table A2.

25. Subject to meeting the minimum energy efficiency and carbon compliance requirements, developers will have the flexibility to choose how to reach zero carbon in light of prevailing site conditions by using the allowable solutions.

26. Developers will need to employ some combination of the following allowable solutions in order to deal with the residual emissions remaining after taking account of the minimum carbon compliance standard:

- carbon compliance beyond the minimum standard (towards or all the way up to mitigating 100% of regulated emissions plus emissions from cooking and appliances)
- a credit for any energy efficient appliances or advanced forms of building control system installed by the house builder that reduce the anticipated energy demand from appliances or reduce regulated emissions below the level assumed by SAP
- where, as a result of the development, low or zero carbon heat (or cooling) is exported from the development itself, or from an installation that is connected to the development, to existing properties that were previously heated (or cooled) by fossil fuels, then credit will be given for the resulting carbon savings
- a credit for any S106 Planning Obligations paid by the developer towards local LZC energy infrastructure

[11] For ease of reference, all future options will simply refer to Advanced Practice Energy Efficiency (APEE). In 2008, EST published its guidance on energy efficiency for new homes to meet the various levels of the Code for Sustainable Homes (www.energysavingtrust.org.uk/)

[12] The modelling assumes Best Practice Energy Efficiency is being met

- retrofitting works undertaken by the developer to transform the energy efficiency of existing buildings in the vicinity of the development
- any investment by the developer in LZC energy infrastructure (limited to the UK and UK waters where the benefits of ownership of that investment are passed to the purchaser of the home
- where offsite renewable electricity is connected to the development by a direct physical connection (and without prejudice to any regulatory restrictions on private wire), a credit for any carbon savings relative to grid electricity
- any other measures that government might in future announce as being eligible.

27. A 'buy-out' fund has been proposed by some stakeholders as an allowable solution. The Government does not consider that the case has been made for a 'buy-out' fund. The case for any such fiscal measures would need to be considered by the Government in the context of the broader fiscal and economic environment. There are no plans at this stage to take a buy-out fund forward, so instead we are focusing on the above list of 'allowable solutions' to address residual emissions.

28. The cost of the allowable solutions in a given place is currently hard to assess – not least because the markets for heat and renewables are likely to change substantially as a result of other policy changes. For purposes of modelling the allowable solutions, we have assumed that residual emissions can be abated at a cost of between £50/tCO_2 and £100/tCO_2.

29. The £50/tCO_2 is taken as the average net cost of renewable heat technologies per tonne of carbon dioxide. This figure has been arrived at from internal analysis of different types of district heating networks, and has been used to analyse the 'renewable heat' elements of the allowable solutions.

30. The figure of £100/tCO_2 is for modelling renewable electricity elements of the allowable solutions. It is based on an average renewable electricity cost of £43/MWh in 2016, and the average carbon content of grid electricity being 0.43kgCO_2/kWh, putting the cost in the region of £100/tCO_2[13].

31. Sensitivity analysis was performed on the above figures by looking at an 80/20 and 20/80 split for each, as well as the central 50/50 assumption.

13 See *UK Renewable Energy Strategy* (2008) www.berr.gov.uk/whatwedo/energy/index.html

32. Additionally, sensitivity analysis is performed using higher and lower costs of allowable solutions. The higher figure of £125/tCO_2 represents a premium of some £50/tCO_2 over the average cost of allowable solutions implied by a 50/50 heat and electricity combination, and the lower figure of £30/tCO_2 represents the likely value of the Shadow Price of Carbon in 2016, and is therefore equivalent to one of the options put forward in the consultation for capped cost of allowable solutions.

33. In order to allow developers the certainty to plan ahead, we are proposing to set a maximum cost that they will be expected to bear in mitigating residual emissions via allowable solutions. We are consulting upon a range of options (not fully modelled), including:

- Cap equal to the shadow price of carbon
- Cap equal to the price of ROCs (the incentive available for relatively mature renewable technologies)
- Cap equal to the price of ROCs multiplied by two (the incentive for emerging renewable technologies).

34. We have assumed in the analysis that 30 years of residual carbon will need to be abated via the allowable solutions, which is broadly representative of the design life of many LZC technologies. The consultation seeks opinions on 30 versus 60 years (broadly representing the minimum design life of a home).

35. The availability and cost of allowable solutions will be reviewed in 2012. In the event that government is not satisfied that these are available on the scale required, at or below the 'capped cost' to be set by government, then they will consider the further steps to be taken at that stage. For instance, this could include adding to the list of allowable solutions. The Government will also check that each of the allowable solutions continues to support their wider energy and climate change policies.

36. The carbon compliance level does not mandate any particular type of energy solution. The cost-benefit analysis makes no allowance for the possibility that developers might be eligible for incentives such as feed-in tariffs or renewable heat incentives. This remains an area of ongoing policy consideration.

Analysis of options – methodology and key assumptions

37. The results presented in this Impact Assessment come from a dynamic cost and benefit model produced by Cyril Sweett, Faber Maunsell and Europe Economics. Initial results from this model were published in the summer[14] and additional runs have subsequently been undertaken in order to inform this Impact Assessment[15].

[14] Cyril Sweett report (September 2008) www.cyrilsweett.com/pdfs/carbon_footprint_housing_september_08.pdf

[15] Cyril Sweett analysis (forthcoming)

38. The model selects the optimal combination of measures required to achieve a specific carbon reduction against the baseline. In previous analysis the baseline was the 2006 Part L Building Regulations. However, since *Building A Greener Future* announced interim steps of improving on the 2006 level by 25% in 2010 and by 44% in 2013, these have been taken as the baseline in the latest analysis. This means all Options (except the 'do nothing' option) assume the 25% and 44% steps set out previously have been taken and show the marginal policy cost relative to that baseline.

39. The optimisation process is 'dynamic' in that the technologies selected in one year affect their predicted cost in the following year because of the influence of uptake on technology costs. The optimisation is carried out separately for each development type, dwelling type and sector (ie for affordable and open market housing) and year.

40. The four generic development scenarios, representing planned development in England, are in turn built up from four generic dwelling types. The model analyses the costs and benefits for each year of the study period based upon:

- Housing projections
- Composition of development scenarios
- Dwelling types and their baseline energy and carbon projections
- Predicted percentage compliance with each policy option for each year
- Policy standards for percentage improvement in regulated and unregulated carbon emissions for each year 2008-2025 (homes built after 2025 have been excluded from the analysis)
- Build costs, based on four dwelling types across four development types
- Carbon saving options for each dwelling type, including energy efficiency measures and renewable energy technologies
- Applicability of offsite solutions
- Learning rates for each technology broken down by global and local learning rates
- Financial value of carbon savings (following DECC guidance) by using the Shadow Price of Carbon for the non-traded sector and EU Emissions Trading Scheme allowance prices for the traded sector[16]
- Carbon intensity of grid electricity
- Domestic energy prices, using DECC guidance[17].

[16] www.defra.gov.uk/environment/climatechange/uk/ukccp/pdf/greengas-policyevaluation.pdf
Note that the guidance on the Shadow Price of Carbon is currently under review.

[17] www.defra.gov.uk/environment/climatechange/uk/ukccp/pdf/greengas-policyevaluation.pdf

41. As uncertainty surrounds some elements of the input data, sensitivity analysis is discussed in the costs and benefits section for key variables such as energy prices and uptake of biomass.

42. The new analysis follows closely the approach set out in the previous Cyril Sweett *et al*. analysis for *Building A Greener Future,* but updates a few of the more significant assumptions. The key assumptions, and the relevant changes that have been made to the original assumptions, are summarised below. For a more detailed description, please refer to the consultants' reports.

43. A range of housing development scenarios was modelled, to represent the different development types for current and projected new build. The key development types (unchanged from the previous Impact Assessment) were as follows:

- **Small development:** fewer than 10 units of different housing types, but no flats, representing low density, rural sites, and making up around 15% of new build
- **City infill:** flats only, with an average of 18 units, high density city sites, and making up around 3% of new build
- **Market town:** an average of 100 units, of 75% houses and 25% flats, making up around 70% of new build. These sites could be part of a larger site, but are treated separately for the purposes of modelling
- **Urban regeneration:** large sites of on average 750 units, comprising 90% flats, representing large brownfield, high density, mixed use sites making up around 10% of new build.

44. Note that the composition of development types takes no account of developer behaviour and the dynamics of the planning system. In practice it is possible that developers could bring forward sites with different dwelling configurations as a result of this policy, in order to reduce costs below those modelled in this Impact Assessment.

45. The analysis reflects the Government's housing ambitions of 240,000 net additions per year by 2016, set out in the 2007 Housing Green Paper.[18] We model 219,000 new homes per year rather than 240,000, recognising that around 21,000 per year may be from change of use of existing buildings.

46. The analysis allows for various technologies to be adopted. These include:

- Energy efficiency measures (EST Best and Advanced Practice)
- Solar water heating

[18] www.communities.gov.uk/publications/housing/homesforfuture

- Solar photovoltaics
- Biomass heating
- Ground source heat pumps
- Gas combined heat and power
- Biomass combined heat and power
- Small/medium/large scale wind turbines.

47. The availability of these technologies is constrained by development type. For each development type, the technologies are selected to meet the energy efficiency and onsite/near-site level of carbon reduction required. The lowest cost technology mix meeting these requirements is then selected. It is assumed that the lowest capital cost solution is adopted. Such an approach would be expected in a scenario where the house builder pays for the up-front capital cost but where ongoing energy cost savings are not reflected in the price at which the builder sells the house and so no attempt is made to optimise whole life costs.

48. The economic benefit is greater if the choice of technology is based on minimising the whole life cost of the technologies available (ie including ongoing energy costs). Such an approach might be expected if either (i) an Energy Service Company (ESCO) were to take responsibility for the installation of the technologies and for ongoing provision of energy services[19] or (ii) the price of the home sold by the builder reflected the ongoing energy costs. Some of the modelling runs take account of this potential variation by looking at two scenarios, one where just capital costs are optimised and the other where ongoing costs are also taken into account.

49. The carbon intensity of electricity assumed for electricity imported from and exported to the electricity network was previously assumed to be 0.423 and 0.568 kilograms of carbon dioxide per kilowatt hour respectively. However, the new analysis is based on carbon intensity of the overall electricity system of 0.43kgs CO_2/kWh for both imports and exports. This reflects current thinking to align the two under SAP and makes some allowance for the future decarbonisation of the grid.

50. The above assumption limits the combinations of technologies which can be used to meet a given level of onsite and near-site carbon reduction relative to our earlier analysis for *Building A Greener Future* and increases the cost of meeting a given carbon compliance standard via low and zero carbon technologies. Also, given issues of potential technology lock-in, we are looking at two versions of Option 3 (a 70% reduction), to see the difference in costs if biomass were not for any reason widely used as a measure for meeting onsite carbon compliance.

[19] There could be distributional impacts of involving ESCOs for landowners and householders. In other words, if ESCOs bear some or all of the capital cost of the technologies, then the net cost to the house builder/landowner would be lower.

51. The modelling work has retained the cost assumptions for the technologies that were used in the *Building A Greener Future* Final Regulatory Impact Assessment. We have made one change, however, which is to include a 5% design cost premium. See the consultants' report for details.

52. The learning rates for each of the technologies are the same as in previous analysis[20]. Learning rates represent the rate at which assumed costs of a technology will decline over time as additional capacity is installed and are typically expressed as a percentage cost reduction for each doubling of the market. Learning can occur at both global and local levels. Global learning relates to the global price for a particular technology and is influenced by the size of the global market. Local learning relates to the elements of cost that are influenced by local markets. This applies, for example, to advanced energy efficiency measures, whose cost should decline faster once they are widely deployed in the UK compared to some of the other technologies which are traded in a global marketplace, such as solar photovoltaic (PV).

53. Energy savings are valued using the cross-departmental guidance provided by DECC[21]. Following this guidance, analysis of costs and benefits uses the variable element of residential prices (which does not incorporate any carbon price or taxes) whereas distributional analysis uses the retail price for residential electricity.

54. Carbon savings are valued using the cross-departmental guidance provided by DECC[22], i.e. a Shadow Price of Carbon of £26.50 per tonne of carbon dioxide in 2008 (in current prices), escalating at 2% per annum to £33.60/tCO_2 in 2020 and £82/tCO_2 in 2065.

55. Reductions in carbon associated with electricity demand are considered in light of the EU ETS cap, covering all emissions from electricity whereby the 'carbon' saved is fixed. The implication of reducing electricity demand in the UK is that UK generators will either need to purchase fewer EU ETS permits from abroad or have extra EU ETS permits that they are able to sell to others. For this reason, carbon reductions from reducing electricity use are modelled as a financial benefit valued at the price of EU ETS permits, rather than as carbon reductions valued at the Shadow Price of Carbon.

56. Costs and benefits of the Options are incurred over 49 years (from 2016 to 2065), as benefits accrue, and ongoing servicing and maintenance costs are incurred, until each technology's lifetime comes to an end.

Administrative costs

57. The development industry (and its supply chain, professions, etc.) faces costs of developing expertise in the new system; changing standardised designs, and investigating allowable solutions that are available for each development.

[20] See Cyril Sweett report for details

[21] www.defra.gov.uk/environment/climatechange/uk/ukccp/pdf/greengas-policyevaluation.pdf

[22] www.defra.gov.uk/environment/climatechange/uk/ukccp/pdf/greengas-policyevaluation.pdf

58. Costs to regulators and enforcers include the need to learn the new system, set up any new regulatory mechanisms, monitor and enforce compliance with onsite carbon compliance and allowable solutions. Also, there will be a role for local planning authorities to plan for local energy infrastructure that can support zero carbon developments.

59. Some costs are already reflected in existing policies e.g. Part L 2006 and the climate change Planning Policy Statement (PPS). There may also be savings because a clear national framework avoids the need for local standards, which can impact on the costs of development. For example there should be lower costs after 2016 to the industry of dealing with different environmental standards imposed by local planning authorities in different places. Government already faces the cost of developing SAP software to reflect new requirements, and Local Planning Authorities (LPAs) are already spending time negotiating local requirements for environmental standards and thinking about local low and zero carbon (LZC) energy planning.

60. Administrative costs were modelled as:

1) £10m one-off learning costs for industry[23].

2) 5% uplift in capital costs for energy systems to take account of cost to industry of changing standardised designs[24].

3) £0.5m one-off cost to government of developing new SAP software[25].

4) £1m one-off cost to regulatory bodies of learning the new system[26].

   - Total one-off costs: £11.5m

5) £24m recurring costs to industry of investigating and administering allowable solutions[27].

   - Total recurring costs: £24m

[23] Same assumption as for the Part L 2006 RIA –these costs are assumed to be incurred evenly over 2015-2018.

[24] See paragraph 51.

[25] Same assumption as for the Part L 2006 RIA.

[26] Part L 2006 RIA assumed 1 day's training @ £100/day for 4,000 building control inspectors; we allow £0.5m for this to reflect a more significant policy shift. Recognising that there may be some double-counting of learning associated with the 2010 and 2013 changes, this may be a highly conservative assumption. These costs are assumed to be incurred evenly over 2015-2018.

[27] Costs will vary substantially, depending on solution adopted and delivery vehicle (e.g. admin costs to the developer should be very low where CIL is used as the vehicle for allowable solutions). For present analysis, we assumed £100 per home x 240,000 zero carbon homes/year. This is also an overestimation as only around 219,000 homes would be built zero carbon – the remaining 21,000 pa are conversions. It is assumed these recurring costs recur until 2065.

Timing

61. In 2006 Part L, we modelled a one year phase-in of the policy. For this analysis, we have looked again at the period over which introduction of the policy will translate into numbers of zero carbon homes built, and have assumed a one year phase-in from 2016.

62. For illustrative purposes we have therefore assumed that small scale/city infill (accounting for 18% of homes in the model) take 1 year to build out; market town scale (72%) 2 years (ie 36% in 1st year, 36% in 2nd year); and urban regeneration (10%) three years (ie 3% in 1st year, 3% in 2nd year, 4% in 3rd year). Assuming an allowance of one year transitional arrangements for buildings that have already received approval when the policy is introduced, this implies that 40% of homes are zero carbon from April 2017; 60% from 2018, 90% from April 2019; and 100% from April 2020.

Compliance

63. We assume that it takes an extra year for people to comply with the regulations during which time the 'previous' standard, ie in 2017 60% of the homes are built to the standard enforced in 2013.

Costs and benefits of the options considered

Option 1: Do nothing

64. Continuing with current (2006 Part L) Building Regulations would still entail costs. Local authorities can set their own requirements for developers to meet energy efficiency standards of the Code for Sustainable Homes, where reasonable to do so[28]. This could cause extra costs for developers particularly if, in the absence of a strong national framework, local authorities seek to fill the void by setting local building standards via planning.

65. There would also be foregone carbon and fuel bills savings, higher total energy demand (requiring more EU allowances and additional generation capacity) and it would be harder to meet the legally-binding climate change targets.

[28] Climate Change Planning Policy Statement www.communities.gov.uk/publications/planningandbuilding/ppsclimatechange

Reference case: 25% reduction from 2010 and 44% reduction from 2013[29]

Table 1: Reference case compared to 'do nothing' 2006 Part L baseline

Present Value (PV) Financial benefits (£m)	PV Financial costs (£m)	Net Present Value[30] (NPV) before carbon benefit (£m)	Cumulative CO_2 savings by 2065 ($MtCO_2$)	NPV including all carbon benefits (£m)	Annual CO_2 savings by 2020 ($MtCO_2$)	Annual CO_2 savings by 2050 ($MtCO_2$)
£9,306	£22,682	–£13,376	68.7	–£10,772	1.37	7.0

66. Table 1 costs and benefits refer to measures taken onsite. There is no discussion of allowable solutions here as it is simply the baseline reference case.

Table 2: Cost-effectiveness of the reference case compared to 'do nothing 'baseline

Cost-effectiveness in the ETS Sector[31] (£/tCO_2)	Cost-effectiveness in the Non-ETS Sector (£/tCO_2)
243	726

67. **All options presented below are compared to this reference case**, where there is a 25% improvement on Part L 2006 Building Regulations in 2010, and a 44% improvement in 2013. The details of the 2010 requirements will be formally consulted on in more detail in Spring 2009, together with a high-level narrative on 2013. A more detailed Impact Assessment is being undertaken for this consultation, which will be used to inform and update the reference case. We would expect that the more detailed analysis should include further optimisation than is possible in a high-level analysis such as this, including making the burden fairer between types of buildings. All things being equal, this should bring down the NPV.

68. The reference case leads to a 5.7-6.4% increase in construction costs by 2017 compared to Part L 2006 Building Regulations, in line with the estimate for the *Building A Greener Future* Regulatory Impact Assessment[32].

69. Further breakdown of figures is provided in the annexes, and the distribution of carbon savings between the traded and non-traded sectors is given in the Carbon Assessment. This gives the monetary value of the tonnes of carbon saved in the ETS (traded) and non-ETS (non-traded) sectors, which makes up the difference between the NPV before carbon benefit and the NPV including carbon benefits.

29 With BPEE mandatory for modelling purposes

30 Note that a positive cost-effectiveness figure indicates a *cost* of £x/tCO_2 whereas a positive Net Present Value (NPV) figure indicates a net *benefit*.

31 Cost-effectiveness is calculated according to DECC guidance (www.defra.gov.uk/environment/climatechange/uk/ukccp/pdf/greengas-policyevaluation.pdf) whereby CE = (PV costs – PV benefits)/(tonnes CO_2 in ETS *or* non-ETS sector) where everything other than the unit in the denominator is valued and placed in the numerator

32 This differs slightly from the figures shown the 2007 consultation document because of the inclusion of 5% design costs and local learning effects. The *Building A Greener Future* RIA available at: www.communities.gov.uk/publications/planningandbuilding/final-regulatory

Option 2: 44% reduction plus APEE and allowable solutions

70. Option 2 costs and benefits are presented as a range. In the modelling runs, we assume house builders optimise carbon compliance based on the capital costs, but for this Option we also modelled them optimising on the net present value (NPV) of ongoing costs as well as capital costs[33]. This tends to raise costs *and* benefits, as they take more long-sighted decisions (eg a wind farm that may be viable in the long run as it provides financial benefits, but may not be selected if looking purely at upfront costs). The first figures presented in the range are optimising solely on capital expenditure; the second figures are optimising on both capital and NPV.

Table 3: Option 2 costs and benefits (onsite measures only, ie excluding allowable solutions)

	Financial benefits (£m) PV	Financial costs (£m) PV	NPV (before carbon benefit) (£m)	Cumulative CO_2 savings by 2065 ($MtCO_2$)	NPV including all carbon benefits (£m)	Annual CO_2 savings by 2020 ($MtCO_2$)	Annual CO_2 savings by 2050 ($MtCO_2$)
Option 2 (only optimised on capex)	–£288	£2,401	–£2,689	4.47	–£2,683	–0.08	–0.08
Option 2 (optimised on capex and NPV)	£3,142	£7,585	–£4,443	25.1	–£3,631	0.5	2.1

71. The surprising result that the Present Value (PV) financial benefits are negative when optimised only on capital expenditure is because they are compared to the reference case. This assumes that the performance standard assumed from 2013 (ie a 44% reduction on Part L with Best Practice Energy Efficiency) is maintained in 2016. So the change that Option 2 makes is to require a higher level of energy efficiency. In the modelling, this is the Advanced Practice Energy Efficiency standard (though the particular level is open to consultation) which makes the Option appear costlier than the reference case for a relatively small (or even negative) amount of carbon savings. This is unlikely to happen in reality as the 2016 standards will be clear well in advance of 2013.

Table 4: Cost-effectiveness of Option 2 (onsite measures only)

	Cost-effectiveness ETS Sector (£/tCO_2)	Cost-effectiveness Non-ETS Sector (£/tCO_2)
Option 2 (only optimised on capex)	–129	165
Option 2 (optimised on capex and NPV)	311	333

[33] The model does not optimise with respect to allowable solutions.

72. The allowable solutions are modelled separately based on the number of 'residual' tonnes of CO_2 after the onsite measures have been taken. In Option 2 – which requires 44% carbon compliance onsite – up to 56% of the typical dwelling's regulated emissions (plus emissions from appliances and cooking) must be dealt with using allowable solutions, therefore Option 2 uses allowable solutions most and Option 4 (100% onsite carbon compliance) uses them least.

73. Sensitivity analysis on the cost of the allowable solutions is shown in annex Table A5. It is worth remembering that the cap is the maximum cost considered, and it is likely that in practice the lowest-cost abatement options would be pursued first, making the costs an overestimate.

74. The cost-effectiveness of the allowable solutions on their own is the same for each policy Option (so will not be repeated). This is because they are all modelled at the same assumed cost caps[34] and only differ regarding how many tonnes of residual carbon each Option has to abate using the allowable solutions.

Table 5: Cost-effectiveness of all Options' allowable solutions

Cost-effectiveness of allowable solutions in ETS Sector (£/tCO_2)	Cost-effectiveness of allowable solutions in Non-ETS Sector (£/tCO_2)
50	38

[34] For this analysis we assume 50% use of renewable electricity allowable solutions and 50% of renewable heat solutions, modelled at £100/tCO_2 and £50/tCO_2 respectively. The annex contains sensitivity analysis of varying the proportion of allowable solutions that rely on renewable electricity or heat.

75. The 'Total NPV' figures in the right hand side of Table 6 represent the net present values of the onsite measures (presented in Table 3) combined with the allowable solutions (Table 6, left hand side), and are the 'final' NPVs shown in the Impact Assessment summary sheets. Table 7 shows the 'final' cost-effectiveness figures for Option 2, ie combining the onsite measures and allowable solutions.

Table 6: Option 2 costs and benefits of allowable solutions and total Net Present Values including allowable solutions

PV cost of allowable solutions: electricity (£m)	PV cost of allowable solutions: heat (£m)	Cumulative CO_2 savings by 2065 ($MtCO_2$)	Total NPV of onsite and allowable solutions (before carbon benefit) (£m)[35]	Total NPV of onsite and allowable solutions (including carbon benefits) (£m)	Total cumulative CO² savings to 2065
£3,298	£990	107	–£6,977 to –£8,731	–£3,116 to –£4,065	112 to 132.5

Table 7: Final cost-effectiveness of Option 2 combining onsite costs and benefits with allowable solutions

	Cost-effectiveness of onsite and allowable solutions in ETS Sector (£/tCO_2)	Cost-effectiveness of onsite and allowable solutions in Non-ETS Sector (£/tCO_2)
Option 2 (only optimised on capex)	125	72
Option 2 (optimised on capex and NPV)	100	93

76. Requiring less onsite carbon compliance (at the same 44% reduction on 2006 Building Regulations as from 2013) means there are more residual emissions which need abating via allowable solutions in Option 2. There are lower annual carbon savings compared to Option 3, giving a less cost-effective (ie higher) figure. The final result, taking carbon benefits into account, is a **net cost of £3.1 billion**[36].

[35] The first figure refers to Option 2 optimising only on capex; the second figure refers to Option 2 optimising on capex and NPV.

[36] Including onsite costs and benefits (including carbon) and allowable solutions

Sensitivity analysis

77. Sensitivity analysis is performed on Option 2 with respect to higher and lower energy prices. Table 8a shows that doubling the assumed energy prices makes the NPV slightly more negative due to the higher energy use compared to the reference case in the scenario when the model only optimises on capital expenditure. Conversely, lower energy prices (75% of the assumed central level) raises the NPV. When the model optimises on ongoing costs and benefits as well as capital costs (i.e. optimises the NPV), a doubling in assumed energy prices raises the onsite measures only social NPV to -£490 million, and the combined onsite and allowable solutions social NPV to **–£923 million**[37].

Table 8a: Option 2: sensitivity analysis on energy prices

	Onsite financial benefits present value, PV (£m)	Onsite NPV (not incl. carbon) (£m)	Cost-effectiveness of onsite measures (£/tCO_2) ETS sector	Cost-effectiveness of onsite measures (£/tCO_2) non ETS sector
Option 2 – high energy price (2x central)	–£576	–£2,977	–148	179
Option 2 – central energy price	–£288	–£2,689	–129	165
Option 2 – low energy price (3/4x central)	–£216	–£2,617	–125	161

Table 8b: Option 2 sensitivity analysis on prices (continued)

	Combined onsite and allowable solutions NPV (not incl. carbon) (£m)	Combined onsite and allowable solutions NPV (including carbon) (£m)	Cost-effectiveness of onsite measures and allowable solutions ETS sector (£/tCO_2)	Cost-effectiveness of onsite measures and allowable solutions non ETS sector (£/tCO_2)
Option 2 – high energy price (2x central)	–£7,265	–£3,404	–132	76
Option 2 – central energy price	–£6,977	–£3,116	–125	72
Option 2 – low energy price (3/4x central)	–£6,905	–£3,044	–123	71

37 High energy prices do not affect the costs and benefits of the allowable solutions as these have been modelled with no financial (i.e. fuel bill) benefits.

Option 3: 70% reduction plus APEE and allowable solutions

78. Option 3 requires house builders to go further than the reference case, which already has a 44% improvement on Part L Building Regulations, by raising the level of onsite carbon compliance to 70% and increasing the energy efficiency backstop. This makes the onsite costs and benefits higher. It is assumed house builders only optimise with respect to capital expenditure, ie do not try to maximise the Net Present Value over time[38].

Table 9: Option 3 costs and benefits (onsite measures only, i.e. excluding allowable solutions)

Financial benefits PV (£m)	Financial costs PV (£m)	NPV (before carbon benefit) (£m)	Cumulative CO_2 savings by 2065 ($MtCO_2$)	NPV including all carbon benefits (£m)	Annual CO_2 savings by 2020 ($MtCO_2$)	Annual CO_2 savings by 2050 ($MtCO_2$)
£4,228	£11,958	–£7,730	36.2	–£6,494	0.49	4.7

Table 10: Cost-effectiveness of Option 3 (onsite measures only)

Cost-effectiveness ETS Sector (£/tCO_2)	Cost-effectiveness Non-ETS Sector (£/tCO_2)
545[40]	309

Table 11: Option 3 costs and benefits of allowable solutions and total NPVs including allowable solutions

PV cost of allowable solutions: electricity (£m)	PV cost of allowable solutions: heat (£m)	Cumulative CO_2 savings by 2065 ($MtCO_2$)	Total NPV (before carbon benefit) (£m)	Total NPV (including carbon benefits) (£m)	Total cumulative CO_2 savings to 2065 including allowable solutions ($MtCO_2$)
£2,585	£776	84.2	–£11,091	–£6,833	120.4

Table 12: Final cost-effectiveness of Option 3 combining onsite costs and benefits with allowable solutions

Cost-effectiveness of allowable solutions in ETS Sector (£/tCO_2)	Cost-effectiveness of allowable solutions in Non-ETS Sector (£/tCO_2)
166	135

38 In the sensitivity analysis of Option 3, the 'without biomass' scenario is also looked at optimising both capital spend and NPV

39 This result is obtained because of the relatively low carbon savings in the ETS sector

79. Option 3 needs a higher proportion of the carbon abatement to be met onsite than Option 2 (70% rather than 44%) which gives higher benefits in terms of fuel bill savings, but also higher costs (construction and maintenance). When taking allowable solutions into account the final result is a **net cost of £6.83 billion.**

Sensitivity analysis

80. Sensitivity analysis around Option 3 is shown in the tables below for energy prices, the use of biomass and the energy efficiency backstop level. In summary:

- If biomass were not an available technology to be used to meet carbon compliance and the allowable solutions, both the costs and benefits rise so there would not be a significant impact on the NPV. There is no effect on the costs or benefits of the allowable solutions as these have been modelled with a range of caps rather than with specific technologies. The difference in Option 3 when allowing biomass or not is in Table 13.
- Higher energy prices – a doubling of the assumed central projection – raises fuel bill savings to households and significantly improves the NPV. Tables 14a to 14d look at the effect of changing energy prices on Option 3's NPVs and cost-effectiveness, both with and without biomass.
- Using a less demanding energy efficiency backstop – in this example, Best Practice Energy Efficiency rather than Advanced Practice – improves the Net Present Value as it lowers benefits but lowers costs by a greater amount. Table 15 sets out the impact on NPV and cost-effectiveness.

Table 13: Option 3: sensitivity analysis for biomass availability (onsite measures only, i.e. not counting allowable solutions)

	Total financial benefits (PV £m)	Total financial costs (PV £m)	Total NPV (before carbon benefit) (£m)	NPV including carbon benefits (ETS and Non-ETS) (£m)	Cumulative CO_2 savings by 2065 ($MtCO_2$)	Annual CO_2 savings by 2050 ($MtCO_2$)
Option 3 – 70% + APEE (no biomass)	£4,765	£13,342	–£8,577	–£7,180	40.4	4.7
Option 3 – 70% + APEE (allowing biomass)	£4,228	£11,958	–£7,730	–£6,494	36.2	4.7

Table 14a: Option 3 (70% plus APEE): sensitivity analysis on energy prices: Net Present Values

	Onsite financial benefits PV (£m)	Onsite NPV (not incl. carbon) (£m)	Combined onsite and allowable solutions NPV (not incl. carbon) (£m)	Combined onsite and allowable solutions NPV (incl. carbon) (£m)
70% + APEE – high energy price (2x central)	£8,456	–£3,502	–£6,863	–£2,606
70% + APEE – central energy price	£4,228	–£7,730	–£11,091	–£6,833
70% + APEE – low energy price (3/4x central)	£3,171	–£8,787	–£12,148	–£7,891

Table 14b: Option 3 (70% plus APEE): sensitivity analysis on energy prices: cost-effectiveness

	Cost-effectiveness of onsite measures ETS sector (£/tCO_2)	Cost-effectiveness of onsite measures Non-ETS sector (£/tCO_2)	Cost-effectiveness of onsite and allowable solutions ETS sector (£/tCO_2)	Cost-effectiveness of onsite and allowable solutions Non-ETS sector (£/tCO_2)
70% + APEE – high energy price (2x central)	215	128	89	70
70% + APEE – central energy price	545	309	166	135
70% + APEE – low energy price (3/4x central)	627	354	185	151

Table 14c: Option 3 (70% plus APEE without biomass): sensitivity analysis on energy prices: Net Present Values				
	Onsite financial benefits (£m)	**Onsite NPV (not incl. carbon) (£m)**	**Combined onsite and allowable solutions NPV (not incl. carbon) (£m)**	**Combined onsite and allowable solutions NPV (incl. carbon) (£m)**
70% + APEE without biomass – high energy price (2x central)	£9,530	–£4,026	–£7,173	–£3,404
70% + APEE without biomass – central energy price	£4,765	–£8,577	–£11,938	–£7,519
70% + APEE without biomass – low energy price (3/4x central)	£3,574	–£9,769	–£13,129	–£8,710

Table 14d: Option 3 (70% plus APEE without biomass) sensitivity analysis on energy prices: Cost-effectivenes				
	Cost-effectiveness of onsite measures ETS sector (£/tCO_2)	**Cost-effectiveness of onsite measures Non-ETS sector (£/tCO_2)**	**Cost-effectiveness of onsite and allowable solutions ETS sector (£/tCO_2)**	**Cost-effectiveness of onsite and allowable solutions Non-ETS sector (£/tCO_2)**
Option 3 without biomass – high energy price (2x central)	202	140	89	72
Option 3 without biomass – central energy price	484	327	170	144
Option 3 without biomass – low energy price (3/4x central)	557	377	191	162

81. Looking at energy price sensitivity when combining onsite and allowable solutions in Option 3 (assuming biomass is available) gives a cost-effectiveness figure of £89/tCO_2 for high energy prices in the ETS/renewable electricity allowable solutions[40], and £70/tCO_2 for renewable heat allowable solutions. This is a final **social net cost of £2.6 billion**. When modelling biomass as an unavailable technology, Option 3 with high energy prices has a final social net cost of £3.4 billion.

[40] These assume biomass is available.

82. When the energy efficiency backstop is lowered – requiring less stringent measures – to (for example) the Energy Saving Trust's Best Practice Energy Efficiency, the final **social NPV rises from -£6.8 billion to -£4.4 billion**[41].

Table 15: Option 3: sensitivity analysis for energy efficiency backstop level

	PV onsite measures financial benefits (PV £m)	PV onsite measures financial costs (£m)	NPV onsite measures (not incl. carbon) (£m)	NPV onsite measures (including carbon) (£m)	Combined onsite and allowable solutions NPV (not incl. carbon) (£m)	Combined NPV (including carbon) (£m)	Combined cost-effectiveness – ETS sector (£/tCO_2)	Combined cost-effectiveness – Non-ETS sector (£/tCO_2)
Option 3 – 70%+ BPEE	£3,102	£7,882	–£4,780	–£4,070	–£8,141	–£4,410	£127	£104
Option 3 – 70%+ APEE	£4,228	£11,958	–£7,730	–£6,494	–£11,091	–£6,833	£166	£135

Option 4: 100% reduction plus APEE and allowable solutions

Table 16: Option 4 costs and benefits (onsite measures only i.e. excluding allowable solutions)

Financial benefits (£m) PV	Financial costs (£m) PV	NPV (before carbon benefit) (£m)	Cumulative CO_2 savings by 2065 ($MtCO_2$)	NPV including all carbon benefits (£m)	Annual CO_2 savings by 2020 ($MtCO_2$)	Annual CO_2 savings by 2050 (MtCO2)
£6,070	£19,938	–£13,914	49.7	–£12,368	0.79	8.3

Table 17: Cost-effectiveness of Option 4 (onsite measures only)

Cost-effectiveness ETS Sector (£/tCO_2)	Cost-effectiveness Non-ETS Sector (£/tCO_2)
731	416

[41] These are the NPV figures for the combined onsite measures and allowable solutions, including carbon benefits (making them the final social NPVs).

Table 18: Option 4 costs and benefits of allowable solutions, and total NPVs for onsite measures combined with allowable solutions					
PV cost of allowable solutions: electricity (£m)	PV cost of allowable solutions: heat (£m)	Cumulative CO_2 savings of allowable solutions by 2065 ($MtCO_2$)	Total NPV of onsite and allowable solutions (before carbon benefit) (£m)	Total NPV (including carbon benefits) (£m)	Total cumulative CO_2 savings to 2065 (incl. allowable solutions)
£1,762	£529	57	–£16,204	–£12,599	107.1

Table 19: Final cost-effectiveness of Option 4 combining onsite costs and benefits with allowable solutions	
Cost-effectiveness of allowable solutions in ETS Sector (£/tCO_2)	Cost-effectiveness of allowable solutions in Non-ETS Sector (£/tCO_2)
310	237

83. Regulating that house builders must achieve a 100% reduction in regulated emissions onsite raises costs significantly compared to Option 3 with only a small rise in financial benefits. A smaller amount is spent on allowable solutions compared to the other Options (due to lower residual emissions) resulting in a **net cost of £13.28 billion**.

84. For full summary tables, see the annex.

Sectors and groups affected by the policy

House builders and landowners

85. Zero carbon policies will place additional costs on builders and landowners. These costs reflect:

- The need for new designs and being sensitive to site conditions (eg designing the home in a way which maximises space available for micro-generation)
- Purchase of materials and equipment either of a higher specification than otherwise required (eg triple glazed windows rather than double glazing) or that otherwise would not be required at all (eg micro-generation)
- Increased costs in building and installation (eg building to a very high standard to avoid thermal bridging)
- Increased project management (eg incremental costs of arrangements to connect to near-site heat sources, where relevant)
- Cost of dealing with residual net emissions via allowable solutions
- Increased compliance costs to ensure high performing homes are built.

86. An allowance for such costs is reflected in the analysis above. The analysis does not take full account of the range of means through which builders can reduce these increased costs. In particular, the costs relate to the additional costs of meeting building regulations but do not take account of the fact that, in some areas of design, builders may already go beyond building regulations. For example, some builders may choose to cut back on discretionary costs (eg sash windows or slate roof tiles) in order to reduce the net cost of the zero carbon requirement.

87. Setting a clear national framework should reduce the costs that could potentially otherwise be caused by the uncertainty attached to a proliferation of local standards. This greater certainty should facilitate industry to focus its research and development in bringing forward innovation and exploit economies of scale.

88. The additional costs associated with zero carbon homes will largely be borne by landowners in reduced land value uplift. This risks eroding the value of land for housing and potentially reduce the amount of land that can come forward for housing, especially in areas of lower house prices, higher existing / alternative use values and remediation costs. In practice however the scale of any impact will depend on a variety of factors such as:

- The scale of the starting land values and uplift – sites and areas with high starting land values will be able to absorb more of the increase in costs without an impact on land being brought forward, such as greenfield sites
- The increase in land values that would be expected, all things being equal, as a result of increased house building targets due to greater demand for land
- Local infrastructure spending arising from CIL or s106 (see below) which makes certain development locations more attractive
- The impact of other regulatory requirements (whether through Building Regulations, e.g. water efficiency, or otherwise) that may be passed back to land-owners and reflected in land values
- Any reduction in negotiable costs and planning obligations and/or the substitution of development which can support higher costs
- Housing market conditions, in particular house prices which ultimately drive the value of the land on which the housing will be built, reflecting the fact that the demand for land is 'derived demand'
- The extent to which home builders are able to pass back (to landowners) or pass forward (to house buyers) the net increase in costs of meeting zero carbon standards will determine the scale of any impact on supply
- Any change in landowner expectations (as to land values).

89. Some of the net costs of meeting the zero carbon homes standard may be reflected in a reduction in the price of land sold for housing development. This is not modelled as a separate cost in our analysis of costs and benefits as it simply represents a transfer from one economic agent to another, rather than an incremental cost. To include it separately would be to double-count the increased costs of construction that are already included in the analysis.

90. Additionally, the possibility of less land being brought forward for housing would mean foregone learning and experience benefits from building zero carbon homes and fewer knowledge spill-overs..

Supply chain

91. The need to install new energy saving measures and renewable energy technologies creates opportunities for suppliers and installers of energy efficiency products and micro-generation technologies to expand their sales and to develop new products and services aimed at new zero carbon homes. This may in turn require manufacturers to invest in research and development and in new or expanded production facilities.

92. For a further discussion of the impact of the zero carbon homes policy on the UK and international market for micro-generation technologies, see two recent reports by Element Energy[42]. They suggest that the zero carbon homes policy would not only meet the Government's objective of accelerating the uptake of existing technology, but that it could also meet its objective of developing new technology. The new build market will drive significant economies of scale in manufacturing, which should be reflected in lower costs for onsite renewable technology and stimulate an increase in uptake in existing homes.

Home buyers

93. As noted above, buyers of new zero carbon homes may bear some proportion of the cost of meeting the zero carbon standard in the form of a premium to the market price of a new home. However since the price of new homes is determined mainly by the market for existing homes, any such premium should depend on the willingness and ability of consumers to pay extra for zero carbon homes rather than a straightforward cost pass-through from house builders.

94. Research suggests that there is not a lack of desire for low or zero carbon homes, but rather a reluctance to pay a higher price[43]. It is possible that growing consumer awareness of energy costs and environmental issues will mean that, eventually, consumers are willing to pay a premium for zero carbon homes.

[42] *The Role of Onsite Energy Generation in Delivering Zero Carbon Homes: A study* – Element Energy (2007) www.renewables-advisory-board.org.uk/vBulletin/showthread.php?p=123#post123 and "The growth potential for Microgeneration in England, Wales and Scotland" – Element Energy (June 2008) www.berr.gov.uk/whatwedo/energy/sources/sustainable/microgeneration/research/page38208.html

[43] www.spongenet.org/index.php?page=news&news_id=101

95. In the longer term, the introduction of Energy Performance Certificates should address some of the information barriers that prevent the energy efficiency of homes being fully reflected in house prices, and greater familiarity with zero carbon homes should enable the housing market to price in the attributes on which consumers might place a value, in particular:

    1) Lower energy bills as a result of energy efficiency and, in some cases, use of solar or wind technologies.

    2) Receipt of any revenues from exports of surplus energy, potentially including incentives such as Feed-in Tariffs.

    3) Costs associated with servicing and eventually replacing microgeneration technologies installed on the home[44].

    4) Costs of running renewable energy system such as biomass heating.

    5) Non-monetary benefits and costs, eg enhanced thermal comfort[45] (although conversely there could be some negative connotations, which will need to be addressed, in relation to summer temperature and ventilation), consumer preferences for environmentally sustainable housing, aesthetic considerations and the "hassle" factor of operating and servicing microgeneration technologies.

96. Home occupiers benefit from lower fuel bills. The impact (priced at commercial rates) is given in the table below.

Table 20: Annual impact on household energy bills (relative to current Part L)

	Low impact on bills (£)	High impact on bills (£)
Reference case	149	256
Option 2	131	213
Option 3	214	397
Option 4	203	406

Energy companies and consumers

97. In the absence of policy, 240,000 new homes per year would add to the total demand for energy in the economy. All things being equal, such increases would be met primarily from large scale centrally generated sources (ie grid electricity and natural gas). Hence the policy may save the energy sector from needing to invest in additional large scale electricity generating plant and upstream gas infrastructure as well as purchasing larger amounts of fossil fuel resources to meet this demand. Additional energy demand also means that even more renewables are needed to meet EU targets.

44 Note that these are included in the 'capital and ongoing costs' modelling analysis, however replacement costs are not included

45 A reduction in assumed benefits to reflect comfort-taking has not been factored into the analysis. In practice, we anticipate that this should be less significant for new homes than for existing homes (which are less energy efficient and, in many cases, harder to keep warm).

98. So, by conserving energy and providing renewable energy supply, there is an avoided cost of renewables and energy infrastructure for the energy sectors.

99. The reduction in fossil fuels used for electricity generation should mean that electricity generators should be able to buy fewer EU ETS permits than would otherwise be the case, or to sell more surplus permits. This should offset some of the reduction in revenues (from lower demand) compared to the do-nothing case and make it easier to meet renewable energy targets.

Local authorities

100. It is unclear at this stage what the financial impact would be on local authorities. These depend on the regulatory role taken on by LAs in relation to the policy and, perhaps, on extra capital costs of any new homes built by LAs to the extent not funded through government grant programmes. If there are additional net funding requirements for LAs a result of these issues, then government will provide the necessary additional funding, in accordance with the new burdens doctrine.

Risks

101. **Industry preparedness.** There is a risk that the house building industry and its supply chain will not have sufficiently adapted its designs, products and production capability, or made the necessary investment in developing skills, to meet the zero carbon standard in 2016. To minimise this risk, we have signalled the policy almost a decade in advance of the policy coming into effect so as to give industry as much time as possible to adapt. An industry-led zero carbon delivery body has been formed to identify and address these issues over the period to 2016[46]. The need for industry to follow a trajectory to the zero carbon homes standard, via the interim changes in 2010 and 2013, also reduces the risk that industry takes no steps to prepare.

102. **Learning rates.** The analysis in this Impact Assessment assumes that costs will decline over time as energy efficiency and low and zero carbon (LZC) technologies are deployed. It is possible that costs will not decline to the extent anticipated, with the result that the cost burden on the private sector will be increased. The analysis conducted by Cyril Sweett in support of the *Building A Greener Future* policy included sensitivity cases varying capital costs and learning rates. This showed a range of some £6 billion in the net present value of costs between the high and low case. Whilst this is significant, it should not fundamentally affect the ability of the industry to comply with the policy. The policy will need to be structured in a way that is viable from 2016, at a stage when the impacts of the learning effects will have had relatively little time to work their way into the industry cost structure.

[46] Zero Carbon Hub www.zerocarbonhub.org/pressrelease.html

103. **Economics of housing development**. It is important that the costs of zero carbon do not undermine the economic viability of housing development. There are a number of factors which influence land viability, both on the cost side and on the price side (housing market)[47].

104. **Consumer acceptance.** There is a risk that consumers might be reluctant to buy zero carbon homes if they are uncomfortable with some of the features described earlier. Similarly, there is a risk that they might not use the installed technologies correctly, with the result that energy and carbon savings are not fully realised. To minimise these risks, as part of its work programme the Zero Carbon Hub is planning to address consumer issues, so that consumers are receptive to the features of zero carbon homes and understand how to operate them. Prioritisation of energy efficiency measures within the proposed hierarchy, and inclusion of technologies which are not all mounted on the individual home, should minimise the risks associated with home occupants allowing microgeneration technologies to fall into disuse.

105. **Compliance and enforcement**. There is a risk that builders will not comply with the regulations and that they will not be effectively enforced by the relevant regulators, with the result that energy and carbon savings will be lower than predicted. Again, this risk will be reduced by giving industry and regulators sufficient time to become accustomed to the regulations, and by ensuring that there is straightforward guidance on how to comply. Government is taking steps to improve compliance as outlined in its Future of Building Control consultation.

106. **Technology risks.** There is a risk that new technologies do not operate as well as predicted. There is also the risk that the policy could inadvertently encourage builders to adopt particular technology solutions which, in the longer term, are sub-optimal. The zero carbon policy does not rely on development of brand new technologies, and our analysis has explored the implications of a particular technology (biomass) not being available. So rather than rely on currently unavailable technologies, the policy will encourage the deployment, and perhaps ongoing improvement, of technologies which are already available but not yet widely adopted in this country. The policy is designed to accommodate a range of energy technologies at a variety of scales, and should therefore be relatively robust if any particular technology proves to be less effective than assumed in the analysis. Government intends to work with industry and the Zero Carbon Hub on monitoring, and will wish to take this general technology risk into account in finalising the carbon compliance level and in its review of the list of allowable solutions in 2012.

107. **Unintended health consequences.** There is a risk that buildings with high levels of air-tightness could have adverse health impacts in terms of air quality (but, where technological ventilation with heat recovery is deployed, this could be

[47] See paragraph 88.

counterbalanced by improvements in the welfare of those suffering from allergies to airborne particles like pollen). See the Health Impact Assessment, below.

Enforcement, monitoring and evaluation of the policy

108. Government will need to decide what regulatory processes and bodies we should task with monitoring and enforcing compliance with allowable solutions. We will wish to put in place a process which is as streamlined as possible and which does not place unrealistic expectations upon either Building Control Bodies or Local Planning Authorities (LPAs). It may be that there is a role for other parties here – for example, the growing industry associated with providing energy advice and certifying the energy performance of buildings.

109. The allowable solutions will not be needed until 2016. The detailed mechanisms will need to be designed in further detail, and will be consulted upon at a later date. This will include consideration of what further powers are needed, if any, over and above existing legislation in order to give effect to the allowable solutions (and, potentially, carbon compliance too).

110. Consultation on the future changes to Part L in 2010 and 2013 will include surveying implementation of the 2006 amendments. A similar approach will be adopted in the run-up to 2016 and subsequent reviews of Building Regulations beyond that date. The aim of these surveys is to determine how the regulatory provisions are working, whether the projected carbon savings are being achieved, and to tailor the new amendments accordingly. Further evaluation will be undertaken, for example making use of the Energy Performance Certificates and other existing information-gathering mechanisms.

111. The availability and cost of allowable solutions will be reviewed in 2012. In the event that government is not satisfied that these are available on the scale required, at or below the 'capped cost' anticipated by government, then they will consider the further steps to be taken at that stage. For instance, this could include adding to the list of allowable solutions.

Implementation

112. The detailed implementation of the policy will be taken forward as part of the regular three year cycle of reviews of Part L of the Building Regulations. Government will be consulting in early 2009 on the revisions to be made to Part L of the Building Regulations in 2010. Extensive modelling of detailed technical considerations will be undertaken to support the Part L work and it is beyond the scope of this Impact Assessment to anticipate the precise level of costs associated with the 25% reduction in 2010. The Part L consultations will take account of the need for an appropriate trajectory from current regulations through to zero carbon in 2016. There will be similar processes of engagement in advance of the detailed amendments to the

regulations to be made in 2013 and 2016. The Government will also ensure that planning policies which support the policy are kept up to date[48].

113. Government is supporting the Zero Carbon Hub to steer delivery of this agenda. The work of the delivery body, in its formative stages, will be overseen at a strategic level by the 2016 Task Force which is co-chaired by the Minister for Housing and Planning and the Executive Chairman of the Home Builders Federation.

114. The 2016 Task Force and the delivery body should not need to continue indefinitely, as eventually implementation of the zero carbon homes agenda will be become "business as usual" for the delivery body and industry in turn. Government will therefore keep its participation in and support for these bodies under review as implementation proceeds.

Competition Assessment and Small Firms Impact Test

115. The proposed policy should not have a significant impact on competition in the affected industries.

116. Small and medium-size (SME) firms (who employ up to 250 people) make up almost 60% of the construction market by turnover, and there are around 140,000 SMEs employing 937,000 people in 2007[49].

117. The Department has already discussed the proposed policy with organisations representing small businesses and will continue to do so throughout the consultation period. The work of the Zero Carbon Hub will be available to support smaller house builders and they will be establishing a workstream to engage with the house building sector. The structuring of the policy to include allowable solutions also diminishes the impact of the policy on small sites and therefore small builders (since smaller builders tend to develop smaller sites).

118. However, it is possible that smaller builders and developers may find it more difficult to adjust to the new regulations. Larger firms tend to have an employee dedicated to ensuring regulations are met and at the lowest cost, whereas smaller firms may have to spend more time on it – using someone less expert – or hire consultants. Larger firms also benefit from economies of scale, lowering the average cost of building as more developments or dwellings are built.

119. Research undertaken by Government for the review of the 2006 Part L Building Regulations[50] found that many small firms interviewed thought there would not be a differential impact on them, as bigger firms may be better placed to understand the

[48] Communities and Local Government (2007): Climate Change Planning Policy Statement www.communities.gov.uk/publications/planningandbuilding/ppsclimatechange

[49] http://stats.berr.gov.uk/ed/sme/smestats2007.xls

[50] www.communities.gov.uk/publications/planningandbuilding/regulatoryimpactassessment7

issues, but small firms may be better placed to exploit niches and opportunities. We shall continue to monitor this in the consultation period.

Carbon Assessment

120. Electricity savings result in financial benefits but not carbon benefits as emissions from this sector are fixed by the EU Emissions Trading Scheme. As such, carbon benefits from reductions in electricity demand/decarbonised electricity supply are instead quantified in terms of the value of EU allowances saved, according to DECC guidance[51].

121. Heat savings result directly in carbon savings as they are not covered by the Emissions Trading Scheme (i.e. they are non-ETS) and are monetised at the level of the Shadow Price of Carbon using DECC guidance.

Table 21: Changes in CO_2 emissions in ETS and non-ETS sectors

	Carbon savings in the ETS sector (Mt CO_2)	Carbon savings in the Non-ETS sector (Mt CO_2)	Carbon benefit for ETS traded reductions (£m)	Carbon benefit for Non-ETS traded reductions (£m)
Reference	53.2	15.5	£2,130	£473
Option 2	38.0	73.9	£1,622	£2,239
Option 26[53]	66.5	66.1	£2,603	£2,603
Option 3	54.9	65.5	£2,276	£1,981
Option 4	46.4	60.7	£1,811	£1,795

Environmental Impact Test

122. Assisting in mitigating the causes of climate change by reducing carbon emissions from new homes is the primary purpose of this policy. This will be achieved through higher carbon performance standards for new homes from 2016 which will have an increasingly positive impact as more new homes are built over time and as zero carbon technologies and learning are transferred to existing homes.

123. In developing the zero carbon homes policy in the light of this consultation, we will have regard to other potential environmental impacts, in particular:

- the need not to unduly prejudice the development of smaller brownfield sites in favour of larger greenfield sites
- the implications of the possible large scale adoption of biomass energy and the possible consequences of this for land and water use; biodiversity; air quality; and the transportation of biomass fuel.

51 www.defra.gov.uk/environment/climatechange/uk/ukccp/pdf/greengas-policyevaluation.pdf

52 Assuming optimisation of NPV and capital expenditure, rather than just optimisation of capital expenditure as the other Options in the table are presented as.

Sustainable Development Impact Test

124. In addition to environmental impacts, the zero carbon homes policy will have an influence on wider aspects of sustainable development:

- The policy will contribute to wider national, regional and local sustainability goals by promoting innovation and by providing opportunities for new "green" businesses and employment
- Social sustainability will be enhanced by new homes in all sectors to have improved levels of thermal comfort and energy efficiency which may also improve affordability of energy.

125. The consultation paper seeks views on the links between the zero carbon homes policy and the Code for Sustainable Homes which includes a wider range of sustainability criteria. This will be considered further in development of this policy following consultation. In addition, sustainability principles will be taken into account in developing the range of allowable solutions permitted in taking this policy forward.

Health Impact Assessment

126. Depending on the technologies adopted and location, biomass can potentially have a negative effect on air quality, manifested in poorer health. These impacts are valued using Defra guidance[53], based on how much biomass (in kWh) each Option results in but assuming no reductions in emissions from ultra high efficiency biomass boilers (which is a conservative assumption).

127. The model assumes that the lowest cost modelled solution will be adopted in all situations and therefore shows higher uptake of biomass in Options 3 and 4. Such a pattern of uptake is not necessarily likely in practice, and may not be desirable. For this reason we modelled Option 3 (the 70% reduction with APEE and allowable solutions) both with and without biomass as an available technology. The costs and benefits section shows that not allowing biomass makes no significant difference to the Net Present Value as both the financial costs and the benefits are higher.

Table 22: Annualised present value air quality impacts of biomass, taken over 35 years (£m)	
Reference case	£6.7
Option 2	£0
Option 2 (optimised)	–£5.5
Option 3 without biomass	–
Option 3	£20
Option 4	£274

[53] www.defra.gov.uk

Table 23: Air quality impacts of biomass, present value (£m)	
Reference case	£236
Option 2	£0
Option 2 (optimised)	–£191
Option 3 w/o biomass	–
Option 3	£695
Option 4	£9,571

128. Option 2 does not lead to a change in the amount of biomass used. Option 2, when optimised to take account of future benefits as well as costs, decreases the amount of biomass used compared to the reference case, so the £190.8 million is a benefit. Options 3 and 4 increase the uptake of biomass, resulting in air quality damages.

129. As for other health impacts, experience from programmes such as Decent Homes and Warm Front suggests that improving the thermal comfort of dwellings (which will be a direct result of the proposed improvements to Building Regulations) has direct health benefits and can improve the quality of life for the occupants of the dwellings.

130. However while there can be positive air quality impacts from highly insulated or airtight buildings (such as fewer problems with pollen and other airborne allergens inside the home), negative effects are also possible. Part F of the Building Regulations which covers ventilation will be reviewed at the same time as Part L and will look specifically at ventilation system requirements and indoor air quality issues to ensure that health standards are not undermined.

Legal Aid

131. There would be no impact on Legal Aid.

Equalities and Human Rights Assessments

132. The policy would affect all parties the same regardless of race.

133. The policy would affect all parties the same regardless of gender.

134. The proposed policy would have the same effect on all parties regardless of disabilities. There is already a level of accessibility required by the current Building Regulations so zero carbon homes would still need to meet these.

Rural Proofing

135. The policy would not apply differentially to rural areas compared to urban. However, it may have different impacts in the two as follows:

1) the zero carbon technologies which are most appropriate to rural and urban areas may differ (eg onsite wind power may be more appropriate in rural areas and district heating solutions less so).
2) economies of scale may be harder to achieve in rural housing developments which will usually be smaller and often of lower density.
3) local learning rates are likely to be more costly in rural areas and, in scarcer rural markets, it may take longer to develop sufficient numbers of service and maintenance engineers with skills in new technologies.
4) in some rural areas (eg Areas of Outstanding Natural Beauty and National Parks), there may be restrictions on permitted design, building materials, etc which will make development in these areas more expensive.

Specific Impact Tests: Checklist

Use the table below to demonstrate how broadly you have considered the potential impacts of your policy options.

Ensure that the results of any tests that impact on the cost-benefit analysis are contained within the main evidence base; other results may be annexed.

Type of testing undertaken	Results in Evidence Base?	Results annexed?
Competition Assessment	Yes	No
Small Firms Impact Test	Yes	No
Legal Aid	Yes	No
Sustainable Development	Yes	No
Carbon Assessment	Yes	No
Other Environment	Yes	No
Health Impact Assessment	Yes	No
Race Equality	Yes	No
Disability Equality	Yes	No
Gender Equality	Yes	No
Human Rights	Yes	No
Rural Proofing	Yes	No

Annexes

Annex 1: Tables

Annex 2: List of related publications

- Communities and Local Government (September 2008): 'Research to Assess the Costs and Benefits of the Government's Proposals to Reduce the Carbon Footprint of New Housing Development'
    - (www.communities.gov.uk/publications/planningandbuilding/housingcarbonfootprint)
- Communities and Local Government (July 2007): 'Building a Greener Future: Policy Statement'
    - (www.communities.gov.uk/publications/planningandbuilding/building-a-greener)
- Communities and Local Government (July 2007): 'Building a Greener Future: Final Regulatory Impact Assessment'
    - (www.communities.gov.uk/publications/planningandbuilding/final-regulatory)
- Renewables Advisory Board, RAB (August 2007): 'The Role of Onsite Energy Generation in Delivering Zero Carbon Homes'
    - (www.renewables-advisory-board.org.uk/vBulletin/attachment.php?attachmentid=324&d=1195637587)
- Communities and Local Government (January 2008): 'Planning Policy Statement: Planning and Climate Change: Impact Assessment'
    - (www.communities.gov.uk/publications/planningandbuilding/climatechange)
- Department of Energy and Climate Change (2008): 'Renewable Energy Strategy'
    - (http://renewableconsultation.berr.gov.uk/consultation/consultation_summary)

Table [A1]: Summary of Options

Case/Option	Description	Energy efficiency standard in 2016	Onsite/near-site carbon reduction in 2016	Allowable solutions for the remainder?
Option 1	Do nothing from now on	2006 Part L (current standards, equivalent to Best Practice Energy Efficiency, BPEE)	N/A	N/A
Reference case	25% improvement on current Building Regs in 2010, and 44% improvement in 2013	BPEE	44% of regulated emissions (from 2013)	N/A
Option 2	Maintain reference case and also require stricter energy efficiency standards	EST Advanced Practice Energy Efficiency (APEE)	44% of regulated emissions	Yes
Option 2a	Maintain reference case and also require stricter energy efficiency standards (optimised on capex and NPV)	APEE	44% of regulated	Yes
Option 3	70% improvement on Building Regs in 2016 with APEE and allowable solutions	APEE	70% of regulated	Yes
Option 3a	70% improvement on Building Regs in 2016 with APEE and allowable solutions (assuming biomass unavailable)	APEE	70% of regulated	Yes
Option 3b	70% improvement on Building Regs in 2016 with APEE and allowable solutions (assuming biomass unavailable) (optimised on capex and NPV)	APEE	70% of regulated	Yes
Option 3c	70% improvement on Building Regs in 2016 with BPEE and allowable solutions	BPEE	70% of regulated	Yes
Option 4	100% improvement on Building Regs in 2016 with APEE and allowable solutions	APEE	100% of regulated emissions	Yes

Note: All cases include the reference case requirement of 25% and 44% reductions in regulated emissions in 2010 and 2013, equivalent to energy efficiency levels in Code Levels 3 and 4 respectively. All Options optimised on capital expenditure only (rather than capex and NPV i.e. ongoing costs) unless otherwise stated

Table [A2]: Costs and Benefits for all options explored

		Onsite solutions										
		Present value of costs and benefits (PV £m)						Carbon savings Mt CO_2 (undiscounted)				
Option		Total financial benefits	Total financial costs	Total NPV (before carbon benefit)	Carbon benefit for ETS sector reductions (from homes built to 2025)	Carbon benefit for Non-ETS reductions (from homes built to 2025)	NPV including carbon benefits (ETS and Non-ETS)	Carbon savings in the ETS sector	Carbon savings in the Non-ETS sector	Cumulative CO_2 savings by 2065	Annual CO_2 savings by 2020	Annual CO_2 savings by 2050 (assuming build at current rates through to 2050)
	2010-25% + BPEE (first step)	£6,438	£16,151	-£9,713	£1,374	£464	-£7,875	33.92	15.04	48.97	0.95	4.24
Reference	2010-25% + BPEE, 2013 44% + BPEE (both steps)	£9,306	£22,682	-£13,376	£2,130	£473	-£10,772	53.18	15.48	68.66	1.37	6.99
2	2016-44% + APEE	-£288	£2,401	-£2,689	-£645	£651	-£2,683	-15.76	20.22	4.47	-0.08	-0.08
2a	2016-44% + APEE (optimised on NPV and capex)	£3,142	£7,585	-£4,443	£336	£475	-£3,631	12.74	12.34	25.09	0.46	2.08
3	2016 – 70% + APEE	£4,228	£11,958	-£7,730	£499	£737	-£6,494	12.83	23.40	36.22	0.49	4.69
3a	2016 – 70% + APEE (no biomass)	£4,765	£13,342	-£8,577	£625	£772	-£7,180	16.14	24.28	40.42	0.57	4.67
3b	2016 – 70% + APEE (no biomass) (optimised on NPV and capex)	£17,260	£13,394	£3,866	£928	£519	£5,313	27.42	13.70	41.12	0.69	4.85
3c	2016 – 70% + BPEE	£3,102	£7,882	-£4,780	£341	£370	-£4,070	9.33	15.58	24.91	0.52	4.94
4	2016 – 100% + APEE	£6,070	£19,983	-£13,914	£600	£946	-£12,368	17.74	31.97	49.71	0.79	8.30
3a High	Option 3a – high energy price (2x central)	£9,530	£13,342	-£4,026	£625	£772	-£2,629					
3a Med	Option 3a – central energy price	£4,765	£13,342	-£8,577	£625	£772	-£7,180					
3a Low	Option 3a – low energy price (3/4 x central)	£3,574	£13,342	-£9,769	£625	£772	-£8,371					

Table [A3a]: Cost-effectiveness of Options (before allowable solutions included)		
	Cost-effectiveness ETS Sector (£/t CO_2)	**Cost-effectiveness Non-ETS Sector (£/t CO_2)**
Option 1, Reference Case	243	726
Option 2 -44% + APEE	–129	165
Option 2a -44% + APEE (optimised on NPV and capex)	311	333
Option 3 – 70% + APEE	545	309
Option 3a – 70% + APEE (no biomass)	484	327
Option 3b – 70% + APEE (no biomass) (optimised on NPV and CAPEX)	–160	–350
Option 3c – 70% + BPEE	473	285
Option 4 – 100% + APEE	731	416
Option 2 – high energy price (2x central)	–148	179
Option 2 – central energy price	–129	165
Option 2 – low energy price (3/4 x central)	–125	161
Option 3a – high energy price (2x central)	202	140
Option 3a – central energy price	484	327
Option 3a – low energy price (3/4 x central)	557	377

Table [A3b]: Combining Options' cost-effectiveness with reference case (before allowable solutions included)		
	Cost-effectiveness ETS Sector (£/t CO_2)	**Cost-effectiveness Non-ETS Sector (£/t CO_2)**
Reference Case	243	726
Option 2 -44% + APEE	399	408
Option 2a -44% + APEE (optimised on NPV and capex)	256	552
Option 3 – 70% + APEE	301	475
Option 3a – 70% + APEE (no biomass)	299	483
Option 3b – 70% + APEE (no biomass) (optimised on NPV and CAPEX)	106	221
Option 3c – 70% + BPEE	277	505
Option 4 – 100% + APEE	365	518
Option 2 – high energy price (2x central)	211	211
Option 2 – central energy price	399	408
Option 2 – low energy price (3/4 x central)	512	526
Option 3a – high energy price (2x central)	40	32
Option 3a – central energy price	299	483
Option 3a – low energy price (3/4 x central)	349	571

Note: for illustrative purposes we are showing the full cost of the Options and the reference case together. At all other times the Options are shown as the marginal cost on top of the reference case.

Table [A3c]: Cost-effectiveness of Options (including allowable solutions)	Cost-effectiveness ETS Sector (£/t CO_2)	Cost-effectiveness Non-ETS Sector (£/t CO_2)
Reference Case	£243	£726
Option 2 -44% + APEE	£125	£72
Option 2a -44% + APEE (optimised on NPV and capex)	£100	£93
Option 3 – 70% + APEE	£166	£135
Option 3a – 70% + APEE (no biomass)	£170	£144
Option 3b – 70% + APEE (no biomass) (optimised on NPV and CAPEX)	–£33	–£58
Option 3c – 70% + BPEE	£127	£104
Option 4 – 100% + APEE	£310	£237
Option 2 – high energy price (2x central)	–£132	£76
Option 2 – central energy price	–£125	£72
Option 2 – low energy price (3/4 x central)	–£123	£71
Option 3a – high energy price (2x central)	–£89	£72
Option 3a – central energy price	–£170	£144
Option 3a – low energy price (3/4 x central)	–£191	£162

Table [A4]: Allowable solutions

		Allowable Solutions									
			Costs (PV £m)		Carbon Saved			Carbon Benefits		Cost effectiveness	
		Residual Carbon emissions	Cost of payment – renewable electricity	Cost of payment – renewable heat	Carbon savings in the ETS sector[55]	Carbon savings in the Non-ETS sector	Cumulative CO2 savings by 2065	Carbon benefit for ETS traded reductions	Carbon benefit for Non-ETS traded reductions	ETS Sector	Non-ETS Sector
Option		Mt CO_2 per year	£m		Mt CO_2			£m		£ per t CO_2	
Do Nothing & Reference	2010 -25% + BPEE, 2013 44% + BPEE										
2	44% onsite carbon compliance [of regulated emissions]	3.58	3,298	990	54	54	107	2,267	1,588	50	38
3	70% onsite carbon compliance	2.81	2,585	776	42	42	84	1,777	1,244	50	38
4	100% onsite carbon compliance[56]	1.91	1,762	529	29	29	57	1,211	848	50	38

[54] This assumes a 50/50 split of effort in the ETS (i.e. renewable electricity) and non-ETS (i.e. renewable heat) sectors

[55] All allowable solutions for Option 4 are to deal with unregulated emissions

Table [A5]: Cost (£) per unit of allowable solutions

Type of development	Option 2 (44% + APEE)						
	SPC £30/ tCO_2	Heat @ £50/tCO_2		Electricity @ £100/tCO_2			Elec @ £125/ tCO_2
	100% heat	100% heat	80% heat 20% elec	50/50	20% heat 80% elec	100% elec	100% elec
Detached	78	130	156	195	234	260	325
End terrace/ semi	62	104	125	156	187	208	260
Mid terrace	59	99	119	148	178	198	247
Flat	51	86	103	129	154	172	215

Type of development	Option 3 (70% + APEE)						
	SPC £30/ tCO_2	Heat @ £50/t O_2		Electricity @ £100/tCO_2			Elec @ £125/ tCO_2
	100% heat	100% heat	80% heat 20% elec	50/50	20% heat 80% elec	100% elec	100% elec
Detached	60	99	119	149	179	199	248
End terrace/ semi	49	82	98	123	147	164	205
Mid terrace	47	79	95	118	142	158	197
Flat	41	68	81	102	122	136	170

Type of development	Option 4 (100% + APEE)						
	SPC £30/ tCO_2	Heat @ £50/tCO_2		Electricity @ £100/tCO_2			Elec @ £125/ tCO_2
	100% heat	100% heat	80% heat 20% elec	50/50	20% heat 80% elec	100% elec	100% elec
Detached	38	64	77	96	115	128	160
End terrace/ semi	34	56	67	84	101	112	140
Mid terrace	34	56	67	84	101	112	140
Flat	28	47	57	71	85	94	118

Table [A6]: Impact on construction costs (percentage increase compared to reference case)				
	Increase in construction costs reference for compliant homes in 2017 (low)	**Increase in construction costs reference for compliant homes in 2017 (high)**	**Increase in construction costs reference for compliant homes in 2025 (low)**	**Increase in construction costs reference for compliant homes in 2025 (high)**
Reference case	5.7%	6.4%	4.7%	5.4%
Option 2	2.5%	4.3%	1.5%	2.7%
Option 3	6.3%	9.6%	4.3%	6.6%
Option 4	10.3%	11.6%	8.3%	9.6%

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