Department for Communities and Local Government

Changes to Part L of the Building Regulations 2013

Impact Assessment

August 2013
Department for Communities and Local Government

This document/publication is also available on our website at www.gov.uk/dclg

If you have any enquiries regarding this document/publication, email contactus@communities.gov.uk or write to us at:

Department for Communities and Local Government
Eland House
Bressenden Place
London
SW1E 5DU
Telephone: 030 3444 0000

For all our latest news and updates follow us on Twitter: https://twitter.com/CommunitiesUK

August 2013

ISBN: 978-1-4098-3984-2

Title:	Impact Assessment (IA)
Proposed Changes to Part L of the Building Regulations 2013	**Date: 01/08/2013**
IA No: DCLG/0086	**Stage: Final**
Lead department or agency: Department for Communities and Local Government	**Source of intervention: Domestic**
Other departments or agencies:	**Type of measure: Secondary Legislation**
	Contact for enquiries: Paul DeCort/David Craine

Summary: Intervention and Options

RPC Opinion: Green
RPC11-CLG-1130(3)

Cost of Preferred (or more likely) Option

Total Net Present Value	Business Net Present Value	Net cost to business per year (EANCB on 2009 prices)	In scope of One-In, Two-Out?	Measure qualifies as
£379m	£146m	- £16m (-£15m)	Yes	Zero net cost

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

Reducing carbon emissions from the built environment is essential for the UK to meet its Climate Change Act targets. Appropriately designed performance based Building Regulations can help to achieve this if the market would not make these changes of its own accord. Market failures include the cost of climate change not being fully reflected in energy prices, lack of information about energy efficiency opportunities and limited incentives to make improvements. Action at the point of build can 'lock in' efficient design, reducing energy/heat demand and future retrofit costs. Regulation also has a role in setting energy efficiency standards where owners decide to carry out building work to existing properties.

What are the policy objectives and the intended effects?

To deliver cost effective abatement at the point of construction and when building work is carried out, through changes to Part L of the Building Regulations, contributing to demanding targets to reduce carbon emissions and to help reduce energy costs. The Part L 2013 changes should achieve cost effective abatement in the construction of new buildings and stimulate fabric focused learning and innovation as the basis for more demanding future policies. Changes in standards for the existing stock where building work is carried out, including replacement services such as cooling and lighting, can also achieve cost effective abatement and savings on energy bills.

What policy options have been considered, including any alternatives to regulation? Please justify preferred option (further details in Evidence Base)

Option 1: Do nothing. Keeping existing Part L 2010 standards as the baseline.

Option 2: Central case. New homes target that delivers circa 6% improvement on 2010 aggregated across the build mix, based on an overall performance based carbon compliance target with mandatory energy efficiency requirements. New non-domestic buildings target of circa 9% aggregate improvement on 2010 based on an overall performance based carbon compliance target with energy efficiency backstops. Tighter energy efficiency standards when particular building work is carried out on existing non-domestic buildings, primarily replacement chillers, fan coil units and lighting.

Option 2 is the selected approach. This represents cost effective tightening of carbon standards.

Will the policy be reviewed? It **will** be reviewed. **If applicable, set review date: 2015**					
Does implementation go beyond minimum EU requirements?			No		
Are any of these organisations in scope? If Micros not exempted set out reason in Evidence Base.	**Micro** Yes	**< 20** Yes	**Small** Yes	**Medium** Yes	**Large** Yes
What is the CO_2 equivalent change in greenhouse gas emissions? (Million tonnes CO_2 equivalent)			**Traded: -2.38**	**Non-traded: -3.99**	

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: 3/8/2013

Summary: Analysis & Evidence

Policy Option 2

Description: Tighter carbon compliance standards for new homes (differentiated by home type to give an overall 6% improvement on 2010) and non-domestic buildings (differentiated to give a 9% improvement on 2010). Tighter standards for existing buildings when certain building work is undertaken, primarily non-domestic replacement chillers, lighting and fan coil units.

FULL ECONOMIC ASSESSMENT

Price Base Year 2011	PV Base Year 2012	Time Period Years 70	Net Benefit (Present Value (PV)) (£m)		
			Low: 37	High: 893	Best Estimate: 379

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	2.6	1	32	**919**
High	8.8		57	**1,574**
Best Estimate	5.0		40	**1,109**

Description and scale of key monetised costs by 'main affected groups'

Increased costs (present value): new homes £301m, new non-domestic buildings £604m, existing non-domestic buildings £199m plus transition costs £5m.
The initial capital costs will be borne by developers and building occupiers, but these costs may ultimately be passed to landowners. The costs would fall with efficiency gain through learning. Maintenance and replacement costs borne by building owner/occupier.

Other key non-monetised costs by 'main affected groups'

These modest but technically meaningful changes are unlikely to have a substantial impact on the demand for new buildings or the demand for replacements to existing buildings so this has not been monetised.

BENEFITS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low			35	**956**
High			90	**2,466**
Best Estimate			54	**1,488**

Description and scale of key monetised benefits by 'main affected groups'

Energy savings: new homes £294m, new non-domestic buildings £604m, existing non-domestic buildings £269m. **Non-financial benefits** including carbon savings and air quality savings: new homes £240m, new non-domestic buildings £74m, existing non-domestic buildings £5m.

Other key non-monetised benefits by 'main affected groups'

The savings to consumers will be greater than shown because of reduced payments for network charges and VAT. The latter will be a cost to the exchequer while fixed energy system costs will be a cost to energy suppliers, ultimately passed on to all consumers. No allowance is made for fuel security benefits, employment opportunities from developing energy saving products or spill-over benefits of innovation.

Key assumptions/sensitivities/risks **Discount rate (%)** 3.5 /3.0

The analysis has taken a common set of assumptions on fuel prices, traded and non-traded carbon values, emissions factors and air quality damage costs from 2012 Green Book Supplementary guidance. Sensitivity analysis has been carried out for energy prices, carbon values, new homes build mix, counterfactual, compliance and learning rates. As impacts are relatively small and there are no changes to existing homes, no comfort taking or other rebound effects have been assumed.

BUSINESS ASSESSMENT (Option 2)

Direct impact on business (Equivalent Annual) £m: [2009 prices]			In scope of OITO?	Measure qualifies as
Costs: **120** [114]	Benefits: **136** [129]	Net: **16** [15]	Yes	Zero IN

EVIDENCE BASE :

Summary of final options

For this Final Proposal stage Impact Assessment, we have focused on two options, summarised below:

1. ***Do nothing***. This means no change to the 2010 Part L regulations, with lost opportunity to undertake cost effective abatement opportunities.

2. ***Cost effective energy efficiency changes***. Tighter carbon compliance standards for:

- new homes, differentiated by building type to give 6% improvement on 2010 standards aggregated across the build mix based on an overall performance based carbon compliance target with new mandatory fabric energy efficiency requirements.
- new non-domestic buildings, differentiated to give a 9% aggregate improvement on 2010 with energy efficiency backstops.
- existing non-domestic buildings for specific building services work such as fan coil unit, chiller and lighting replacements.

Proposed Change since consultation

This differs from the preferred option at Consultation (Option 4 of four options in the Consultation Impact Assessment) in that:

- the new homes uplift is slightly relaxed – we consulted on an overall 8% improvement - and the approach simplified with the fuel factor retained at current levels.
- the new non-domestic building standard is a slightly relaxed version of the 11% consultation option rather than the 20% option which was preferred at consultation.
- the existing non-domestic building standard for building services elements is similar to consultation with the lighting standard slightly relaxed following consultation.
- the consultation proposals for additional consequential improvements and tighter standards for existing homes and non-domestic extensions and regulating for a quality assurance process for new homes are not being taken forward at this time.

Option 2 is less ambitious than the proposals consulted on in January 2012 but ensures that cost effective momentum is maintained towards cutting energy bills and tackling the long-term climate change challenge whilst respecting deregulatory commitments. The total package will save 6.4 $MtCO_2$ and deliver a £379m net present value benefit to society over the apprasial period from 10 years of policy. It will result in significantly lower and manageable regulatory changes for home builders and an equivalent annual net benefit to business of £16m. Further details are in the relevant sections of the Evidence Base. A Summary of Costs and Benefits is included in Table 1.1.

Average extra over cost increase is £453 per new dwelling.for housebuilders. It varies from 1.2% of build cost for a detached house down to 0.1% for a gas heated apartment. Incremental capital cost for new non-domestic buildings varies from 0.02% for a hotel to 1.2% for a small warehouse unit.

TABLE OF CONTENTS

1 BACKGROUND AND SCOPE OF PROPOSALS

1.1 The Government is fully committed to meeting its carbon targets under the Climate Change Act 2008, at the heart of which is a legally binding target to reduce emissions by at least 80% by 2050 (relative to 1990 levels). To drive progress towards this, the Act also introduced legally binding five-year 'carbon budgets' governing the trajectory to the 2050 target. Around 45% (27% from homes and 18% from non-domestic) of UK carbon dioxide (CO_2) emissions come from buildings, principally space heating and cooling, water heating, lighting and other fixed systems[1] - energy uses which are covered by the Building Regulations. Energy used by industrial processes and plug-in appliances (computers, white goods, televisions etc.) is not covered by the Regulations except in so much as heat gains from these impact upon the energy performance of the building.

1.2 The Building Regulations typically apply at original point of build, subsequent conversion and renovation, and on replacement of specified fixed components and systems. Part L of the Building Regulations sets requirements for the conservation of fuel and power on a functional basis – that is, the regulations are technology-neutral. The scope to demonstrate that different designs can meet the regulations means that raising regulatory standards will help to encourage the take up and innovation of more energy efficient and low carbon technologies. The Secretary of State for Communities and Local Government is responsible for Building Regulations applying in England. Responsibility for Building Regulations has been devolved to Scotland and Northern Ireland, and also now Wales (as of the end of 2011).

1.3 The Government has announced that from 2016 all **new homes**[2], and from 2019 all **new non-domestic buildings**[3], in England will be built to zero carbon standards and reaffirmed its commitment to implementing 'zero carbon homes' from 2016 in the 2013 Budget document[4]. The expectation is that Part L of the Building Regulations, which already sets limits on the emissions of new buildings, will be the regulatory vehicle for achieving the on-site elements of these zero carbon standards. Changes to the regulations in 2013 have been developed to act in part as an interim step on the trajectory towards achieving zero carbon standards.

1.4 Reducing energy demand through strengthened energy efficiency requirements not only helps to reduce UK carbon emissions it also helps to reduce fuel bills for consumers and businesses and the depletion of energy resources.

1 Meeting the energy challenge: A White Paper on energy - May 2007 http://www.decc.gov.uk/en/content/cms/legislation/white_papers/white_paper_07/white_paper_07.aspx (more up to date data can also be seen in the Energy Efficiency Strategy Statistical Summary, Nov 2012)

2 Written Ministerial Statement, Grant Shapps, 27 July 2010: http://www.publications.parliament.uk/pa/cm201011/cmhansrd/cm100727/wmstext/100727m0001.htm

3 Written Ministerial Statement, Grant Shapps, 20 December 2010: http://www.publications.parliament.uk/pa/cm201011/cmhansrd/cm101220/wmstext/101220m0001.htm

4 Budget 2013, HMT, 20 March 2013 http://cdn.hm-treasury.gov.uk/budget2013_complete.pdf

Rationale for intervention

1.5 Reducing carbon emissions from the building stock is essential for the UK to meet its Climate Change Act targets.[5] Building Regulations should be used to achieve this only where it can be shown to be cost effective and that the market would not make these changes of its own accord, or that other measures (regulatory or otherwise) are not already driving this change.

1.6 A number of market failures exist:

(a) Climate change creates a huge externality: polluters (builders and building occupiers) do not incur the true cost of their emissions. Even if an appropriately high and sustained carbon price were applied, the mix of other market failures can act as a barrier to action.

(b) Building buyers/tenants/mortgage providers do not have information on long term energy price rises, and most do not value better performing buildings at point of construction, sale or rent. In particular for most businesses (as opposed to households), energy costs are (at present) too small a percentage of their operating costs to make energy efficiency a material consideration in the choice of building they occupy.

(c) Even where consumers (householders in particular) do have the information to act to take advantage of energy efficiency savings, many fail to do so for a variety of reasons. High fabric standards for buildings reduce the influence of such behaviour, as the occupant's actions have little impact on building performance.

(d) Conversely, a failure to set standards at point of build can lock a building into higher energy consumption, giving those consumers who do want to act limited scope to make savings.

(e) Split incentives mean that developers have little reason to build better performing buildings, as they do not enjoy the benefits of lower energy bills or income from energy generated by renewable technologies installed in the building.

(f) Occupants have limited incentive to refurbish their buildings to higher energy standards, as the payback periods through lower fuel bills alone can be unattractive, and there is limited evidence that higher performance results in a price premium when they come to sell or rent the building on.

(g) Lack of capital, lack of information and fear of hassle can act as barriers to households and businesses taking action to renovate and improve existing buildings even if these would be cost effective in the medium or long term.

1.7 Building regulations and standards are widely recognised as an appropriate point of intervention to overcome these market failures in construction. Action at the point of build has the advantage of 'locking in' low carbon technologies and efficient design, reducing overall energy/heat demand in the building and the future need for decarbonised energy/heat to meet

[5] The Carbon Plan sets out proposed actions to meet the 2050 commitments: http://www.decc.gov.uk/en/content/cms/tackling/carbon_plan/carbon_plan.aspx

this demand. The need for energy efficiency measures to be retrofitted at a higher cost later can be avoided, and if the building undergoes major renovation, an appropriate level of basic energy performance is maintained. Intervention to improve energy efficiency at the point of build or where building work is already being carried out can avoid the 'hidden costs' associated with the disruption and hassle which is typically involved when additional energy efficiency retrofits are carried out. For instance, replacing lighting or chillers with more energy efficient products at the point when they need to be replaced in any case, avoids the extra hassle involved when incentivised as part of an additional retrofit which is not associated with the replacement lifetime of the product.

1.8 For these reasons there is a primary focus on energy efficient fabric and services rather than building integrated renewable generation technologies in setting the standards. This said, adopting a performance based approach, through overall carbon emissions or energy demand targets without prescribing how this is met, gives the designer choice in the combination of elements they adopt to meet this standard. This is important in a context where some renewable technologies are falling in price over time as experience of their production and use grows. The 'performance approach', through giving flexibility in how the outcomes are achieved, stimulates innovation in the construction process.

1.9 The changes seek to maximise the level of carbon reduction possible from new buildings by recognising that the opportunities for cost effective abatement are not identical across the stock. In 2010, **differentiated standards** for new non-domestic buildings were introduced, with targets differing according to building type. This meant that standards did not have to be set at the level of the lowest common denominator, or at a level where some building types were unfairly penalised and the potential to cost effectively improve others was not fully exploited. The impact assessment for the 2010 standards estimated that when applied to new non-domestic buildings this aggregate approach would save around £2 billion NPV over the lives of the buildings covered by the policy. For Part L 2013, this impact assessment proposes that a similar principle is also applied to new homes. Such an approach results in an overall or 'aggregate' reduction in emissions when viewed across the new build mix, but with different standards for different home types.

Other relevant drivers

1.10 The Building Regulations interact with (and support) a number of associated initiatives:

(a) The **Green Deal** is at the heart of the Government's policy for improving the energy performance of existing buildings. This approach provides voluntary 'pay as you save' opportunities for individuals to choose to reduce energy use in existing buildings which complements regulatory intervention setting energy efficient standards at the point of build or when building work is carried out.

(b) The **EU Emissions Trading Scheme** (ETS) addresses carbon emissions associated with the generation of electricity. This is reflected in the different, lower value placed on traded carbon compared to non-traded carbon in supplementary Green Book guidance used in this analysis. The building-related emissions from homes are primarily associated with space and water heating using gas fired appliances, and thus falls in the non-traded sector. For non-domestic buildings this is less true, and (in particular) electric lighting loads can dominate energy demand in many building types.

– All the proposed options for Part L 2013 standards for new buildings prioritise 'locked-in' fabric and fixed services efficiency. The preferred option for standards for new homes can be cost effectively achieved without the need to install renewable energy technologies, largely avoiding overlap with the ETS.[6] For non-domestic buildings, the selected option suggests some traded carbon savings. It assumes higher standards for fixed services including cooling and electric lighting. However, the standard has been designed so that developers can achieve it through energy efficiency alone if they choose. Solar photovoltaic (PV) panels are only likely to be included where cost effective. And the energy saving benefit stream alone for the overall package for non-domestic buildings more than covers the costs.

(c) European legislation is moving the market towards higher performing products. Under the **EU Energy Related Products Directive (2009/125/EC)**[7], the EU Commission has powers to set minimum performance standards for products being placed on the Union market, phasing out more inefficient products. At present there are standards (or plans for standards) for products such as electric motors, boilers, lighting, computers, televisions and many others.

– These standards complement the Building Regulations by driving down non-regulated plug-in energy use. But where the two potentially overlap (for example on motors used in fixed ventilation systems) then the Regulations provide the enabling installation arrangements (for example requiring commissioning and controls upon installation).

6 The EU Climate and Energy Package (December 2008), introduced separate emissions reduction targets for the traded sector (that is those emissions covered by the EU Emission Trading System), and for the non-traded sector (that is those emission not covered by the EU Emission Trading System). The presence of separate targets in the Traded and Non-Traded sectors implies that emissions in the two sectors are essentially different commodities.

7 Also known as the Ecodesign Directive: http://efficient-products.defra.gov.uk/cms/ and http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:285:0010:0035:en:PDF

(d) The recast **EU Energy Performance of Buildings Directive (2010/31/EU)**[8] builds on the original Directive and introduced a number of new measures. These included a comparative cost-optimal methodology enabling the relative performance of Member States in improving the energy performance of their buildings to be benchmarked, a reduction in the size threshold for Display Energy Certificates and a requirement that all buildings developed after 2020 are 'nearly-zero energy buildings'.

– Part L played an important role in transposing the original 2002 Energy Performance of Buildings Directive (EPBD), in particular on the setting of minimum energy performance requirements for new and refurbished buildings. In many respects the Regulations already meet the requirements of the recast EPBD however some key changes have previously been made to Part L to comply with the requirements of the recast Directive. These changes include an obligation to consider the technical, environmental and economic feasibility of high-efficiency alternative systems before starting construction, and a requirement to ensure that in existing buildings, a replacement or renovated thermal element meets minimum energy performance requirements. These changes are reflected in the recast EPBD Impact Assessment[9]

– Part L and the Building Regulations will have a key role in implementation of some of the other recast EPBD requirements, principally the requirement for all new buildings to be 'nearly zero' energy from 2020. The Government's assumption is that these requirements will be met by the commitment to zero carbon standards for new homes and non-domestic buildings[10]. However, these requirements do not impose costs or benefits from 2013 through Part L, and as such are not discussed in this impact assessment, except in so much as the Part L 2013 changes are a step on the trajectory towards zero carbon standards in the future.

– In accordance with the **Renewable Energy Sources Directive** (2009/28/EC) the UK has committed to generating 15% of its energy from renewables by 2020. Part L has a role in facilitating implementation of the Directive by encouraging an increased share of energy from renewable sources in buildings. However, the selected options for Part L 2013 new build standards in this impact assessment should be achievable without the need for renewables. The main costs and benefits of transposition and implementation of the Directive are assessed by DECC.

(e) Voluntary standards relevant for new buildings ensure that a proportion of new buildings exceed the minimum standard set out in Part L 2010. Sometimes these standards are required as a planning requirement, though there may be other drivers for developers to achieve these standards, including opportunities to brand them as high quality buildings or for social responsibility reasons. For dwellings, these standards include the **Code for Sustainable Homes**, for which Code Levels 4, 5 and 6 require an energy standard which exceeds that being introduced for Part L 2013. For non-domestic buildings, standards such as the **Building Research Establishment Assessment Method** (BREEAM) ensure that

8 European Energy Performance of Buildings Directive (recast), 19 May 2010 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:EN:PDF

9 www.gov.uk/government/uploads/system/uploads/attachment_data/file/39379/Impact_Assessment.pdf

10 The zero carbon ambitions and the Building Regulations (and therefore this impact assessment) applies to England. The UK's full transposition of the Directive will cover implementation in Wales, NI and Scotland.

some buildings are built to higher than Part L 2013. These non-mandatory standards can help ensure learning and innovation which can reduce costs of subsequent changes to Part L, as illustrated by Code Level 3 homes which required an energy standard similar to that eventually introduced in Part L 2010. An estimate of the proportion of buildings which would be built to Part L 2013 standards or beyond even in the absence of the change being introduced is included in the appropriate counterfactual baseline.

Description of Options Considered.

1.11 The following paragraphs briefly outline the options considered at consultation and how they have been taken forward post-consultation for each building category. Further details are given in Section 2 which provides more detail on the costs and benefits.

New homes

1.12 The potential change in the standards for new homes has been considered in the context of the Government's commitment to move to zero carbon standards from 2016. Any Part L 2013 step would need to drive innovation and aid learning in advance of implementation of the 2016 standards. For example we do not want to set standards which rely on a particular technology that then becomes redundant from 2016.

1.13 The consultation examined three options for new homes in the Consultation Stage IA. They were to:

(a) Do nothing.

(b) Introduce CO_2 emission standards equivalent to introducing a Fabric Energy Efficiency Standard in full, accompanied by a reasonable level of services provision (an efficient boiler and low energy lighting for example) but without reliance on renewables. *This was the preferred approach at consultation*.

(c) Introduce CO_2 emission standards equivalent to a 'halfway' point towards the 2016 carbon compliance standards as recommended by the Zero Carbon Hub.[11].

1.14 Following the responses in the consultation, the work was focused on the 8 per cent option uplift for new dwellings, which provides a more manageable improvement in the new home standards for Part L 2013. 45% of those responding to the consultation including many home builders either wanted no uplift at all or supported the 8% uplift option. Some stakeholders such as the green groups however preferred the 26 per cent uplift but the regulatory costs of this was considered to potentially pose challenges to home builders in the current economic climate.

1.15 The post consultation work drew on the principles of fabric energy efficiency, meaningful learning in advance of 2016 and avoiding technical cul-de-sacs. It also focused on Government's commitment that the costs on home builders will be at least offset by

[11] **CARBON COMPLIANCE, SETTING AN APPROPRIATE LIMIT FOR ZERO CARBON NEW HOMES, Zero carbon Hub, Feb 2011 http://www.zerocarbonhub.org/resourcefiles/CC_TG_Report_Feb_2011.pdf**

equivalent deregulatory changes (see also Impacts on business). In balancing these objectives it was necessary to adjust the final policy which now delivers around a 6 per cent level of improvement in CO_2 emission standards. The final package remains broadly in keeping with the principles of the preferred "FEES plus services" consultation option whilst respecting deregulatory commitments. When developing the final solution we also considered feedback to the Cabinet Office Red Tape Challenge[12] process and concerns about the complexity of the Building Regulations and associated guidance plus the work carried out on new homes standards in other parts of the United Kingdom to develop a concurrent notional recipe for new dwellings.

1.16 This change to the new build standards will be introduced from 6 April 2014, subject to the transitional arrangements outlined.

New non-domestic buildings

1.17 As for new homes, this change for new non-domestic buildings should be seen as one step on a trajectory towards zero carbon from 2019. However, as an overall aggregate target for 2019 zero carbon on-site standards has not been set, for Part L 2013 the emphasis has been on setting challenging on-site targets based on an assessment of what levels of improvement would be cost-effective over the next few years.

1.18 For new non-domestic buildings it is proposed that targets will continue to be set on an 'aggregate' basis with different standards for different subsets of buildings (for example heated only, or heated and cooled buildings). We expect that this approach will continue to deliver cost savings compared with a requirement for all buildings to meet the same level of reduced energy consumption.

1.19 At consultation the options for new non domestic buildings examined in the Consultation Stage IA were:

(a) Do nothing.

(b) Introduce an 11% improvement on 2010 standards. It is likely that this would be achievable in most building types through fabric and services efficiency improvements.

(c) Introduce a 20% improvement on 2010 standards. The assumption of the modelling is that in most building types, as well as more efficient fabric and services, some building-integrated renewable energy generation (such as PV panels or combined heat and power plant) would also be needed to meet the standards. *This was the preferred approach.*

1.20 The consultation responses for raising standards for new non-domestic buildings were mixed with some supporting the more ambitious 20 per cent uplift while others preferred the 11 per cent uplift. Post consultation work further explored both options.

[12] http://www.redtapechallenge.cabinetoffice.gov.uk/building-regulations-and-related-legislation/

1.21 Solar PV costs were revised based on the latest DECC data[13] and fabric specifications were eased towards 2010 levels. In line with the feedback received from the industry, lighting performance standard in the notional building was relaxed to 60 luminaire lumens per circuit watt while the top-lit notional building was modified with standards eased for smaller buildings.

1.22 Taking into account the costs and benefits to society and better cost effectiveness, the circa 9 per cent option was chosen (a modified version of the 11% option with fabric and service components relaxed as above). This is the maximum uplift that should be achievable with only fabric and fixed services for most building and is therefore consistent with the approach taken for new homes.

1.23 The changes to the non-domestic new build standards will come into force from 6 April 2014, subject to the transitional arrangements outlined.

Existing buildings

Raising standards for works to existing buildings

1.24 Much has been done through previous Part L amendments to strengthen energy efficiency standards when building owners carry out building work to existing properties. The Consultation Stage IA assessed the impact of:

(a) Raising performance standards for domestic extensions and extensions to non-domestic buildings of similar construction;

(b) Raising the required performance levels for replacement domestic windows;

(c) Strengthening the standards for replacement cooling and lighting installations to non domestic buildings.

1.25 Whilst there was support for strengthening domestic extension standards, the consultation stage Impact Assessment showed that the present value of revenues from energy savings, at the social variable rate, was insufficient on its own to cover the present value of costs.

1.26 For windows, the cost effectiveness appeared more positive with the present value of energy benefits exceeding the present value of costs. However, at consultation, there was some significant concern from the window industry, with the proposed improvement in U value and around 30% of manufacturer responses opposed the improved standards. They felt that the consultation had not taken into account the variation in costs between different window products and that it would be prohibitively expensive to produce many steel windows and other non-basic window styles, thus reducing choice in the market.

[13] **Solar PV cost update,** Department of Energy & Climate Change, **May 2012**
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/43083/5381-solar-pv-cost-update.pdf

1.27 For these and other reasons, including the impact of the extra cost burden on householders trying to improve their homes in the current economic climate and the associated inconsistency with proposed planning permission reforms it has been decided not to proceed with these changes for existing homes at the current time.

1.28 To help maintain consistency of construction standards it has therefore also been decided not to proceed with the introduction of a separate set of strengthened standards for the extension of non-domestic buildings that are domestic in character.

1.29 Government regards regulation as a last resort in addressing market failure. And market change in the light of improvements in technology, higher energy prices, awareness of the need to tackle climate change and especially labelling of the energy efficiency of products, including windows, is already driving an increase in consumption of more energy efficient products. If the pace of this change is considered insufficient over coming years and alternative interventions are limited in their impact, potential changes to the building regulations could be revisited in a future review of Part L. The consultation responses suggest that these proposals should remain under consideration as a future option. However, as it is not proposed to introduce these Part L changes at this time, their impact has not been included in this IA which focuses on the costs and benefits of the final proposal.

1.30 The main changes from the consultation in this IA have therefore been to develop a model to assess the changes in the Non-Domestic Building Services Compliance Guide standards for the replacement of fixed building services such as minimum cooling efficiency increases for chillers tighter standards for fan coil units and increased initial luminaire efficacy to 60 lamp lumens per circuit watt.

1.31 These changes to the standards for replacement services to existing non domestic buildings will come into force from 6 April 2014 subject to appropriate transitionals.

Consequential Improvements

1.32 At consultation, options were proposed for extending the requirements for consequential improvements on existing buildings where work is already planned and Green Deal finance is available. Consultation responses, further quantitative research undertaken by the Energy Saving Trust and qualitative research by AECOM were assessed and raised a number of concerns with the proposals including the potential for regulatory intervention to deter home owners from carrying out building works thus stifling growth. Having carefully considered all the representations and evidence, it was reported in a Written Ministerial Statement[14] that the Department will not be going ahead with the regulatory proposals for additional consequential improvements at this point in time. As these proposals are not included in the selected Option 2 below, the proposals for 'consequential improvements' analysed at consultation stage are not being included in this Impact Assessment. This Final Proposal stage IA focuses on the costs and benefits of the selected option in accordance with IA guidance.

Compliance and performance

1.33 For new homes, the consultation proposed that industry development and adoption of a quality assurance process to further ensure compliance levels be incentivised through the regulations. A key element would be development of a codified quality assurance process for the whole housing supply chain, potentially in the form of a BSI Publicly Available Specification (PAS) or similar to encourage continual process improvement.

1.34 The Consultation Stage impact assessment also recognised the potential for discrepancy between the design and eventual as built performance of new homes but was unable to offer clear quantification as to its extent. These wider performance issues are over and above what builders need to do now to show compliance with the Building Regulations and are currently not well understood e.g. the real performance of construction products when used in completed buildings, as opposed to theoretical performance in a laboratory environment. The consultation stage impact assessment therefore welcomed industry's commitments to the Zero Carbon Hub recommendations that from 2020 at least 90% of new dwellings would meet or better their designed energy/carbon performance[15].

1.35 There was strong consultee support for the principle of addressing these issues but some, including many home builders, felt more evidence is needed to better understand where potential discrepancies occur before taking regulatory action.

1.36 Government has therefore decided against regulation for quality assurance processes at this stage. Not taking the regulatory requirements forward at this time reduces the overall regulatory burden in this analysis. The Government is however supporting the wider Zero Carbon Hub led industry 'as built' work programme looking at future approaches to tackle the issues. More on this voluntary industry approach post-consultation and wider compliance, performance and enforcement issues are contained in Section 3 below.

[14] https://www.gov.uk/government/speeches/minor-consequential-improvements
[15] Carbon Compliance Setting an Appropriate Limit for Zero carbon New Homes, Zero Carbon Hub, February 2011 http://www.zerocarbonhub.org/definition.aspx?page=8

Summary of Impacts

1.37 A summary of the impacts considered under this IA, broken down by area of policy, is provided in Table 1.1 below. All figures are Net Present Values (NPV) over 10 years of policy and the life of the buildings. The figures given represent the aggregate impact across the entire build mix.

Table 1.1: Summary of Selected Results from the IA (£m)

	New domestic buildings	New non-domestic buildings	Existing non-domestic buildings	Total
Energy savings	294	604	269	1,167
Incremental costs	(301)	(604)	(199)	(1,104)
Total financial benefit/(cost)	(6)	(0)	70	64
Non-financial benefits (carbon savings, comfort taking, air quality savings)	240	74	6	320
Total net benefit	**234**	**74**	**76**	**384**
Transition costs (one year)	*(2.3)*	*(2.0)*	*(0.7)*	(5)
Total net benefit	**232***	**72***	**75***	**379***
Equivalent annual net benefit/(cost) to business	**(34)***	**28***	**22***	**16***
Carbon savings ($MtCO_2$)	*4.50*	*1.67*	*0.21*	*6.40*

Source: Europe Economics.

* This figure includes the transition cost to business

Summary of final options

1.38 At consultation four options packages were proposed. Following the consultation, for this Final Proposal stage Impact Assessment, we have now focused on two options, summarised below:

1. ***Do nothing***. This means no change to the 2010 Part L regulations, with lost opportunity to undertake even relatively modest cost effective abatement opportunities.

2. ***Cost effective energy efficiency changes***. Tighter carbon compliance standards for new homes (differentiated by building type to give an overall 6% improvement on 2010 standards based on an overall performance based carbon compliance target with mandatory energy efficiency requirements) and new non-domestic buildings (differentiated to give a 9% improvement on 2010 with energy efficiency backstops). Tighter standards for existing buildings when certain building work is undertaken, specifically non-domestic building fan coil unit, chiller and lighting replacements.

Regulatory burden: 'One In Two Out'

1.39 'One In Two Out' is the Government's new commitment[16] that any new regulatory cost introduced by a department (an In) will at least be matched by cuts to twice the equivalent cost of existing regulations (Outs). Only costs and benefits to businesses and civil society organisations are included in One In Two Out calculations.

1.40 The calculations are done at the level of overall impacts on the economy, so:

(a) Costs to business (for example developers) can be offset against benefits to other businesses (for example fuel bill savings for business building occupiers).

(b) Costs to business (for example developers) cannot be offset against benefits to private citizens (for example fuel bill savings for households).

(c) Where both the costs and the benefits accrue to private citizens (for example requirements for works on existing homes, where the householder will both pay for the works and enjoy the fuel bill savings) are not counted in the calculations.

1.41 In the 2010 Comprehensive Spending Review[17] the Government also committed to reduce the total regulatory burden on the house building industry over the Spending Review period (which runs to March 2015). This means that any new regulation must be **at least** matched by deregulatory measures of the same value and so no effect on house building numbers. For new homes, the implication for this impact assessment is that the savings for building occupiers, private citizens or businesses, cannot be offset against the costs for housebuilders. The Government will publish reports against this commitment at Budget 2014 and 2015.

Impacts on business

1.42 An example of how the equivalent annual impact on business is calculated is given for new homes above Table 2.8 below.

1.43 The costs and benefits are shown in Table 1.2 below. The net benefits to business overall are significantly higher than the net cost to business so the IA is in effect zero for One In Two Out purposes for the selected option. The £16m equivalent annual net benefit to business (EANBB) is a lot higher than at consultation. This is because the equivalent annual net cost to business (EANCB) for new homes has dropped considerably (see section 2 for more detail) and although the EANBB in relation to new non-domestic buildings has dropped compared with the consultation analysis (see section 2), the additional more detailed analysis for existing non-domestic buildings has resulted in a much higher EANBB (see section 2).

1.44 The assessment period for calculating the impact upon business is 10 years and for the overall NPV calculation it is 70 years. Further details on the calculation period are outlined in Section 2 below.

[16] http://www.bis.gov.uk/policies/bre
http://news.bis.gov.uk/Press-Releases/-One-in-two-out-Government-to-go-further-and-faster-to-reduce-burdens-on-business-and-help-Britain-compete-in-the-global-race-6838c.aspx

[17] http://cdn.hm-treasury.gov.uk/sr2010_completereport.pdf paragraph 2.31

Table 1.2: Cost and benefits to business

2011 Prices	Relevant option	Level of improvement	Equivalent annual cost to business (£m)	Equivalent annual benefit to business (£m)	**Equivalent annual net benefit or (cost) to business (£m)**
New homes	Option 2	6%	34	0	**(34)**
New non-domestic buildings	Option 2	9%	64	92	**28**
Existing non-domestic buildings	Option 2	See text	22	44	**22**
Total (including transition costs)	**Rounded**		**120**	**136**	**16**

1.45 The overall impact of the preferred Option 2 is an equivalent annual net benefit to business (including transition costs) of £16m in 2011 prices. For consistency and comparison with other policies, guidance requires that this is presented in 2009 prices for OITO purposes which gives an annual net benefit to business of **£15m**. This is presented in Table 1.3.

Table 1.3: Breakdown of costs and benefits of selected option (2009 Prices)

	Equivalent annual net (cost) or benefit to business (£m 2009 prices)
Changes to standards for new homes	(32)
Changes to standards for new non-domestic buildings	27
Improved standards for existing non-domestic buildings	21
Total (including transition costs)	**15**

Moratorium on regulation for micro businesses

1.46 The moratorium period on new domestic regulation for micro and start-up businesses ends on 31 March 2014. These Part L changes come into force on 6 April 2014 therefore a waiver from this moratorium is not applicable.

1.47 The differences in construction costs between volume developers and smaller occasional builders cannot be directly attributed to Part L 2013 however we have considered the likely impacts of these changes on small firms at Section 4 of this impact assessment. The construction industry is made up of businesses of all types and sizes working together and applying and policing differing construction standards to some businesses and not to others would be impracticable e.g. manufacturers would have to operate additional production lines. We have made changes post consultation to help mitigate the effects on small businesses and plan to work with industry, in the run up to introduction of the changes in April 2014, to develop simple 'pattern book' style guidance which should be particularly helpful to small and self builders.

2 ESTIMATION OF COSTS AND BENEFITS

Overview

2.1 The proposed policy change will affect all new buildings in England and some changes to existing non-domestic buildings. The impact of the policy will be felt both at the point of new construction and replacement of non-domestic building services and over the life of the building during which energy savings will be achieved. As such, the policy will have an impact on manufacturers of construction products, the construction industry and the users of buildings. These wide-ranging effects justify a detailed analysis of costs and benefits broken down between different categories of building and with quantitative analysis undertaken to Level 5: monetise fully all costs and benefits, as far as possible, with some less significant effects quantified to Level 4[18]. Given the long lives of the buildings affected there is considerable uncertainty about future values; the quantification is therefore supplemented by sensitivity analysis of key assumptions. This is in line with the approach adopted for the changes to Part L in 2010.

2.2 In order to estimate the overall costs and benefits of the proposed policy options we have modelled the changes in building costs, energy use and related CO_2 emissions using the building standards proposed for Part L 2013 compared with a baseline of costs and energy use implied by the 2010 standards which are now in place. We have reviewed impacts of three types of building development:

- New homes, broken down between detached, semi-detached/end-terraced, mid-terraced houses, electrically heated flats and gas heated flats.
- New non-domestic buildings represented by the building types that represent 70 per cent to 80 per cent of the new build mix: offices; education; hotel; warehouses; and retail. Although this does not cover every non-domestic building type, this breakdown gives an indication of the impact for the non-domestic stock as a whole.
- Replacements of fixed building services in existing non-domestic buildings.

2.3 The figures in the following analysis are based on central estimates, with sensitivity analysis undertaken separately where appropriate.

Assumptions applicable to all models

2.4 Since the consultation IA was produced, two new versions of Interdepartmental Analysts' Group (IAG) Supplementary guidance to the Green Book have been released. Therefore, in

[18] HM Government (2011) "IA Toolkit: How to do an Impact Assessment"

this IA we move to the most recent version of the IAG guidance published in 2012[19]. This IA hence takes account of updated fuel prices, traded and non-traded carbon values and emissions factors, as well as removing avoided renewables calculations from the analysis.

2.5 In particular, this means that, compared with the values used in the Consultation IA:

- Emissions factors have been slightly increased for gas.
- Emissions factors have been significantly decreased for electricity up to 2040, after which they are roughly similar.
- Non-domestic electricity variable prices are higher until 2024, after which they drop lower than before. Non-domestic electricity retail prices are similar until 2024, after which they are approximately 25 per cent lower.
- Domestic electricity variable prices are higher until 2025, after which they are lower than before. Domestic electricity retail prices start higher than before, then become roughly the same after 2026.
- Non-domestic gas variable prices start higher than before, then converge down to the previous estimated prices. Non-domestic gas retail prices also start higher than before, but after 2018 they drop below the previous figures used.
- Domestic gas variable prices are initially higher, then converge down to the previous figure. Domestic gas retail prices are also initially higher, then after 2023 drop to slightly below the previous estimate.
- Traded and non-traded prices of carbon are slightly higher than before.

2.6 We have also added in air quality damage costs to the analysis, with values taken from the 2012 IAG guidance. This implies additional benefits from any policy that involves a reduction in carbon emissions, in addition to the traded and non-traded carbon values themselves.

2.7 A separate calculation of avoided renewables has now been excluded from the costs/benefits calculations and the cost-effectiveness calculations, in accordance with the 2012 IAG guidance[20].

2.8 Energy savings are valued at the variable rate in macroeconomic calculations in accordance with the IAG supplementary Green Book guidance. This is appropriate for social analysis and

[19] "Valuation of energy use and greenhouse gas emissions for appraisal and evaluation, October 2012" and accompanying tables. HM Treasury and DECC

[20] The long-run variable cost of electricity supply (LRVC) figures published by IAG now incorporate expected changes in renewable electricity generation resulting from demand changes, so no further valuation is needed for changes in grid electricity consumption. For policies driving small-scale generation of electricity from renewable sources, such as solar PV, there is no automatic policy adjustment that would lead to a reduction in renewables deployed elsewhere. Hence, it is unclear whether the policy would actually lead to a decrease in the amount of renewables deployed elsewhere. Due to this uncertainty, the potential value of a reduction in the required amount of deployed renewables is excluded from the analysis.

assumes that the retail energy saving enjoyed by the consumer occupying an energy efficient building does not fully reflect the social benefit. For instance fixed energy costs fall ultimately on all existing consumers via energy supply company prices. The full retail savings to occupiers are reflected in the section on distributional impacts in Tables 2.23 and 2.24.

2.9 A discount rate of 3.5 per cent has been used for the first 30 years of building life and 3 per cent for subsequent years. This is in line with guidance in HM Treasury's Green Book - Appraisal and Evaluation in Central Government[21].

2.10 In addition, unless otherwise stated, prices and estimates shown below are in 2011 prices.

2.11 The appraisal time period for estimating the impact of the policy is 10 years which is consistent with that used at consultation, in the 2010 Part L Impact Assessment and in other Impact Assessments associated with the construction industry. It is important to ensure there is a full appraisal of the 'lock in' impact of tighter fabric standards, for instance associated with walls, which will impact over a long period of time, potentially the entire lifetime of the building.

2.12 For building fabric insulation (external walls, floors, roofs) we have assumed an asset life of 60 years. For external windows and doors, we have assumed an asset life of 30 and 25 years respectively. This is comparable with indicative values provided in Annex E of BS EN 15459 Energy performance of buildings — Economic evaluation procedure for energy systems in buildings[22]. For heating, ventilation and air conditioning (HVAC) equipment and lighting we have assumed an asset life of 15 and 20 years respectively. This is comparable with indicative values provided in CIBSE Guide M – Maintenance engineering and management[23].

2.13 In order to ensure an appropriate comparison between fabric insulation standards and windows or fixed building services with a much shorter life it is necessary to ensure replacement costs for these other components are also included over the same long time period. While fabric standards have an impact over a much longer period than say a light fitting it is important to compare fabric impact with other elements which could improve significantly in efficiency when replaced over time. So estimates are needed for learning rates. Consequently, we have estimated the ongoing costs associated with maintenance and replacement along with the benefits from energy, air quality and carbon savings over a 60 year period for each building, which provides a sufficiently long period to capture the benefits of fabric 'lock in'. For instance in the new homes analysis, a boiler is assumed to have a lifetime of 15 years. So replacements after 15, 30 and 45 years are assumed. Again this is consistent with the 2010 Part L Impact Assessment. Given the 10 year of policy being assumed, the total period for the IA is therefore 70 years so that the full 60 year impact of a building constructed in year 10 is assessed.

[21] HM Treasury (2011) "The Green Book: Appraisal and evaluation in central government"
[22] BS EN 15459 Energy performance of buildings — Economic evaluation procedure for energy systems in buildings, BSI, 2007
[23] CIBSE Guide M – Maintenance engineering and management, CIBSE, 2008

New Homes

Developments since consultation

2.14 Responses to the consultation were divided on the issue of an improvement in the new homes standards for Part L 2013, with strong representation from homebuilders, who did not want the standards changed at all, but with green groups and some manufacturers wanting the more ambitious 26 per cent uplift on 2010 standards. Many recognised the preferred 8 per cent uplift provided a technically meaningful step at a more manageable cost. The Government has committed to finding compensatory 'outs' or to amend the package accordingly.

2.15 Post consultation, work has focussed on the preferred 8 per cent consultation option. No further work has been done on the 26 per cent uplift as the regulatory costs of this was considered to pose too great a challenge to home builders in the current economic climate, and DCLG do not consider the overall consultation response supports this option.

2.16 In addition, a number of responses raised concerns that the proposed 'hybrid' metric (the combination of an absolute or fixed kWh/m^2 energy target with a relative and more flexible CO_2 improvement target) was confusing and would be complex to deliver. Some, based upon their experience of building homes to meet the higher standards required by the Code for Sustainable Homes, suggested that the Zero Carbon Hub's Fabric Energy Efficiency Standards could lead to inconsistent construction specifications and questioned whether they were achievable in practice by all builders across the full range of home types.

2.17 At the same time, the Building Regulations have been through the Cabinet Office Red Tape Challenge[24] process. Whilst there was strong support for retaining the Building Regulations and Building Control System, a number of respondents stated concerns about the complexity of the Regulations, and DCLG has been asked to look at ways to make navigating the regulations and associated tools and guidance simpler for small builders and those doing self-build projects.

2.18 To respond to the concerns raised at consultation and the Red Tape Challenge, it was necessary to adjust the final policy and identify a Part L 2013 step which:

- Focuses on the consultation principles of fabric efficiency, meaningful learning in advance of 2016, and avoiding technical cul-de-sacs;
- Focuses on affordability for home builders in the current economic climate;
- Delivers a 6 per cent level of improvement in CO_2 emission standards across the build mix;

[24] http://www.redtapechallenge.cabinetoffice.gov.uk/building-regulations-and-related-legislation/

- Introduces a new mandatory target for fabric energy efficiency, and

- Is simpler to design/build to.

2.19 To deliver this, DCLG has focussed on developing a concurrent recipe for new dwellings. The recipe is made up of fabric and fixed building services specifications only. This approach has a number of advantages:

- Fundamentally, the recipe is still a performance standard. The developer can select an alternative design as long as it achieves the same or better Target Emission Rate (TER) than the recipe. However, a key advantage of the concurrent recipe approach is that it provides a robust starting design for iteration by any developer/builder;

- The notional recipe is based on efficient services including low energy lighting throughout and an A rated condensing boiler and a similar level of fabric performance to the full Fabric Energy Efficiency Standard (FEES) as recommended by the Zero Carbon Hub[25] for semi-detached and terraced houses and flats, but relaxed back from full FEES for detached homes. This delivers a similar construction specification across the build mix.

2.20 In keeping with the focus on fabric efficiency, the consultation response supported the introduction of a mandatory energy target in addition to the CO_2 emission target discussed above. Some wanted this energy target to be in line with full FEES pointing out that it was the most cost-effective whilst others supported an energy target in line with Interim FEES for greater flexibility for example when meeting local planning requirements for renewables.

2.21 In response to this and concerns that full FEES may not currently be achievable in practice by all builders across the full range of home types it has been decided to set the Target for Fabric Energy Efficiency (TFEE) broadly in line with Interim FEES. This does not generate particular constraints on any build forms or affect the overall cost benefit analysis

2.22 As for the CO_2 emission target, the concurrent recipe will generate a Target for Fabric Enenergy Efficiency (TFEE).

2.23 The modellling has been based on the retention of the 'fuel factor' (a partial relaxation in the CO_2 targets for homes off the gas grid) in Part L 2013. There was strong support from consultees for retaining it at current levels for Part L 2013 in light of limited grid decarbonisation in the short term, and in the context of the impact assessment, there has also been challenge about the cost-effectiveness and regulatory burden of reducing or removing it particularly for rural home builders who build off of the gas grid.

[25] http://www.zerocarbonhub.org/resourcefiles/ZCH-Defining-A-Fabric-Energy-Efficiency-Standard-Task-Group-Recommendations.pdf

2.24 The notional dwelling recipe is based upon the major fuel type (gas is used to heat around 80% of dwellings built in England). The recipe therefore provides a CO_2 emissions target for a gas dwelling which is then modified by the application of the fuel factor to provide the emissions target for other fuel types.

2.25 Building modelling for the consultation was undertaken in SAP 2009. For this IA, a more up to date version of the software, cSAP 2012, was used. The emissions factors used in the SAP modelling were also updated for this IA, with the emissions factor for gas increased by around 9 per cent and that for electricity increased by around 2 per cent.

2.26 The assumed build mix for new homes has been revised following consultation, with an increase in the number of detached houses and gas heated flats and a reduction in semi-detached houses and electrically heated flats.

2.27 In the consultation IA the modelling assumed that 15 per cent of buildings would have been built to a higher standard in the absence of a regulatory change. For this IA, a more comprehensive evaluation of the counterfactual was undertaken by DCLG based on analysis of Code Statistics and Council policies, leading to an increase in the estimated counterfactual up to 22-32 per cent.

2.28 Consideration was made as to whether comfort taking should be taken into account in the new homes model. With reference to the approach taken in the Green Deal IA[26], the most appropriate approach to take for comfort taking in new homes was less clear than for other models. The Green Deal IA calculation of 15 per cent comfort taking for existing dwellings was based mostly on existing social housing rather than owner-occupiers. A further and larger extrapolation would be required to take the same conclusions to new-build homes. Since people in different situations are unlikely to perceive the same value of comfort, it is not reasonable to assume the same level of comfort taking for existing and new homes. The counterfactual for the new homes analysis is a Part L 2010 standard which is already a much more energy efficient standard than for a typical existing home. It is much less likely that there would be substantial further comfort taking because consumers are unlikely to perceive this relatively small differences in standards. Given the lack of empirical data available applying any other assumption other than no comfort taking would effectively involve the imposition of an arbitrary and non-evidence base assumption. We have therefore applied no comfort taking to new dwellings, which is consistent with the Green Deal IA approach to non-domestic buildings. Similarly we have also concluded that indirect rebound effects, such as a decision to spend more on higher temperatures out of savings, would not be substantial and have not included this. Had we taken forward proposals to tighten standards for existing homes, which would typically be considerably less energy efficient than new homes, then we would have included a 15% comfort taken estimate in that analysis.

[26] DECC (2012) "Final stage impact assessment for the Green Deal and Energy Company Obligation" IA No: DECC0072

2.29 The learning rates bringing down prices of solar PV have been amended to reflect the most recent values from DECC[27]. The thermal bridging learning rates used in the implementation IA have been shifted by two years, to start from 2012 rather than 2010, to reflect lower build rates and thus slower learning in the housing industry.

2.30 Work was undertaken to assess the costs and benefits of improvement in energy efficiency and reductions in carbon emissions from Part L 2010. In developing the recipe, a number of packages of measures (fabric, fixed services and low and zero carbon technologies) were evaluated for each dwelling type.

Final policy for new homes

2.31 A concurrent recipe has been developed for gas homes for Part L 2013 based on specifications for efficient fabric and services components. Over the build mix, this results in a 6 per cent uplift compared to Part L 2010 i.e. there is a 6 per cent savings in CO_2 emissions.

Modelling assumptions

2.32 The four house types modelled (detached, semi-detached, mid-terraced and flats) are the same core dwelling models used by the Zero Carbon Hub for both the previous Fabric Energy Efficiency and Carbon Compliance work. Each house type was modelled assuming gas heating and the flats were also modelled for electric heating using the build mix in Table 2.2 below.

2.33 All building modelling was carried out in cSAP 2012. SAP is the responsibility of the Department for Energy and Climate Change (DECC). The software used reflects the amendments to SAP proposed in the 2011/12 consultation. The SAP modelling in this IA uses the following emission factors to rebase both the Part L 2010 and proposed Part L 2013 emission standards.

- Gas: 0.216 kgCO2/kWh
- Electricity: 0.535 kgCO2/kWh

2.34 To complement this modelling, the costs associated with achieving these steps have been determined. In particular, thermal bridging costs have been reviewed and revised post-consultation to better reflect the associated activities in delivering improved thermal bridging standards. The costs for solar PV have also been revised to reflect the later values from DECC. The costs used include an allowance for learning effects such that unit costs of production fall as the volume of output rises (see Appendix 3).

[27] Parsons Brinckerhoff (2012) "Solar PV cost update" For the Department of Energy and Climate Change, http://www.decc.gov.uk/assets/decc/11/meeting-energy-demand/renewable-energy/5381-solar-pv-cost-update.pdf

2.35 The model makes an assessment of the most cost-effective way of meeting the new standards, given today's technologies, costs and assumed learning rates. The Part L 2013 scenarios for the gas home were modelled using the fabric and services specifications from the Part L 2013 gas recipe. For the electric home, PV panels were additionally included to meet the requirements in the Part L 2013 electricity recipe. The improvements in building components selected for use in the modelling for each building type are given in Table 2.1 below. Designers would be free to choose alternative technologies to meet the required outcome.

Table 2.1: Illustrative Improvements Made in the Modelling for New Dwelling Types

Building Type	Improvements Modelled
Detached House – Gas Heated	Floor, Roof, Wall, Thermal Bridging
Semi-Detached House – Gas Heated	Floor, Thermal Bridging
Mid-Terrace House – Gas Heated	Thermal Bridging
Flat – Gas Heated	Thermal Bridging
Flat – Electrically Heated	Thermal Bridging, Solar PV

Source: AECOM

2.36 Any forecasting of build rates or mix over the appraisal period out to 2023 involves significant uncertainties. At consultation we estimated an indicative trajectory for build rates, for the purposes of this modelling only, based on historic information and trends for new dwellings. Annual trends on housebuilding in England are reported in Figure 2 of the House Building Statistical release[28].

2.37 No further evidence at consultation has led us to adjust this and we have made a minor updating adjustment to build rate since consultation. We have taken, as a central assumption, an annual rate of new building of 130,000 dwellings in 2014, rising to 190,000 in 2020. It is assumed that house building will increase steadily back to pre-2008 levels, before flattening from 2020 onwards, as the economic effects, including access to credit, which caused a drop in build from 2008 are addressed and action to boost supply takes effect. The assumption that house building will increase at this rate ensures that the burden on house builders is not being underestimated in the Impact Assessment, although it does risk overstating energy and carbon savings. The uncertainty associated with this issue is considered further in the sensitivity analysis section below.

2.38 The estimated split between dwelling types is shown in Table 2.2. This is based on NHBC statistics and estimates of long-term trends. At consultation a number of respondents suggested that the proportion of detached houses was underestimated. We have used updated NHBC statistics, have increased our estimate of the proportion of detached houses

[28] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/199172/House_Building_release_-_March_Qtr_2013.pdf

and undertaken sensitivity testing to assess the impact if there are a still higher proportion of detached houses over the appraisal period. The results of this are presented in Table 7.2.

Table 2.2: Build Rate Assumptions - New Homes

Building type	% in build mix	Annual number of new dwellings 2014	2015	2016	2017	2018	2019	2020 and thereafter
Detached house	20%	26,000	28,000	30,000	32,000	34,000	36,000	38,000
Semi-detached house	29%	37,310	40,180	43,050	45,920	48,790	51,660	54,530
Terraced house	14%	17,680	19,040	20,400	21,760	23,120	24,480	25,840
Flats (gas)	29%*	37,738	40,641	43,544	46,446	49,349	52,252	55,155
Flats (electric)	9%*	11,272	12,139	13,007	13,874	14,741	15,608	16,475
Total		**130,000**	**140,000**	**150,000**	**160,000**	**170,000**	**180,000**	**190,000**

- Flats were assumed to make up 38 per cent of the build mix. Of these, 23 per cent were assumed to be electrically heated and 77% gas heated. Source: National House-Building Council(NHBC), National Energy Services(NES) and DCLG

2.39 There is a relationship between regulatory costs and housing supply, though the overall impact of the cost increases attributable to the Part L 2013 changes is likely to be minimal. In addition, as the Government is committed to reducing the overall burden of regulation upon the house-building industry by March 2015, we have assumed that there will be no overall impact, and the numbers in the table above are unaffected. This is the same assumption taken in the consultation IA.

2.40 The following phasing assumptions were made at consultation regarding the percentage of new homes that would be built to the new Part L 2013 standards in the first few years of the policy, to reflect the time lags between planning and building of new homes. No concerns or further evidence in the consultation have led us to change these and we have used the same phase in assumptions as in the consultation IA.

Table 2.3: Phase-in Assumptions - New Homes

	2014	2015	2016	2017 and thereafter
Phase in (% dwellings captured by Part L 2013)	40%	60%	90%	100%

Source: DCLG

2.41 The modelling also takes account of the number of homes that would have been built to the new standards (or higher) in the absence of any regulatory change, due to overlaps with other policies such as the Code for Sustainable Homes or an onsite renewable requirement under the Planning and Energy Act 2008. In our counterfactual, we assume that 22 per cent of homes would have been built to at least Part L 2013 standards in 2014 in the absence of the introduction of Part L 2013 and that this would have risen to 32 per cent by 2023. This is higher than was assumed at consultation reflecting trends in building performance, but is still a cautious estimate given, for instance, trends identified in Code statistics and local planning policies over recent years. For instance the Code statistics show a significant increase in the number of new homes being built to Code Level 4 since 2010/11. This level is tighter than the Part L 2013 standard. The actual outcome will be subject to subsequent decisions including those arising from the current review of local standards which is not covered by this Impact

Assessment. The assumption below is an estimate of what would happen locally out until 2023 if there were no further increase on 2010 Part L. To reflect uncertainty about this we have undertaken sensitivity testing below to estimate the impact of different counterfactual assumptions. The results are reported in Table 7.3.

Table 2.4: Counterfactual Assumptions for New Homes Built to Part L 2013 Standards

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Counterfactual (% dwellings built to Part L 2013)	22%	23%	24%	25%	26%	27%	29%	30%	31%	32%

Source: DCLG estimates based on analysis of Code Statistics (https://www.gov.uk/government/organisations/department-for-communities-and-local-government/series/code-for-sustainable-homes-statistics) and Council policies

2.42 Updated assumed fabric costs are given in Appendix 1: Additional Building Costs, Specifications and Energy Use. Energy and carbon saving benefits are valued using Supplementary Guidance to the Green Book. This values the social benefit at the 'variable' prices in the tables, which exclude fixed costs. Further details are outlined under 'Distribution of Costs and Benefits' in Section 2 [29].

Estimated impacts

2.43 The analysis shows that there would be a small net financial cost of £6 million NPV from the policy. However, once the social benefits of carbon and air quality savings are taken into account the total benefit of improving efficiency standards in new domestic buildings is found to come to £234 million NPV. A summary of the costs and benefits is shown in Table 2.5 below.

Table 2.5: Present Values of Costs and Benefits: Part L 2013 Policy – New Homes (NPV £m)

Energy savings (£m)	**294**
Incremental costs (£m)	(301)
Net financial benefit/(cost) (£m)	**(6)**
Carbon savings - non-traded (£m)	229
Carbon savings - traded (£m)	5
Total carbon savings (£m)	234
Air quality savings (£m)	6
Net benefit/(cost) (£m)	**234**
Amount of gas saved (GWh)	*23,562*
Amount of electricity saved (GWh)	*2,084*
Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	*4.35*

[29] "Valuation of energy use and greenhouse gas emissions for appraisal and evaluation, October 2012" HM Treasury and DECC

Amount of CO_2 saved - traded ($MtCO_2(e)$)	*0.15*
Cost effectiveness – non-traded (£/tCO_2)	*(1)*
Cost effectiveness – traded (£/tCO_2)	*n/a*
Average capital cost per dwelling (£)*	*453*

Source: Europe Economics

*The average capital cost per dwelling is undiscounted value in 2011 price

2.44 Reasons for key differences between these results and those in consultation IA include:

- Decision not to regulate at this time for quality assurance process – which increases the total NPV, estimated at consultation to add a present value cost of £113m.. A voluntary approach to tackling compliance and performance has been preferred (see Section 3 below).
- Introduction of air quality savings in line with Green Book supplementary guidance - increasing the NPV by £6 million
- Increase in the estimate of the number of homes built to a high enough standard under the counterfactual – reducing the NPV incremental costs and energy savings
- Changing the concurrent recipes with relaxation in the energy efficiency improvement for detached homes, e.g. the level of airtightness was relaxed
- Increasing the learning rates for thermal bridging – reducing the present value incremental costs
- Capital costs of thermal bridging have also been reviewed and revised downwards to better reflect the associated activities in delivering improved thermal bridging standards
- Reducing the price of solar PV to reflect updated DECC data. However, the positive impact on NPV through lower incremental costs is limited due to the counter effect from lower updated learning rates for solar PV.

2.45 The policy would lead to a total of 0.4 million tonnes of CO_2 being saved during the 4th Carbon Budget (2023-2027).

Table 2.6: Carbon Savings Per Annum Over the 4th Carbon Budget – New Homes (tonnes CO_2)

	2023	2024	2025	2026	2027
Carbon savings - non-traded	72,582	72,582	72,582	72,582	72,582
Carbon savings - traded	8,044	7,418	6,748	6,033	5,269
Total carbon savings	80,625	79,999	79,330	78,615	77,851

Source: Europe Economics

Summary of Key Assumptions and Sensitivities

2.46 To assess the potential uncertainty associated with different sources of inputs and assumptions used in IA, sensitivity analysis has been carried out to see what effect of changing one factor at a time on the net benefit to society.

2.47 **Carbon and energy price** uncertainty affects the overall benefits substantially and has the biggest impact on net benefits. A higher **proportion of detached homes** in the build mix increases the overall cost for housebuilders fairly substantially, though the net benefit to society is even higher as energy savings for householders also increase substantially. A change in **counterfactual** assumptions of the number of homes built to the new standard in the absence of regulation simply changes the costs and benefits proportionately. Lower **learning rates** for thermal bridging and solar PV would increase costs, though the fall in net benefit is limited. Lower assumed **compliance** through lower costs and benefits will reduce the costs and benefits proportionately. Where benefits only are reduced through lower compliance, this reduces net benefits, though the cost effectiveness of the policy is such that impact of this fall on net benefit is limited.

2.48 Because of the importance of these assumptions and uncertainties we have provided further detail on each of these sensitivities in the following paragraphs and tables in Appendix 2.

Sensitivity Test Details

2.49 We have undertaken sensitivity tests using higher and lower values of future energy prices and carbon values using the range of values in the DECC IAG guidance. Higher energy and carbon prices result in a higher value of energy and carbon saved and hence, increase the net benefit to £445 million.

2.50 On the other hand, lower energy prices and carbon values result in lower energy savings and hence, reduce the net benefit to £22 million NPV. The full cost benefit tables for these and other sensitivity tests are set out in Appendix 2.

2.51 The build rate for new buildings is another assumption that can be tested to see how far a change in the assumption affects the overall costs and benefits. In the modelling approach adopted here a change in build rate has a simple proportionate effect on both the costs and benefits. For example a 10 per cent reduction in the number of new homes each year would reduce costs and benefits by 10 per cent. The net present value would fall from £234m to £211m, the carbon saved would fall from 4.50 $MtCO_2$ to 4.05 Mt CO_2, and the EANCB for housebuilders would fall from £33.8m to £30.4m. We have not included full cost benefit tables to support this simple scaling factor as it would add little value to the overall analysis.

2.52 We also carried out two sensitivity tests on the build mix in the model, due to the uncertainty in the mix of dwellings that will be built in the future. The first test looked at the alternative scenario of 10 per cent more detached houses and 10 per cent fewer flats. The second test looked at raising the percentage of flats assumed to be electrically heated, from the core figure of 23 per cent of flats electrically heated up to a higher estimate of 50 per cent of flats electrically heated. The percentage mix across the five building types under the core scenario and these two sensitivities is given in Table 2.7 below.

Table 2.7: Build Mix Sensitivity Tests – New Homes

Building type	Percentage in build mix		
	Core	Sensitivity 1 – more detached houses, fewer flats	Sensitivity 2 – higher percentage of flats electrically heated
Detached house	20%	30%	20%
Semi-detached house	29%	29%	29%
Terraced house	14%	14%	14%
Flats (gas heated)	29%	21%	19%
Flats (electrically heated)	9%	6%	19%

Source: National House-Building Council (NHBC), National Energy Services (NES) and DCLG

2.53 Changing the build mix to assume a higher proportion of detached houses and a lower proportion of flats increases energy and carbon savings to a greater extent than the increase in capital costs. Consequently, the net present value of the policy rises by nine per cent to £256 million. Increasing the percentage of electrically heated flats to 50 per cent increases the energy and carbon savings but also the capital costs. Similar to the first build mix sensitivity, the increase in savings outweighs the rise in costs resulting in an increase in net benefit by 15 per cent to £268 million.

2.54 We also tested the counterfactual assumptions included in the model. We looked at cases where different percentages of new houses would be built to the stricter standards in the absence of the proposed regulations. Changing this assumption has a similar proportionate impact on the net value estimation to the sensitivity test on build rate. If the percentage of buildings included in the counterfactual increased (decreased) by 10 per cent[30] in each year then the percentage of dwellings affected by the policy would fall (rise) by 3-5 per cent[31] and the net benefit would also change by the same percentage.

2.55 We also considered the impact of lower learning rates on the costs of new homes. Two components of the recipes for new homes are assumed to be subject to reduction in cost over time due to learning effects: thermal bridging and solar PV (see Appendix 3). For thermal bridging, we have combined two sets of costs: costs of materials which are not assigned a learning rate (e.g. the additional cost of moving to split lintols to achieve higher thermal bridging standards) and costs associated with designing and generally building to higher standards of thermal bridging to which we have assigned a learning rate. We have assumed for the core modelling that there is a steep level of learning associated with the thermal bridging design and build costs, as developers learn to design and build to higher standards of thermal bridging for initial developments and can then duplicate, or refine, the approach over subsequent developments. It may be that this is not the case – future dwelling designs may have significant variations which may require significant thermal bridging design cost and/or

[30] e.g. from 22 per cent to 24 per cent (or 20 per cent)
[31] The range relates to the change in counterfactual over the policy period from 22 per cent to 32 per cent.

the teams constructing on site may frequently change and require support for longer to construct to a higher standard of thermal bridging. Hence, we have undertaken a sensitivity test on thermal bridging where the learning is halved; this leads incremental capital costs to increase by 15 per cent. Net financial costs of the policy increase to £52 million, but after other benefits are taken into account the policy still shows a net benefit of £189 million. If learning rates for solar PV are halved the comparable increase in capital costs is 3 per cent.

2.56 Finally we carried out a sensitivity analysis on the level of compliance for new homes We took a central assumption of 100% compliance. This is in accordance with relevant guidance[32] which requires an assumption of 100% compliance for a regulatory 'IN' unless there is clear evidence. As outlined in Section 3, whilst there is some anecdotal evidence the firm evidence remains inadequate to quantify this. However a recent survey[33] indicates large volumes of interventions by Building Control Bodies are taking place that help those responsible for building work achieve compliance and avoid unnecessary and costly prosecutions. However to reflect the uncertainty, we have done an indicative sensitivity test which analyses the effects of 90% compliance on costs and benefits and the impact of 90% compliance on benefits only. In all scenarions the NPV remains positive.

Direct costs and benefits to business

2.57 Given that the energy savings resulting from tightening of standards in the Building Regulations will not accrue to businesses, the monetary savings are not considered for the purposes of the One In Two Out policy. Similarly, the costs of maintenance and replacement of measures introduced as a result of new Building Regulations will also fall on home owners rather than businesses. As such, for the purposes of the One In Two Out policy, Table 2.8 below presents the net cost to business based on the incremental capital costs for developers of building new homes to tighter standards.

2.58 The following example illustrates how the Equivalent Annual Net Cost to Business is worked out in the impact assessment. To estimate the cost of say a detached house built in 2020, firstly the costs of the extra build required to meet the regulatory standard for that build type is estimated in 2011 prices, taking into account learning effects for the different elements appropriate in 2020 and excluding any replacement or maintenance costs. Costings analysis by the consultant, AECOM, concluded that meeting this would cost £1,101 in 2011 prices in 2020 as a result of a tighter standard for walls, roof, ceiling and thermal bridging at construction joints compared with a 2010 Part L detached house.

2.59 It is assumed that 38,000 detached homes (Table 2.2) are built in 2020 and that 28.5% of these would be built to a higher standard in the counterfactual (Table 2.4 - rounded), which leaves 27,200 detached homes assumed to have an extra over cost due to the policy. The

[32] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/31616/11-671-one-in-one-out-methodology.pdf - paragraph 57
[33] http://www.buildingcontrolalliance.org/wp-content/uploads/2012/03/BCA-Compliance-Actions-Research-from-LABC-ACAI-14-March-2012.pdf]

undiscounted extra over cost of all detached homes in 2020 will therefore be £29.9m. This is then aggregated for each year of the 10 year period (2014-2023), discounted at 3.5% back to the PV Year 2012, to give a net present value cost of £197m for detached homes. This process is then repeated for all dwelling types to give a total present value cost of £289m. This is reported in table 2.8 below. An estimated contribution from the transition cost is then added to the net present value cost to business. The equivalent annual net cost to business (EANCB) of £34m is then reported over the 10 year policy period of the costs to home builders.

Table 2.8: Direct Costs and Benefits to Business – New Homes (NPV £m)

Present value net benefit/(cost) to business	(289.5)
Transition Cost	(2.3)
Present value net benefit/(cost) including transition cost	(291.8)
Equivalent annual net benefit/(cost) to business	(33.9)
Equivalent annual net benefit/(cost) to business in 2009 prices	**(32.1)**

Source: Europe Economics

Existing Homes Performance Standards

2.60 The final policy no longer includes any proposals for the strengthening of energy effciency standards for the extension to or for replacement windows to existing homes so this is not analysed in this Impact Assessment (see paragraphs 1.24 to 1.27).

Consequential Improvements on Existing Homes

2.61 The final policy no longer includes any requirement for consequential improvements on existing buildings so is not analysed in this Impact Assessment (see paragraph 1.32).

New Non-Domestic Buildings

Policy developments since consultation

2.62 Two options were offered for consultation: 11 per cent and 20 per cent aggregate uplift. There was a good level of support for raising standards in Part L 2013. Many respondents favoured the more ambitious 20 per cent uplift. Others, including some key commercial players, preferred the 11 per cent option, feeling that 20 per cent was too ambitious in the current economic climate. Some pointed out that speculative developers cannot recoup higher build costs in higher rent or sale values.

2.63 The responses to the question on whether the notional building specifications were reasonable received a mixed response, with a lot of detailed technical comments and recommendations for changes to particular elements of the specifications.

2.64 Post consultation work has further explored the 11 per cent and 20 per cent options. A key activity post-consultation has been further discussions with those sector groups that had raised concerns with the notional building specifications. Whilst the notional buildings are a performance standard only and not prescriptive, feedback is that many in the industry look to design to these standards and thus the specifications should be pragmatic. In particular, the following is noted:

- The lighting performance standard in the notional building has been improved from 55 to 60 luminaire lumens per circuit watt (LLPCW), rather than an improvement to 65. The intention is to continue to raise the standard in future revisions of Part L as developments in lighting technology allow cost effective uplifts.

- A small warehouse unit was also included in the build mix, since it became clear during the consultation that these buildings faced particular difficulties in achieving higher fabric standards. The toplit notional building which represents warehouses has been modified based on evidence from the industry such that airtightness levels depend on the size of the warehouse (with the standard eased for smaller warehouses and raised for larger warehouses).

2.65 Furthermore, we have revised the solar PV costs based on the latest DECC data, published in May 2012. These are about 15 per cent to 30 per cent lower than were assumed in the consultation, depending on installation size. As a result of the reduction in solar PV costs, and in the light of consultation responses and our own analysis indicating that the fabric specifications in the consultation notional building are being pushed too hard, our approach in the post-consultation work has been to ease the fabric specifications towards 2010 levels for both the policy options under consideration and increase the amount of PV for the 20 per cent option. As a result the 20 per cent option still achieves a 20 per cent carbon saving due to the increased amount of PV. However, the previous 11 per cent option now produces a slightly lower carbon saving (9 per cent) which reflects less fabric and services improvement overall.

Final policy for new non-domestic buildings

2.66 Although the 20 per cent option was preferred by a number of consultation respondents, others including some key commercial respondents were concerned that this was too big a shift, on top of the substantial 2010 changes, in the current economic situation.

2.67 Also the more detailed cost effectiveness analysis carried out for this final IA shows that the 20% improvement is no longer cost effective, even taking into account the value of carbon in the supplementary Green Book Guidance (see Table 2.12 below). The 9 per cent improvement is the maximum uplift that should be achievable with only fabric and fixed services improvements for most building types and so is more consistent with the approach above for new homes. The fabric and fixed services improvements will vary across building types as per Table 2.11 below.

2.68 It is important to note as well that the cost of any change will come upfront, on construction, though the benefits will accrue to occupiers and society only over a much longer period of time. For these reasons 9% has been chosen for the Part L 2013 step.

Modelling assumptions

2.69 We adopted a three stage approach to assess a change in emissions standards for new non-domestic buildings in Part L 2013. A summary of this approach is provided below, with the full description given in Appendix 1: Additional Building Costs, Specifications and Energy Use.

2.70 At the first stage, the scope for reducing emissions in a range of new buildings using energy efficiency measures and low and zero carbon technologies was assessed. Cost curves for

carbon reduction were compiled using capital cost data from published sources and industry based estimates. The cost curves prioritise carbon saving measures by lowest capital cost to achieve a unit saving in carbon reflecting the approach that a developer would take in meeting a given carbon reduction target. These cost curves can be found in Appendix 1: Additional Building Costs, Specifications and Energy Use.

2.71 The second stage involved assessment of the curves to develop an appropriate concurrent notional building (or buildings) to achieve a given aggregate target. The national calculation methodology that underpins the Building Regulations is reliant on the principle of comparing the actual design of the building with a notional building of the same shape and size based on a recipe of fabric and services standards. The carbon emissions from this notional building become the target (the Target Emission Rate) by which the carbon emissions from the actual building (the Building Emissions Rate) are compared.

2.72 The terminal unit efficiency of the notional building at consultation was 0.3 w/l/s for the 20 per cent option (all building types) and 0.4 w/l/s for the 11 per cent option (all building types). Currently, in 2010, it is 0.5 w/l/s in the notional buildings. In the post-consultation analysis, we unified the fabric and services specifications for all options and adopted 0.3 w/l/s for the terminal unit efficiency. There were some objections in the consultation response to improving the standard to 0.3 w/l/s. However, we have chosen to include this value in the notional building as it is currently achievable and the feedback from consultation is that the Energy-Related Products Directive is pushing the market towards EC/DC fancoil units and these generally achieve 0.3 w/l/s or better. Furthermore, this is a performance standard which provides flexibility in the design solution.

2.73 Table 6.6 and Table 6.7 in Appendix 1 summarise the fabric and building service specifications modelled for the new non-domestic concurrent notional buildings.

2.74 The assumed build rates for each of the building types are outlined in the table below. Less information is available for build rates associated with new non-domestic buildings than for new homes[34]. These build rates are based on figures provided by the Building Research Establishment reflecting a long term trend estimate. The build rates supplied by BRE are estimates based on pre-recession trend. It is assumed that the economy will return to those

[34] Stock trends can be analysed based on Commercial and Industrial floorspace statistics at https://www.gov.uk/government/statistical-data-sets/live-tables-on-commercial-and-industrial-floorspace-and-rateable-value-statistics. However, to estimate new build rates from this data it is necessary to estimate demolition rates about which little data is available. Data on new orders in the construction industry suggests that an increase in build rates for new homes since 2009 is not yet matched for commercial buildings, although this could increase to pre-2009 levels over the coming period. This data can be found at http://www.ons.gov.uk/ons/rel/construction/new-orders-in-the-construction-industry/q1-2013/index.html. Table 2.

trend rates. So it is assumed to apply for the 10 year policy period covered in the cost benefit analysis. The estimated further breakdown for warehouses is based on DCLG commercial and industrial property statistics.

Table 2.9: Build Rate Assumptions – New Non-Domestic Buildings

	Build rate in 2014 (m^2)	Build mix
Distribution warehouse	1,344,459	18%
Deep plan office AC	1,949,810	27%
Retail warehouse	1,188,127	16%
Shallow plan office AC	1,299,872	18%
Hotel	256,621	3%
School	783,757	11%
Small warehouse unit	594,063	8%

Source: BRE, AECOM and DCLG statistics on commercial and industrial property (P402)

2.75 There is no clear evidence from DCLG commercial and industrial property statistics to suggest that the non domestic build mix will change significantly. A growing economy will continue to require a variety of building types. Unless there is a major structural shift the existing build mix is assumed to be the default position.

2.76 Assumptions on the proportion of buildings which will be built to the new Part L 2013 standards in each year are shown below. The phase-in is assumed to take longer for new non-domestic buildings than for new homes, given the longer development lead times.

Table 2.10: Phase-In Assumptions – New Non-Domestic Buildings

	2014	2015	2016	2017	2018 and thereafter
Phase in (% new non-domestic buildings captured by Part L 2013)	0%	40%	60%	90%	100%

Source: DCLG

2.77 The modelling also takes account of the number of non-domestic buildings that would have been built to the new standards (or higher) in the absence of any regulatory change, due to overlaps with other initiatives such as BREEAM. In our counterfactual, we assume that 17 per cent of new non-domestic buildings would have been built to at least Part L 2013 standards in the absence of the introduction of Part L 2013. This value was estimated by AECOM based on BREEAM data provided by BRE on how developers currently perform against Part L 2006 (as relatively few buildings have been constructed to Part L 2010). BRE provided the number of buildings which are currently BREEAM certified per year and the number of energy performance credits they achieve. This allowed us to estimate the relative proportion of the build mix that were BREEAM certified and, of these, the proportion that achieved Part L 2010 standards or better. There is clearly an assumption that the same proportion of buildings constructed to Part L 2010 regulations would achieve Part L 2013 or better, but this provides an indicative estimate. This assessment does not account for the fact that some buildings would be constructed to better than Part L 2010 regulations but not to Part L 2013 in the absence of regulatory change – the costs and benefits of introducing Part L 2013 in such case would be less than if they only just complied with the Part L 2010 regulations.

2.78 The aggregate reduction in carbon emissions from 2010 for a range of notional buildings, given the assumed build mix, was calculated.

2.79 Once the actual design (size, shape, etc.) of a particular building is added, each notional building specification then produces a target CO_2 reduction for the actual building to meet. The values for the range of modelled building types are shown in Appendix 2: Sensitivity Analysis.

2.80 At consultation four overall target improvements over 2010 Building Regulations were chosen to test a range of options; 8 per cent, 11 per cent, 14 per cent and 20 per cent. For this implementation stage IA two overall targets have been tested, 9 per cent and 20 per cent. As with the consultation stage IA an area of PV has been added to the roof of the notional building as a proxy, defined as a percentage of floor area to reach the 20 per cent target. The same percentage of floor area is applied to each building to reflect how a notional building might be defined in practice (i.e. package chosen + X per cent floor area, where X per cent is the same in all buildings).

2.81 The choice of 9 per cent and 20 per cent reflected a desire to examine the effect of low and zero carbon technologies in the notional building (particularly at the higher targets where the ability of fabric and services measures to save carbon is becoming exhausted) so that this could be compared to a target based only on fabric and services improvements.

2.82 Because applying one fabric/services package to all building types can result in very different outcomes for different building types, mixes of notional buildings were examined to see if differentiating between building types resulted in a more cost effective solution.

2.83 As a result of this analysis and consultation feedback it is not proposed to push fabric beyond 2010 levels - the exceptions being air-tightness and windows U-values - and as a consequence there is little rationale in differentiating between heated only and heated and cooled buildings in terms of notional buildings as had been proposed during consultation

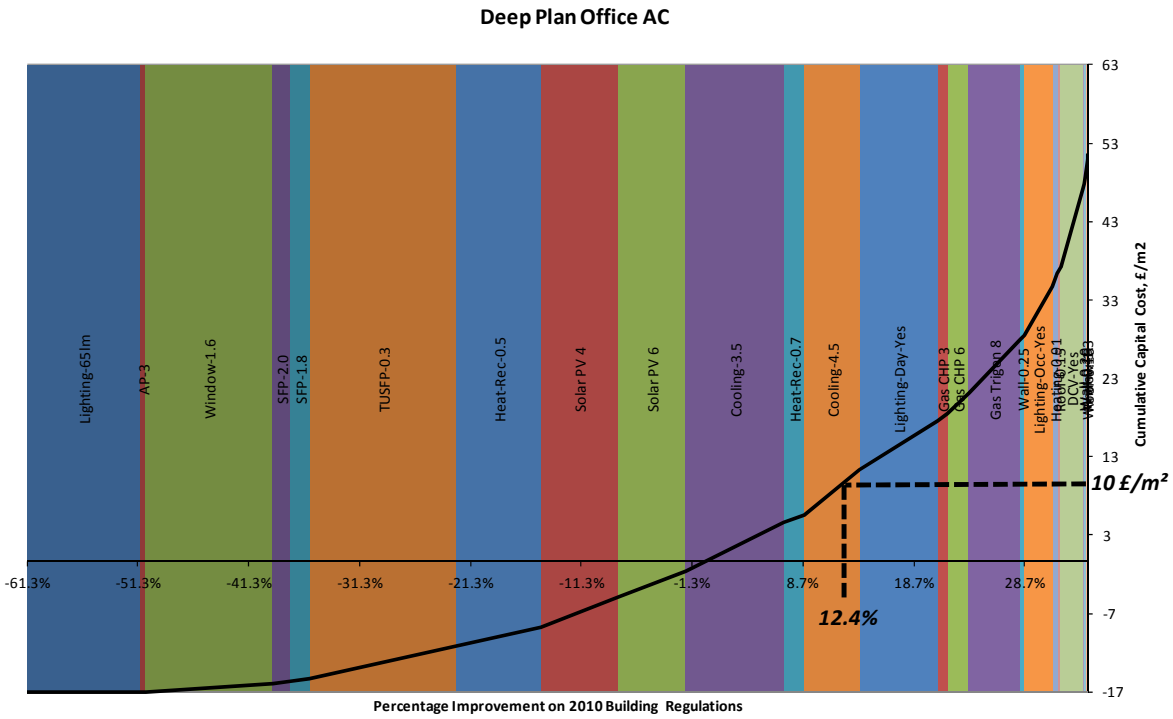
2.84 The resultant target reductions for each of the notional buildings are given in Table 2.11 below.

Table 2.11: Target Reductions for Notional Buildings

Target aggregate reduction	9%	20%
Distribution warehouse	4%	18%
Deep plan office AC	12%	24%
Retail warehouse	8%	16%
Shallow plan office AC	13%	26%
Hotel	12%	15%
School	9%	23%
Small warehouse unit	3%	14%
PV required on notional building	None	Panel area equivalent to 5.4% of floor area applied to roof of each building

Source: AECOM

2.85 The target percentage reductions for each building type were then plotted on the cost curves to establish how an actual building would respond to the target. This identifies the least (capital) cost route to achieving a given target. Figure 2.1 shows the cost curve for the deep plan office. The notional building for a 9 per cent target is A2. This produces a target reduction of 12.4 per cent in the deep plan office. The cumulative cost of achieving this target (£/m^2) is shown plotted on the curve.



2.86 The 20 per cent option requires solar PV to be incorporated in the notional building. However, it is important to note that whilst the notional building featured PV to achieve a 20 per cent aggregate reduction not all buildings would necessarily choose PV to achieve their given target depending on the relative cost effectiveness of PV against other demand-side measures. Conversely a building meeting the 9% standard may include elements of solar pv in preference to some of the energy efficiency measures in the notional building, as is the case in the cost curve above.

2.87 At the final third stage, the capital costs of achieving these reductions and the energy saved were used as inputs to a cost benefit model. This provided aggregate estimates of social costs and benefits across all new non-domestic buildings.

2.88 We did not model the potential change in consumers' behaviour triggered by the improved energy performance of their new buildings. Hence, we assumed no comfort taking. This is also in line with the Green Deal IA approach to savings estimates for non-domestic buildings, which were based only on the physical performance of the building[35].

Estimated impacts

2.89 Table 2.12 sets out the results of the modelling for a 9 per cent and 20 per cent aggregate reduction. At the level of financial costs (energy savings less incremental costs), the model estimates that there are net costs for both options, although these are negligible for the 9 per cent option. When carbon and air quality savings are taken into account, the total net value to society turns positive and is estimated to be £74 million NPV for the 9 per cent option. On the other hand, the 20 per cent option still has a negative NPV of £67 million.

Table 2.12: Present Values of Costs and Benefits: Part L 2013 Policy – New Non-Domestic Buildings (NPV £m)

	9%	20%
Energy savings (£m)	604	1,302
Incremental costs (£m)	(604)	(1,485)
Net financial benefit/(cost) (£m)	**(0)**	**(183)**
Carbon savings - non-traded (£m)	3	(40)
Carbon savings - traded (£m)	55	122
Total carbon savings (£m)	59	82
Air quality savings (£m)	16	34
Net benefit/cost (£m)	**74**	**(67)**
Amount of gas saved (GWh)	*159*	*(4,508)*
Amount of electricity saved (GWh)	*17,582*	*39,277*
Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	*0.03*	*(0.83)*
Amount of CO_2 saved - traded ($MtCO_2(e)$)	*1.64*	*3.62*
Cost effectiveness – non-traded (£/tCO_2)	*n/a*	*n/a*
Cost effectiveness – traded (£/tCO_2)	*(11)*	*52*

Source: Europe Economics

2.90 Key reasons for the differences between these NPV results and those in the consultation IA include:

- Addition of a counterfactual where 17 per cent of new non-domestic buildings would have already been built to high enough standards – reducing the NPV incremental costs and energy savings by 20 per cent
- Inclusion of air quality savings – leaving to an increase in total benefit of £16 million NPV

[35] DECC (2012) "Final stage impact assessment for the Green Deal and Energy Company Obligation" IA No: DECC0072

- Rerunning of cost curves with 9 per cent CO_2 saving – reducing both energy savings and incremental costs. Solar PV costs has also been updated to align with the DECC data.

2.91 The 9 per cent policy would lead to a volume of around 0.3 million tonnes of CO_2 being saved during the 4th Carbon Budget (2023-2027).

Table 2.13: Carbon Savings Per Annum Over the 4th Carbon Budget – New Non-Domestic Buildings (tonnes CO_2)

	2023	2024	2025	2026	2027
Carbon savings - non-traded	(11,085)	(12,488)	(12,488)	(12,488)	(12,488)
Carbon savings - traded	73,643	77,334	71,315	64,882	58,005
Total carbon savings	62,558	64,846	58,827	52,394	45,517

Source: Europe Economics

Sensitivity tests

2.92 To assess the potential uncertainty in the IA, sensitivity tests have been carried out by changing the assumption in build rate and energy prices and carbon values using the DECC IAG Group ranges and build rate.

2.93 With the higher energy prices and carbon values the net benefits of the 9 per cent option shown in Table 2.12 increase to £154 million NPV. With lower energy prices and carbon values the 9 per cent policy shows that the energy and carbon saving would fall by a smaller amount to incremental costs resulting in a net cost of £6 million NPV. The full cost benefit tables for these sensitivity tests are in Appendix 2: Sensitivity Analysis.

2.94 Similar to the effect of build rate of domestic buildings discussed above, a change in build rate acts as a scaling factor to the net benefit/cost to society. Altering the build rate of new non-domestic buildings will have a proportionate change to the net present value of the proposed policy.

Direct costs and benefits to business

2.95 In line with Impact Assessment guidance, the energy savings in the social cost-benefit analysis presented above is valued using the variable price of electricity and gas (to avoid the inclusion of transfer payments in the impact assessment). For the purposes of the OITO policy, we have valued the energy savings at the retail price for the 9 per cent option to show the benefit/cost to business from the changes to Part L.

2.96 In addition, for the new non-domestic OITO analysis, we have removed from the build mix an estimate for the proportion of buildings that are publically owned. These percentages are given in Table 2.14 below.

Table 2.14: Proportion of New Non-Domestic Buildings that are Publically Owned

	Percentage Publically Owned
Distribution warehouse	0%
Deep plan office AC	4.5%
Retail warehouse	0%
Shallow plan office AC	4.5%
Hotel	0%
School	90.9%
Small warehouse unit	0%

Source: Cabinet Office Government's Property and Land asset database, DCLG Commercial and industrial property statistics (P404) and DfE: National Pupil projects: Future trends in pupil numbers, July 2012 Update (proportion of secondary school pupils at non-state funded schools)

2.97 The direct costs and benefits to businesses from the new non-domestic building policy are set out in Table 2.15. As the direct purpose of this policy change is 'conservation of fuel and power', the energy savings captured by the regulation are a direct benefit to any business occupying a building constructed according to this standard. The fabric standards for walls, floors and other elements would be locked in to the construction of the building. It would not be possible to alter these without a major refurbishment. The fixed building services would function in terms of energy use according to their design specification unless the occupant chose to replace them. Clearly the type of and use of appliances in the buildings would be dependent on the occupying business but these are excluded from the regulations. At the sme time, the additional capital, maintenance and replacement costs of the regulation will also fall on businesses.

2.98 The impact has been calculated by estimating the extra over cost of each element which needs tightening for each building type. For example, for the Deep Plan office the additional standards identified in the cost curve above, specifically chillers and heat recovery technology, have been costed per m^2 of build by AECOM and a learning rate applied as appropriate for each year of build. The lifetime of any element has been estimated and a discounted replacement cost included over the full 60 year period. This ensures consistency between considering elements with a short lifetime alongside of other elements, such as fabric U values which could apply over the full 60 year period. Further details are given in Appendix 1. This estimate is then aggregated up using the assumed build rate for each of the 10 years of build and discounted to obtain the present value cost. To calculate the impact on business we have excluded the estimate for public sector buildings included above.

2.99 The energy savings have then been estimated over the 60 year period using commercial retail energy prices in the Supplementary Green Book guidance.

2.100 Unlike for homes, maintenance and replacement costs have been included in the cost for business as it is assumed that the occupant of the building will be a business.

2.101 Where a building has been constructed specifically for a specified client who will both pay for the construction costs and occupy the building then the impact of both the extra over costs and the energy saving benefits will fall on the same business. However, there may be a distributional effect where a building has been constructed speculatively by one business whilst a different business benefits from the energy savings and where the anticipated benefit stream from the energy savings have not been fully factored into the sale price or rent. Given the purpose of the policy is to save energy then this is clearly still a direct benefit to business overall. Table 2.15 shows that overall there is a financial benefit to business of £245 million NPV from the improvement in energy targets.

Table 2.15: Direct Costs and Benefits to Business – New Non-Domestic Buildings (NPV £m)

Energy saving at retail price	792.5
Incremental costs	(547.9)
Present value net benefit/(cost) to business	244.9
Transition Cost	(2.0)
Present value benefit including transition cost	242.9
Equivalent annual net benefit/(cost) to business	28.2
Equivalent annual net benefit/(cost) to business in 2009 prices	**26.7**

Source: Europe Economics

Existing Non-Domestic Buildings

Policy developments since consultation

2.102 The consultation proposed the following main changes:

- Introduction of a separate set of strengthened standards for extensions to non-domestic buildings that are similar in nature to homes (e.g. care homes).

- Various changes to the Non-Domestic Building Services Compliance Guide standards – see below.

2.103 It has been decided not to proceed with a strengthening of standards for extensions or for replacement windows to existing homes because of the extra burden on those trying to improve their homes and inconsistency with proposed planning permission reforms but also on the grounds of poor cost effectiveness.

2.104 To help maintain consistency of construction it has also been decided not to proceed with the introduction of strengthened standards for the extension of or replacement windows to non-domestic buildings that are domestic in character.

2.105 There were a number of comments raised on the proposed revision to the Non-Domestic Building Services Compliance Guide (NDBSCG). A key new component of the work post-

consultation has been to develop a new cost benefit analysis model to assess the changes to the Compliance Guide. The three changes which are most relevant involve the increase in minimum cooling efficiency, the increase in initial luminaire efficacy and the increase in the minimum fan coil unit specific fan power.

2.106 The costs and benefits of these changes have been evaluated in this IA. The methodology used in the calculations is discussed in Appendix 1: Additional Building Costs, Specifications and Energy Use.

Final policy for existing non-domestic buildings

2.107 The final policy no longer includes any strengthening of standards for the extension of or replacement windows to non-domestic buildings that are domestic in character so this is not analysed in this Impact Assessment.

2.108 Increase in building services standards for FCUs, chillers and lighting:

- Minimum cooling efficiency from 2.5 to 2.7
- Initial luminaire efficacy from 55 to 60 lamp lumens per circuit watt
- Minimum fan coil unit (FCU) specific fan power from 0.6 to 0.5 W/l/s.

Modelling assumptions

2.109 We estimate the costs and benefits of the following three types of building services: FCUs, chiller and lighting. Both FCUs and chillers are assumed to have a lifetime of 15 years while Lighting is assumed to have 20 years. In line with other parts of the model, the life of building is assumed to be 60 years and this would imply that the elements would need different number of replacement during the whole lifetime of the building. In addition, various assumptions such as the building floor area and energy requirement per floor area are made to reflect the characteristics of each building type and fabric element.

2.110 This building services analysis was based on five building types: offices (separated into naturally ventilated and air-conditioned); warehouses; retail (separated into general retail and retail warehouses); education (separated into primary and secondary); and hotels. These five types comprise 80 per cent of the existing buildings in England. Aggregation up to the national scale was based on the existing buildings build mix used by DCLG in the 2007 EPBD Impact Assessment. The build mix data was adjusted as to disaggregate certain individual building types of interest. The number of buildings which have their building service replaced each year was determined by taking the existing building stock and by dividing by the asset lives associated with each of the three building services of interest.

2.111 Davis Langdon provided the incremental costs of going from the 2010 to 2013 NDBSCG for the different building types. The additional capital costs (£/m²) derived for the updates to the NDBSCG are given in Appendix 1: Additional Building Costs, Specifications and Energy Use.

2.112 From industry feedback received, we estimate that on average over the 10 year policy period; only 10 to 40 per cent of FCUs specified for existing building would not achieve Part L 2013 standards if the current standard for FCUs was not changed. Similarly, the ranges for comfort

cooling and lighting are 5 – 15 per cent and 10 to 30 per cent respectively. The counterfactual has been incorporated into our analysis and the ranges of counterfactual for each building service type are summarised in the table below:

Table 2.16: Percentage of replacement services that will be affected by the proposed standards

	Low Counterfactual	Central Counterfactual	High Counterfactual
FCUs	10%	25%	40%
Comfort Cooling	5%	10%	15%
Lighting	10%	20%	30%

Source: Aecom

2.113 In line with our approach for new non-domestic buildings, we do not take account of comfort taking in our model for existing non-domestic building. This is again consistent with the methodology used in the Green Deal IA[36].

2.114 There is no phase in assumed in this part of the model as services replacements are expected to meet the new Part L 2013 standards from the point at which the policy is introduced.

Estimated impacts

2.115 The results of this analysis are shown in Table 2.17. The policy gives net financial savings of £70 million NPV, with energy savings greater than installation costs. The total net savings are increased by £6 million NPV when carbon reductions and air quality savings are taken into account. The total net benefit to society in net present value is £76 million.

Table 2.17: Present Values of Costs and Benefits: Part L 2013 Policy – Replacement Services to Non-Domestic Buildings (NPV £m)

	Replacement Services
Energy savings (£m)	269
Incremental costs (£m)	(199)
Net financial benefit/(cost) (£m)	**70**
Carbon savings - non-traded (£m)	(20)
Carbon savings - traded (£m)	19
Total carbon savings (£m)	(1)
Air quality savings (£m)	6
Net benefit/(cost) (£m)	**76**
Amount of gas saved (GWh)	*(1,898)*
Amount of electricity saved (GWh)	*7,614*

[36] DECC (2012) "Final stage impact assessment for the Green Deal and Energy Company Obligation" IA No: DECC0072

Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	*(0.39)*
Amount of CO_2 saved - traded ($MtCO_2(e)$)	*0.59*
Cost effectiveness – non-traded (£/tCO_2)	*n/a*
Cost effectiveness – traded (£/tCO_2)	*(95)*

Source: Europe Economics

2.116 The Key reason for the differences between these NPV results and those in the consultation IA include:

- Inclusion of the impact of standards for replacement services into the analysis which were not monetised in the consultation IA – estimated to be £76 million NPV
- Exclusion of extensions in non-domestic buildings

2.117 The policy would lead to a volume of around 0.1 million tonnes of CO2 being saved during the 4th Carbon Budget (2023-2027).

Table 2.18: Carbon Savings Per Annum Over the 4th Carbon Budget – Existing Non-Domestic Buildings (tonnes CO_2)

	2023	2024	2025	2026	2027
Carbon savings - non-traded	(5,847)	(6,432)	(6,432)	(6,432)	(6,432)
Carbon savings - traded	30,946	31,731	29,261	26,621	23,800
Total carbon savings	25,099	25,299	22,829	20,189	17,368

Source: Europe Economics

Sensitivity tests

2.118 Sensitivity analysis is run to reflect uncertainty in the assumptions used in the IA. The results are sensitive to changes in assumption about energy prices or the value of carbon using the DECC IAG Group ranges. With the higher energy prices and carbon values the net benefits shown in Table 2.17 increase to £92 million NPV. Changing the assumption to lower energy prices and carbon values reduces the net benefits to £59 million.

2.119 In addition, we also tested the assumption on the lifetimes of different elements of service using a 20 per cent range of variation. By extending the lifetimes of all elements, the net benefit dropped to £63 million NPV. However, if the elements need to be replaced in a shorter period, higher energy saving would be generated, leading to greater net benefit (£95 million NPV) to society.

2.120 For the counterfactuals — the percentage of systems that would be not affected by the proposed standards, we have constructed sensitivity tests on the ranges as described above. Using low and high estimates on the percentages of counterfactual, the net benefits (NPV) ranges from £42 million to £109 million.

2.121 The breakdown of the cost and benefit results for these sensitivity tests are in Appendix 2: Sensitivity Analysis.

2.122 An additional sensitivity has been carried out assuming that the remaining life for an existing non-domestic building replacing its services is 30 years rather than 60 years. This gives a

present value energy benefit to business of £271m and present value cost of £136m to deliver a net benefit to business of £135m (down from £190m). The traded carbon saved would be 0.48Mt CO_2 [compared with 0.58MtCO_2 above] over the lifetime of appraisal, although with an additional 0.18Mt CO_2 of non-traded carbon emitted [compared with 0.36Mt CO_2 above] due to more efficient lighting emitting less heat. The equivalent annual net benefit to business would fall from £22m to £16m.

Direct costs and benefits to business

2.123 As for new non-domestic buildings, we have valued the energy savings from changes to standards for existing non-domestic buildings at the retail price for One In Two Out purposes. This has been calculated by estimating the extra over capital cost for each service element whose standard is being tightened and assuming a replacement over the same 60 year period as for new buildings. The energy benefit is then estimated over the same period at the retail commercial value in the Supplementary Guidance to the Green Book. In addition, for replacement services we removed the following percentages of publically owned buildings from the build mix.

Table 2.19: Proportion of New Non-Domestic Buildings that are Publically Owned

	Percentage Publically Owned
Naturally ventilated office	4.5%
Air conditioned office	4.5%
Hotel	0%
Distribution warehouse	0%
Retail	0%
School	92.9%

Source: Cabinet Office Government's Property and Land asset database, DCLG Commercial and industrial property statistics (P404) and DfE: National Pupil projects: Future trends in pupil numbers, July 2012 Update (proportion of all pupils at non-state funded schools)

2.124 The results are shown in Table 2.20 below. Businesses are estimated to receive a financial benefit of £190 million NPV from the existing non-domestic buildings policy.

Table 2.19: Direct Costs and Benefits to Business – Existing Non-Domestic Buildings (NPV £m)

	Replacement Services
Energy saving at retail price	380.9
Incremental costs	(190.6)
Present value net benefit/(cost) to business	190.3
Transition Cost	(0.7)
Present value benefit including transition cost	189.6
Equivalent annual net benefit/(cost) to business	22.0
Equivalent annual net benefit/(cost) to business in 2009 prices	**20.9**

Source: Europe Economics

Consequential Improvements on Existing Non-Domestic Buildings

2.125 The final policy no longer includes any requirement for additional consequential improvements on existing buildings below 1,000 m^2 at this stage so is not analysed in this Impact Assessment (see paragraph 1.32).

Distribution of Costs and Benefits

2.126 The costs and benefits of the various policy options for new buildings are borne by or benefit different groups. Building costs are borne in the first instance by developers although in the longer term these may be passed on to owners or tenants or back to landowners in lower land values. The aggregate approach also means that the level of cost will vary between building types. Maintenance and replacement costs over the life of the building will be largely be borne by the occupier who will also benefit from reduced energy costs as a result of increased energy efficiency. These costs and benefits will also differ by building type.

2.127 Energy and carbon saving benefits are valued using Supplementary Guidance to the Green Book[37]. This values the social benefit at the 'variable' price in the tables, which excludes fixed costs. In practice, the occupant will save energy at the higher retail price. However, this will be partly offset by losses to HM Treasury, which will lose exchequer revenues from VAT, and energy companies which will ultimately pass on the fixed costs to existing consumers of energy but experience lower profits.

2.128 For example, for new non-domestic buildings the present value of the energy saving at the variable price in Table 2.12: Present Values of Costs and Benefits: Part L 2013 Policy – New Non-Domestic Buildings (NPV £m) is £604m while the retail saving in Table 2.15 is £792m. The £188m difference reflects direct benefits to the business occupants of new non-domestic buildings but also offsets by costs to the exchequer and energy supply companies, hence, it will not be an overall benefit to society.

2.129 The incremental capital costs per m^2 for new domestic and non-domestic buildings by building type (compared with a building meeting the Part L 2010 standard) are shown in Table 2.21 and Table 2.22.

Table 2.20: New Homes – Incremental Capital Cost Relative to 2010 Compliant Building (%)

Detached	1.2%
Semi-detached	0.3%
Terraced	0.1%
Flat – gas heated	0.1%
Flat – electric heated*	1.1%

[37] "Valuation of energy use and greenhouse gas emissions for appraisal and evaluation, October 2012" HM Treasury and DECC

Source: Europe Economics

2.130 For non-domestic buildings, retail warehouses and deep plan offices show the highest incremental costs per m^2 (based on the building types which have been modelled). Energy savings by building type reflect the different fabric and services combinations which have been selected as representing the least cost way of achieving each energy reduction target. It is notable that for the hotel there is a significant increase in gas costs reflecting the use of gas combined heat and power to provide the heat requirements for that type of building. However, this is offset by greater savings on electricity costs.

Table 2.21: New Non-Domestic Buildings – Incremental Capital Cost Relative to 2010 Compliant Building (%)

Distribution warehouse	0.5%
Deep plan office AC	0.6%
Retail warehouse	0.9%
Shallow plan office AC	0.5%
Hotel	0.2%
School	0.3%
Small warehouse unit	1.2%

Source: Europe Economics

2.131 Energy savings have also been estimated using the retail price of gas and electricity. These are shown in Table 2.23 and Table 2.24.

Table 2.22: New Homes – Incremental Annual Energy Savings Relative to 2010 Compliant Building (£/building/year)

	Gas	Electricity
Detached	52	0
Semi-detached	19	0
Terraced	4	0
Flat – gas heated	3	0
Flat – electric heated	0	58

Source: Europe Economics. Energy at retail prices

Table 2.23: New Non-Domestic Buildings – Incremental Annual Energy Savings Relative to 2010 Compliant Building (£/m^2/year)

	9%		20%	
	Gas	Electricity	Gas	Electricity
Distribution warehouse	0.05	0.15	0.05	0.88
Deep plan office AC	0.04	0.79	(0.32)	1.84
Retail warehouse	0.00	0.72	0.00	1.43
Shallow plan office AC	0.00	0.79	0.00	1.59
Hotel	(1.81)	3.12	(1.81)	3.82
School	0.00	0.27	0.00	0.70
Small warehouse unit	0.00	0.16	0.00	0.76

Source: Europe Economics. Energy at retail prices

Training strategy and transition costs

2.132 Respondents to the consultation noted that there would be transition costs incurred by businesses to familiarise their employees with the new technical requirements. Hence, we focus on estimating the training costs due to updates to Part L in the section below. In doing so

we note that the overarching Part L methodology has not changed (e.g. businesses will continue to use SAP to assess Part L compliance for new homes). Furthermore, the higher standards that will come into force are progressive and moderate i.e. should be able to be met in the main through straight forward amendments to current practices rather than radical changes in the way new buildings are constructed or existing building works undertaken.

2.133 DCLG has developed a strategy for dissemination and training guidance to provide the necessary support to market participants and training providers to gain the required understanding and knowledge to achieve the regulated standards for energy and carbon performance. The general responses given in the consultation in relation to this strategy were positive and the importance of a well-designed training framework was recognised.

2.134 The proposed framework of education and training would promote several types of programmes with an objective to provide knowledge on different aspects of the policy. These include regulation specific training programmes tailored for changes from the previous Part L regulations and future aspirations, along with testing and evaluation skills development programmes to improve industry knowledge to carry out in-situ testing of buildings. Wider education and training programmes aim to enhance the understanding of low carbon building performance in all sectors of the industry.

2.135 Large firms and smaller firms providing professional services would likely achieve their training requirements through a combination of external training for a small number of staff and dissemination to remaining relevant staff members through in-house training sessions. Small builders would be more likely to find out the information from building control (e.g. through feedback on building application) and builders merchants.

2.136 In the main, the training is necessary for developers and associated professional services to design the buildings to the new Regulations and procure the appropriate building components, for the supply chain to be ready to meet this demand and for building control to assess the building applications and work. There will also need to be some training for those working on site. Their works will be little different to that in Part L 2010 as the improved energy efficiency is often incorporated into the product and the approach to installation is the same. There will be some learning for issues which more relate to the actual construction of the building, such as airtightness and thermal bridging, and these costs have been included in the main cost benefit analysis.

2.137 In the case of external training the cost to businesses would be the price paid to attend training courses as well as the opportunity cost of lost time spent training. External training courses run to support Part L and other parts of building regulations usually last a day and the average

market cost is around £170 per delegate[38]. We note that a number of training courses are put on by private companies free of charge for their clients or for free by trade associations, so not all external training will involve a direct cost; we estimate this may constitute around half of the total courses run. Assuming that the staff sent on external training courses are relatively senior, we estimate the indirect cost of external training at £380[39]. Approximately 50 of these external courses are likely to run, attended by 30 people each; implying 1,500 attend in total. This gives a total cost from external training of around £700,000[40].

2.138 We then assume that each attendee at an external training course disseminates the information acquired to five other employees via half day internal training sessions. These five employees are assumed to be less senior, so we estimate an hourly opportunity cost of half that for managers, at £25. Hence, the total cost of internal training sessions would come to around £1,070,000[41].

2.139 In addition to attending training courses, there is an additional time burden when putting the new learning into practice for the first times. The impact will vary from person to person depending on how the Part L changes affect their work. We assume that, on average, it will require an additional day of each trainee's time.[42] The indirect cost associated with the familiarisation process is estimated to be around £2,000,000[43]

2.140 For small builders, we assume that each small builder will likely have a building application rejected once due to the increased standards. Assuming it would take approximately an hour to update the proposals and taking an hourly opportunity cost of £13, this would imply a total cost of around £1.3 million across the 100,000[44] small builders.

2.141 We note that there will be an additional cost for software developers in implementing the changes to Part L 2013 new build standards. However, these will be relatively small and we have assumed at most 5 days for changes to the software. There are currently up to 25 versions of software approved to Part L 2010 and we note that SAP developers would need anyway to incorporate the SAP 2012 amendments.

[38] The scale of the fees changed by training providers varies depending on the scope and duration of the course. The average market fee for a day course on Part L building regulation found from a search of the websites of training providers was around £170 per delegate per day.

[39] Estimate for halfway between ASHE+30% and EC Harris data. ASHE gives the average hourly wage for managers in the construction industry as £22, giving ASHE+30% of £29. EC Harris lists average hourly wages for managers of between £67 and £79; we take a midpoint of £73. Halfway between ASHE+30% and the EC Harris data therefore comes to £51 per hour. Assuming a 7.5 hour day this gives an indirect cost of around £380.

[40] 1,500 x (£170 x 50% + £380)

[41] The indirect cost for less senior employees is equal to 1500 x 5 x (£25 x 4) and the indirect cost for senior employee to conduct the half day training is 1,500 x (£51 x 4). This gives a total estimation of around £1,056,000.

[42] We have separately allowed for time to develop new thermal bridge details and meet higher airtightness standards in the new-build cost-benefit analysis and the reduction of design and construction costs over time as those involved become more familiar with these practices.

[43] The indirect costs for senior employees are calculated as 1,500 x (£51 x 7.5) while the costs for those that are less senior are 1500 x 5 x (£25 x 7.5), this gives the total of £1,980,000

[44] Source: ONS construction statistics. Taken as the number of firms in the construction industry with only one employee (135,048). Some of these firms with only one employee will not be builders, since the statistic covers the construction industry as a whole, but conversely some

1.3

2.142 Hence, the total cost of transition from the increased standards would come to around £5 million. It is summarised in the table below.

Table 2.24: Transition cost to business (£m)

External training cost	0.70
Internal training cost	1.07
Total training cost	1.77
Familiarisation cost	2.0
Application cost on small builders	1.3
Total transition cost	**5.04**

2.143 The transition cost has been allocated to the different packages as follows. It would reasonably be expected that small builders are more involved in new homes than new non-domestic projects. The existing non-domestic changes mainly relate to replacement building services so it is assumed that this less affects smaller builders who may get involved in extensions (e.g. Victorian houses converted to B&Bs now requiring an extension) where the heating system may, for example, be extended but not changed.

2.144 If we assume that the smaller builder transition costs arises solely in the new dwellings sector, and the remaining transition costs is distributed across the three sectors according to their net cost, this results in the following allocation: 46% new homes, 40% new non-domestic, 14% existing non-domestic.

2.145 This results in new homes having a transition cost of £2.3m, new non-domestic buildings £2.0m and existing non-domestic buildings £0.7m. These have been allocated in Tables 2.8, 2.15 and 2.19 above respectively.

2.146 Sensitivity testing is carried out on a number of assumptions to reflect uncertainty. Using the range provided by ASHE + 30% and EC Harris data, the lowest and highest wage levels have been used to estimate the potential range of the total transition costs which is between £2.9 million and £7.8 million.

2.147 The likely number of small firms that would require additional training on their building application is also tested. By assumption that 75 per cent of all small firms would require training, this increases the transition cost to £5.8 million. In the other hand, it is possible that one of the employees of the small firms is builder and acquires the in-house knowledge to update the application in line with the new standards. If only 25 per cent of the firms will be subject to the application cost, the transition cost will reduce to £4.4 million.

of the firms with 2-3 employees (65,689) are also likely to receive training in this way. Hence, assuming that half of all small firms would require additional training to update the building application, on balance, a figure of 100,000 represents a good estimate.

3 PERFORMANCE, COMPLIANCE AND ENFORCEMENT ISSUES

3.1 As part of the January 2012 consultation proposals, the consultation stage impact assessment set out that *"The 2010 review of Part L recognised the potential for a gap between the energy and carbon performance of new buildings as modelled and their as-built performance"* and that *"Recent case evidence continues to add support to the existence of a performance gap but no clear quantification as to its extent"*. This means that even where new dwellings fully comply with the regulatory standards, the contribution to Government's legally binding carbon reduction targets may be less in practice, and consumers may not be getting from home builders the level of performance they are paying for.

3.2 For new homes, the consultation put forward proposals for a new formal quality assurance standard to further ensure compliance levels and regulating to encourage housebuilders to take part it its development and then use the standard. A preliminary estimate of the impact of this requirement was made, based on an indicative £100 per dwelling cost, in the Consultation Stage Impact Assesment. This would add a present value cost of £113m over 10 years of policy or an Equivalent annual cost of £13m to home builders.

3.3 Industry (home builders, manufacturers and building control bodies) responded by acknowledging the issue, but expressed a view that the regulatory compliance proposal in the consultation was not appropriate at this stage, not least because the problem is insufficiently evidenced. They also expressed concern that the costs to business of fixing an unknown problem could be considerably higher than estimated in the consultation IA and to legislate for a holistic quality assurance process in Part L 2013 would not be appropriate. To reflect compliance uncertainties we have carried out sensitivities to the costs and benefits and to the benefits only as outlined in paragraph 2.56 above with the results presented in Appendix 2.

3.4 On the wider energy performance issues over and above what builders need to do now to show compliance with the Building Regulations, there is very limited understanding and the consultation stage impact assessment was unable to offer clear quantification as to its extent. At consultation the Government welcomed the industry commitments to recommendations from the Zero Carbon Hub that from 2020 90% of all completed new homes should meet or better their design-stage performance. Based in part on the consultation responses, the Zero Carbon Hub has established a programme of work with industry to better understand the problem and potential solutions.

3.5 Whilst a small number of case studies[45] point towards a gap between the design and as built performance for new homes there is currently insufficient evidence as to how widespread the

[45] See for example: Low Carbon Housing: Lessons from Elm Tree Mews, Joseph Rowntree Foundation www.jrf.org.uk/publications

problem may be and there is some more recent, albeit very limited, research[46] of a reduced discrepancy when home builders have paid attention to detail.

3.6 Considerations of underperformance should bear in mind that lack of evidence applies equally to the counterfactual and the Part L 2013 proposal. In the absence of such clear evidence we assume no discrepancy between design and as built performance for both the Part L 2010 counterfactual and the Part L 2013 policy i.e. we have assumed 100% of design performance. Clearly we do not currently have the evidence to estimate underperformance but, as a hypothetical example, if the 2010 Part L house consumed 20% more energy in practice than the regulatory calculations assumed and the eventual Part L 2013 house in practice also consumed 20% more than calculated there is still a 6% reduction due to this Part L 2013 policy. In addition the reported result would underestimate the energy saved due to Part L 2013 by 20%. The reported result could impact as either an underestimate or overestimate of energy saved depending on the relative underperformance of the counterfactual versus the Part L 2013 proposal. For this reason we are of the view that our 100% assumption is reasonable in the absence of robust evidence at this time.

3.7 After giving careful consideration to these developments and the consultation responses it has been decided not to take forward the regulatory quality assurance proposal at this time and the associated costs included in the consultation stage impact assessment have consequently been removed from this final stage impact assessment. Instead the Government is supporting the Hub led industry programme of work to improve the evidence base and understanding of compliance and wider performance issues for new homes and to develop and progressively introduce potential solutions in the future. The Hub has published a progress report providing a summary of the collaborative work carried out to date and initial findings[47]. Not taking the regulatory requirements forward at this time reduces the overall regulatory burden in this analysis but does not rule out the possibility of regulation in the future for which a separate impact would be developed.

3.8 Government and industry are also working collaboratively through the Green Construction Board (GCB) including consideration of the potential energy performance gap between design intent and performance in use of non-domestic buildings[48] and for existing buildings work is being progressed to better understand the performance of energy efficiency improvements in support of the Green Deal and ECO in use factors.[49] This work is being progressed elsewhere in Government and not analysed in this Impact Assessment.

[46] GHA Monitoring Programme Technical Report 2009 -2011, Good Homes Alliance, 2011 http://www.goodhomes.org.uk/downloads/members/gha-monitoring-report-approved.pdf
[47] http://www.zerocarbonhub.org/news_details.aspx?article=40
[48] http://greenconstructionboard.org/index.php/working-groups/buildings?id=19
[49] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48407/5505-how-the-green-deal-will-reflect-the-insitu-perfor.pdf

3.9 Finally a number of changes are being introduced into the Building Control System to reduce burden and improve compliance including compulsory completion certificates, removal of statutory notifications and introduction of risk based ‘service plans’ and the approval of extended and new Competent Persons Schemes. [50] This work is covered in other Impact Assessments.

[50] https://www.gov.uk/government/consultations/building-regulations-the-building-control-system

4 WIDER IMPACTS

Economic and Financial Impacts

Competition

4.1 The main markets affected by changes to Part L of the building regulations are those for the development of new homes and non-domestic property and the replacement of specified building services to existing non domestic property. The supply chains for the production of materials used in the identified markets may also be affected.

4.2 The proposed higher standards mean that building contractors will have to comply with more stringent energy efficiency and building emissions targets. As a result of this, capital costs are expected to increase. Some of this increase in costs is expected to be passed on to landowners (through reduced land values) and to the eventual owners (through higher property prices). The increase in costs will affect all developers and the proportion of the additional costs that cannot be passed on is likely to be small when compared to the overall costs of construction. Hence, any potential competitive impacts on the market for building development as a whole are likely to be minimal. However, it is possible that smaller developers with less buying power may face proportionally higher cost increases than larger businesses. This is considered separately in the section on the impact of the policy on small firms.

4.3 There could be some effects on the manufacturers/suppliers of construction products and materials in the market due to the increased requirement for the use of higher specification construction materials, particularly for existing non domestic buildings where standards for replacements are set per element. Following the consultation stage, discussions have been held with industry representatives to refine the energy efficiency standards for individual building and service elements. Suppliers of low quality products and materials that met the old energy efficiency standards may be adversely affected by the change in regulations. However, the change in regulations is also expected to provide greater opportunities for manufacturers and suppliers of low/zero carbon generation technologies and high energy efficiency products.

4.4 Following the competition assessment guidance of Office of Fair Trading, this analysis considers the competition impacts within and across individual segments of the construction material sector.

Effects on individual segments of the construction material sector

4.5 The impact on the producers of construction products will be highly dependent on the range of products they are currently producing and their ability to produce products of a higher specification. Suppliers producing only lower specification products may face a fall in demand and decline in profitability. Producers of the higher specification products required to meet the new standards may gain a competitive advantage if other firms fail to adjust their product range or exit the market. However, unless there are significant barriers to entry or expansion any such advantage should only operate in the short term.

4.6 The way in which the policies for new buildings have been designed should help mitigate this potential effect on competition. Similar to the policy first introduced for Part L 2006, this policy

will provide developers the freedom to choose the most cost-effective solutions to meet the relevant new targets for each building type. As a result lower specification products may continue to be chosen for some purposes with higher energy efficiency products being used for other parts of the building. This mitigating effect will not occur for replacements in existing non domestic buildings, where energy efficiency standards are set at the level of individual products. Hence any impacts on individual segments of the construction material sector are more likely to be driven by changes to standards for existing non domestic buildings rather than those for new buildings.

4.7 In light of the public consultation of the proposed changes, we have considered the potential competition effects of the strengthened energy efficiency standards for building fabric and service products and for the increased role to be played by the use of Low or Zero Carbon Energy Sources (LZCs). The main construction products that are likely to be affected by the new standards are insulation; windows; doors; lighting; heating and ventilation and air conditioning equipment. Solar photovoltaic systems are expected to be the main LZC option considered for individual buildings.

Insulation

4.8 There are around eight leading suppliers in the insulation market; four manufacturing mineral fibre (40 per cent of the sector) and four plastic fibre (60 per cent of the sector)[51]. About 20-30 per cent of the insulation market relates to insulation of new build, with the remaining 70-80 per cent relating to retrofit[52].

4.9 For new homes the most cost effective method for increasing energy efficiency is expected to include some additional insulation for a number of building types; in particular for detached housing. Since retrofit makes up the larger share of the insulation market and given there would be no proposed increase in fabric performance standards for existing homes, the competition impacts on the insulation market is estimated to be limited.

4.10 For new non-domestic buildings, some may elect to meet the higher standards at least in part through improved insulation. However, as for domestic buildings, given that there is no proposed increase in fabric performance standards for existing non-domestic buildings, it is envisaged that there would not be significant impact on the market.

4.11 In addition, for both new and existing buildings, producers should generally be able to satisfy the requirements with changes in the specification of existing products, such as increasing the thicknesses of the existing products and/ or combining the existing products, without the need

[51] Office of Fair Trading (2012) “Home insulation: A report on the Call for Evidence carried out by the OFT”
[52] Office of Fair Trading (2012) “Home insulation: A report on the Call for Evidence carried out by the OFT”

for new product development. Hence, the proposed standards are unlikely to cause any adverse impact on competition in this market.

Windows

4.12 There is no proposed change to replacement window standards for both existing homes and non domestic buildings. Although developers have the flexibility to meet the higher standards proposed in Part L 2013 for new buildings (homes and non-domestic) through the use of better windows, we do not envisage any major impact on the window market from the proposed policy.

Lighting

4.13 The lighting market may be considered to be comprised of three distinct product types - lamps/bulbs, luminaires/fittings and lighting controls.

4.14 Part L 2013 is likely to have most impact on the lighting put into new non-domestic buildings and replacements in existing non-domestic buildings. It is not expected to have much impact on dwellings, with no change in specification included in this policy for lighting replacements in existing homes. Also, lighting is not expected to contribute significantly to improvements in energy standards for new homes.

4.15 The lighting industry expressed concerns during the consultation with the increase in luminaire efficiency from 55 to 65 luminaire lumens per circuit watt (LLPCW) in the new non domestic notional building recipe. Whilst there is flexibility in the new-build standards (i.e. a less efficient lighting system can be compensated for by a more efficient air conditioning system), it is reported that often the notional building recipes are directly used to specify the building elements required. According to lighting manufacturers, 65 LLPCW begins to rule out fluorescent lamps in many fittings and takes us into the territory of LEDs for certain fitting types. Also the lighting industry warned that the proposed changes could result in poor lighting design. Whilst not necessarily agreeing with all of these claims, DCLG has agreed to reduce this uplift to 60 LLPCW for Part L 2013 with the intention of raising standards in future revisions of Part L.

4.16 According to a recent AMA Research report, this is a mature market with a majority of sales relying on replacement applications[53]. The market for lamps is dominated by four international suppliers while the luminaires market is more competitive with a number of small producers of specialised products. There are also a number of major suppliers operated in the lighting controls market.

[53] AMA research – Lighting Market Report – UK 2012 – 2016 Analysis

4.17 Following the changes set out in 2010 Part L and increasing fuel prices, the lighting industry has been driven by technological improvement in energy efficacy. Although there are concerns expressed on the potential technical challenges for certain light sources, it is expected that the market will continue to improve its energy performance to meet the Part L 2013 and future targets with no adverse effect on competition.

Heating, ventilation and air conditioning (HVAC)

4.18 For HVAC, the main impact is likely to be on the non-domestic replacement market where standards have been generally increased. These increased standards have been agreed with the key trade associations and are based on the capacity and capability of the industry and are not thought to have a significant impact on the competitiveness of the players in the market.

Solar photovoltaic systems

4.19 Solar power is the leading renewable energy source for use in individual buildings and there is growing demand for solar photovoltaic (PV) energy in the UK. One of the key attractions of PV technology is its 'fit and forgot' property, once it is installed, it can be used to deliver electricity at the point of use with minimal maintenance costs.

4.20 Although the main focus of these changes is on energy efficiency, the overall CO_2 targets for new buildings are performance based and would likely result in an increased use of LZC, particularly PV for some domestic and non-domestic buildings and, combined heat and power plant for a small number of non-domestic buildings. No specific requirements for Solar PV are set in the existing building policies.

4.21 There are many distributors and installers of solar PV in the UK with strong competition. The Feed-in-Tariff (FITs) scheme, which aims to increase the number of renewable installations by approximately 750,000 in 2020, has been a large driver of the recent increase in the number of domestic PV installers operating in the UK. Builders/electricians would tend to use a specialist installer for PV installation to meet the FIT requirements. Price comparison sites exist which should help to keep downward pressure on prices charged for installation.

4.22 As the cumulative production of technologies such as PV rises, so learning effects coupled with competition should bring down the unit cost. PV panels are produced by large international companies based principally in China, Japan and the USA. Amongst the 10 leading suppliers of panels, none appears to have a market share in excess of 10 per cent. Since the incremental demand for PV due to Part L 2013 will only form a very small part of total global demand, the policy is very unlikely to have any substantial impact on the competition between these international manufacturers.

Cross market impacts

4.23 The policy targets for new buildings are formulated to allow developers the freedom to choose their own solution to ensure that their building complies with the relevant compliance standard for the building type. This could create cross market effects in which change in demand within one market would affect demand in another market. The demand in individual markets may be positively or negatively correlated, depending on the strategies developers select to meet the

new CO_2 and energy efficiency targets. As such, some products could complement other products while some could be substituted with cheaper alternatives.

4.24 To meet the new requirements, there are three potential options available to the building developers – improving the fabric performance, improving the services (such as adding a heat recovery device) or adding LZC energy source which could be, for example, PV or solar hot water. These options could be used in combination to form the most cost-effective option.

4.25 This freedom to choose a mix of products allows cross product competition to develop. This is likely to be particularly important for the development of PV. Given this freedom, markets which offer the cheapest products to the developers' option may gain an initial relative advantage to other markets but this advantage may not necessarily be sustained. In the competitive environment of the construction material markets a price advantage in one part of the market is likely to lead to a competitive response in another part of the market The flexibility provided in the way that builders meet the higher standards should help to ensure that no one product or manufacturer can dominate any part of the market.

Innovation

4.26 The flexibility to choose product specifications to meet the compliance targets for new developments should not reduce competition but encourage innovation among manufacturers and suppliers of different energy efficiency products to compete with one another. This should lead to more research and development for higher energy and carbon performance in the industry.

4.27 There should also be the potential for new firms to enter the market due to the increased scope for competition on product performance levels, for example, higher efficiency lighting and heat recovery ventilation. This would bring in wider choices along with innovative ideas to the markets.

4.28 The increases in existing non domestic building services standards should also drive innovation. With firms required to manufacture products to higher performance standards, they are likely to try to innovate to find ways of achieving these standards at lower cost. Innovations are also likely to occur in production processes as manufacturers are required to ramp up production capacities for higher performance products.

Overall market impact

4.29 Following the consultation responses, there may be some limited effects on the number of suppliers due to increased demand for higher specification products but the evidence is anecdotal. The flexibility incorporated in the policy should minimise any adverse competition effects within and across the markets. There is a planned lead in period between publication of the regulations and associated guidance and calculation tools and the regulatory changes will be accompanied by transitional provisons to avoid disruption to the design and construction process. Therefore in the vast majority of cases, producers of low specification products will be able to switch to produce higher specification products to compete with existing higher specification producers. Hence, we expect the significance of the adverse competition effects

to be limited and there should not be a substantial reduction in the choice of products offered in the markets.

4.30 The policy may, on the other hand, encourage firms to compete by providing an added incentive for increased innovation to produce higher specification construction materials. We also envisage potential market entry across the market sector due to the increased scope for competition on energy efficiency criteria and CO_2 emission target presented by the policy. The new business opportunities would attract entrepreneurs to enter the market and benefit the markets with innovative products of a higher specification.

Small Firm Impact

4.31 The UK construction industry is dominated by small and micro firms. The Department for Business Innovation and Skills publishes its Construction Statistics Annual every year[54]. This shows that in 2011 there were 253,121 private contractors in the UK; over 95 per cent of which had less than 14 employees and over 99 per cent had less than 60 employees.

4.32 Micro businesses, which employ fewer than 10 full time equivalent employees, make up over 90 per cent of firms for the sector as a whole, employ over 34 per cent of staff and undertake over 26 per cent of work done according to the BIS construction statistics[55].

4.33 The issues relevant to small firms will in general be similar to those faced by micro businesses. Due to the small sample size, it was not possible to ascertain from the consultation responses whether micro businesses would be affected differentially from small businesses, hence the analysis here evaluates the two together. In the following text small relates to both small and micro firms.

4.34 Parties affected by the proposals for Part L 2013 would include in particular small firms involved in the construction of new buildings, and manufacturers and installers of replacement non-domestic building services. There are a number of ways in which small firms may be disproportionately affected by the proposals when compared to larger firms.

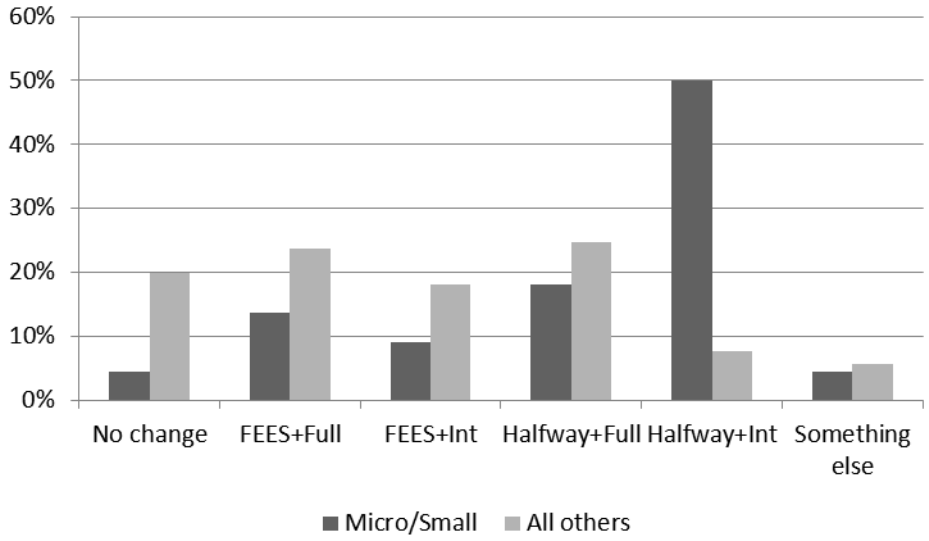
4.35 In their responses to the consultation, small firms were generally much less keen on any increases to standards, with the exception of the standards for new homes. The preference of small and micro businesses for less significant changes to the energy performance standards for each of new and existing, domestic and non-domestic buildings provides some indication that these businesses will be disproportionately impacted by the proposed increases in standards.

[54] ONS: Construction Statistics Annual 2012
[55] ONS: Construction Statistics Annual 2012

4.36 Due to the small sample size of small and micro businesses that responded to the consultation IA, only a few statistically significant differences could be discerned between the responses of these businesses and all other respondents[56]. These are summarised below.

4.37 Micro and small businesses were significantly more likely to prefer a halfway+ interim FEES uplift for new homes in Part L 2013, the most demanding increase in performance. This more ambitious 26% uplift with the interim FEES backstop which provides greatest flexibility in achieving the target is selected by half of these respondents in comparison to only eight per cent of other respondents. The Federation of Master Builders[57] noted in its consultation response that, amongst their members, no change was the most popular choice, with 69 per cent of respondents who expressed a view preferring this to any of the other options under consideration. The difference between these two sets of responses likely reflects the different constituents with the micro and small businesses more dominated by the manufacturer supply/chain and the Federation of Master Builders reflecting the views of builders.

Table 4.1: Q28: which uplift for new homes in 2013?



Source: Stakeholder responses to consultation RIA

Sample size of 22 micro/small and 105 others who expressed a view to this question. 99.9 per cent confidence level of difference between the two groups.

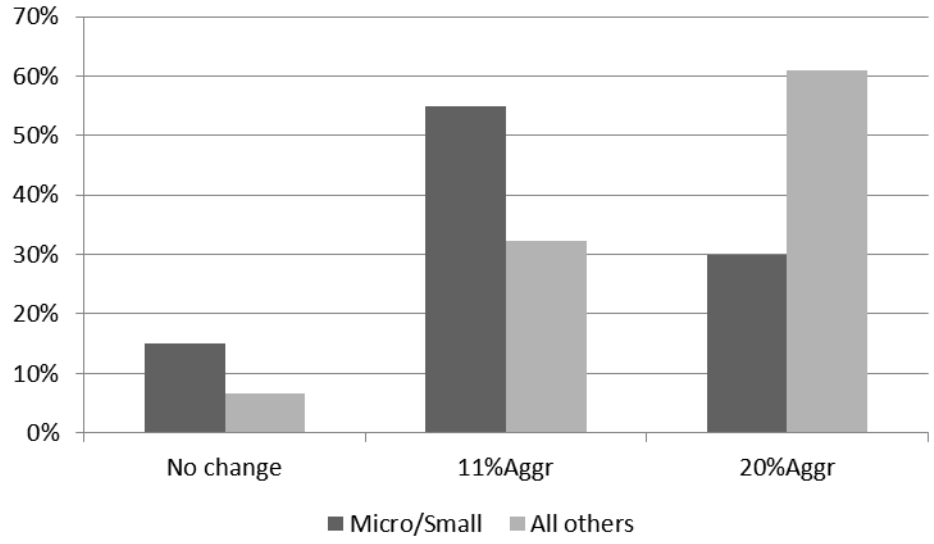
4.38 Small and micro businesses were more likely to prefer a more modest uplift for new non-domestic buildings than other respondents, with higher percentages responding that no

[56] The profile of micro and small businesses was not hugely different from all other respondents in the sample. Manufacturer / supply chain and other micro and small respondents were overrepresented in the sample, but builders / developers and specific interest were underrepresented. Sample size of 38 micro/small and 210 others.

[57] The Federation of Master Builders represents small and medium sized firms.

change or only an 11 per cent uplift should be chosen. The 9 per cent uplift now chosen for new non-domestic buildings is a modified version of the 11% option and is the maximum uplift that should be achievable with only fabric and fixed services for most building types and is consistent with the approach taken for new homes.

Table 4.2: Responses to Q33: what uplift for new non-domestic?



Source: Stakeholder responses to consultation RIA

Sample size of 20 micro/small and 105 others who expressed a view to this question. 97 per cent confidence level of difference between the two groups.

4.39 The decision not to proceed with a tightening of standards for extensions to both existing homes and non-domestic buildings is consistent with the view from small and micro businesses who were much less likely to agree that these should be raised. In each case, approximately half of small and micro businesses agreed extension standards should be raised, compared to around 90 per cent of other businesses[58].

4.40 Similarly the decision not to proceed with a tightening of standards for replacement windows to existing homes and non-domestic buildings that are domestic in character is consistent with the view from small and micro businesses who were also far less likely to agree that the

[58] For domestic buildings: sample size of 20 micro/small and 111 others who expressed a view to this question. 99.9 per cent confidence level of difference between the two groups.
For non-domestic buildings: sample size of 16 micro/small and 115 others who expressed a view to this question. >99.9 per cent confidence level of difference between the two groups.

standard for replacement windows should be raised from C to B, with only 52 per cent of these businesses agreeing with this, compared to 89 per cent of other respondents[59].

4.41 Small businesses were also less likely to agree with referencing Lighting Energy Numeric Indicator (LENI,) with 89 per cent of other respondents agreeing with this but only 43 per cent of small and micro businesses[60]. The decision to adopt softer levels of lighting efficiency improvement and to retain the option of complying through luminaire efficacy and control factors should go some way to meeting the concerns raised by small businesses, particularly small builders.

4.42 In addition, some evidence was provided in the consultation responses that the increase in standards might increase the gap between small firms and large firms of the costs of acquiring building materials. Recent analysis of the Building Cost Information Service data undertaken by the Federation of Master Builders (FMB) found that the mean build cost per m^2 for developments of three units or fewer, which are most commonly built by smaller firms, are currently around 70 per cent higher than those for general estate housing. The comparable gap between the average cost uplift published in the consultation IA for Full Fees (8 per cent uplift) for new homes and the costs estimated in a survey of FMB members was around 300 per cent.

4.43 Figures collected by Cyrill Sweett evaluated the percentage premium small builders currently have to pay over large builders and how this would change with the introduction of Part L 2013. The results show that there will be no clear deterioration of the position of small builders from the increase in standards. The percentage premium on the 2010 base model is slightly higher for large builders for mid terrace and end terrace houses and slightly lower for detached houses.

Table 4.3: Small Builder Costs

	Mid Terrace			**End Terrace**			**Detached House**		
	Large builder	Small builder	% diff.	Large builder	Small builder	% diff.	Large builder	Small builder	% diff.
2010 Base Cost Model (£)	78,049	92,683	18.8%	80,000	95,610	19.5 %	106,341	125,854	18.3 %
Estimated Cost of 2013 Recipe (£ rounded)	146	170	16.0%	467	521	11.4 %	1447	1,783	23.3 %
2013 Total Cost (£ rounded)	78,195	92,853	18.7%	80,467	96,131	19.5 %	107,788	127,637	18.4 %
Percentage	0.19%	0.18%		0.58%	0.54%		1.36%	1.42%	

[59] Sample size of 21 micro/small and 101 others who expressed a view to this question. >99.9 per cent confidence level of difference between the two groups.

[60] Sample size of 7 micro/small and 53 others who expressed a view to this question. 99.8 per cent confidence level of difference between the two groups.

premium on 2010 base model

Source: Cyril Sweett

4.44 Other respondents to the consultation also noted that some of the increased energy efficiency requirements are likely to be more costly in small developments than large developments. Since small firms are more commonly involved in small developments, both in their construction and as occupants, this may disproportionately impact them. For instance, a small building services engineer felt that several elements of the NCM Modelling guide were flawed and yielded unobtainable targets for lighting, Hot Water System (HWS) and Auxiliary Energy Value (AEV); especially in small buildings. Similarly, the Metal Cladding and Roofing Manufacturers Association noted that it had established through a wide series of on-site tests that small warehouses (less than 3,000 square metres) were unable to achieve air tightness figures as low as $3m^3/hour/m^2$. However, the policy has revised the air permeability in the notional specification for warehouses which would not have a negative impact on small buildings in this sector. The revised figures are as shown below:

Table 4.4: Air permeability for roof-lit building (i.e. warehouses)

Warehouse Size (m^2)	Air Permeability ($m^3/m^2/hour$)
< 3,000	7
3,000 – 10,000	5
> 10,000	3

Source: AECOM

4.45 There may be some higher specification products which at this stage can only be produced by large manufacturers and/or it may be more difficult for smaller manufacturers, particularly those specialising in a small number of products, to switch to producing higher specification construction materials than larger manufacturers. However, this risk will be limited by the fact that the policy does not contain major changes to the product performance standards for Part L 2013.

4.46 A number of small construction companies noted in their consultation response that they may be disproportionately affected by the changes to new building standards due to the relatively short period of time, in the timescales of new building developments, which has passed since Part L 2010 standards were introduced. As small builders tend to have larger intervals between taking on projects, the FMB found that nearly a fifth of respondents to their survey of members had not yet built to Part L 2010 standards[61]. Therefore, a significant proportion of small and occasional house builders might feel the impact of both Part L 2010 and Part L 2013 changes simultaneously.

[61] However, one small design engineer noted that even some larger contractors had yet to build to 2010 Regulations.

4.47 A significant number of small builders expressed concern that they were likely to face proportionately larger administrative costs, at least in the short term, in order to comply with the proposed quality assurance scheme. With the development of a quality assurance process being a one-off cost, this would amount to a larger proportion of total costs for small and occasional builders, as well as self-builders, than for larger builders who would be able to spread the development cost over a larger number of new homes. The maintenance of 'backstop values' for fabric elements and fixed building services should continue to help small builders, who tend to rely more heavily on a prescriptive approach to demonstrating compliance.

4.48 No responses to the consultation indicated that certification or other accreditation costs for products meeting Part L 2013 standards would be a greater burden for small manufacturers. Similarly, no respondents indicated that training costs would be a greater burden for small manufacturers.

Cross Regulatory Impacts – Part L and Part F

4.49 The interaction between Part L and Part F for new homes has also been considered. In delivering lower CO_2 emissions and better energy efficiency via Part L, it may result in more airtight homes. It is important to consider what additional ventilation provisions may be required to meet Part F and any challenges and risks that may result from this.

4.50 Within the main CBA modelling, the level of airtightness for the Part L 2010 baseline has been taken at 6 $m^3/hr/m^2$ at 50Pa and the same assumed for the Part L 2013 cases. Furthermore, all dwellings are assumed to be naturally ventilated and the same amount of provision (e.g. trickle ventilator area) is required in both cases.

4.51 However, it may be that developers will build to a higher standard of airtightness for Part L 2013 than has been assumed in our modelling. The Part L 2010 and Part L 2013 CO2 targets (TER) are performance-based and the developer can comply in both cases by designing a more airtight home than $m^3/hr/m^2$ and relax other parts of the specifications. Given the 6 per cent uplift in Part L 2013, it can be expected that to meet the tougher target, in some cases, developers will design to a higher standard of airtightness than for Part L 2010. However, we do note that there are many ways in which the developer can choose to meet this uplift in performance other than improving the airtightness of the building.

4.52 If the standard of airtightness is being designed to 5 $m^3/hr/m^2$ or better, it is important to consider additional ventilation provisions. Approved Document F recommends additional natural ventilation provisions at this level. This may simply be delivered, for example, by installing a greater percentage of the windows with trickle ventilators. However, there may be practical challenges in some cases with delivering a natural ventilation solution and hence a move towards installing mechanical ventilation systems.

4.53 The greatest challenge is likely to be faced by apartments and we have focused on this building type for the rest of the discussion. For the size of apartment considered in the main cost benefit analysis modelling (average 56m^2 floor area), Part F recommends an additional ventilation provision of 10,000mm^2 equivalent when designing to an airtightness of 5 $m^3/hr/m^2$

or better. Based on costs identified for the Part F 2010 IA[62], the additional cost of including trickle ventilation in windows would be around £20-35 per dwelling.

4.54 There may be practical challenges in installing this level of trickle ventilation, particularly in small apartments. Additional ventilation provisions are recommended for single-storey dwellings e.g. apartments. Further ventilation provisions are recommended for dwellings with a single exposed facade, which is common design for apartments. Whilst it is possible to have increased amounts of trickle ventilation through, for example, inserting trickle ventilators at both the top and bottom of the window, it can still result in practical difficulties in providing sufficient amount of trickle ventilation. The challenge may already be present with an airtightness greater than 5 $m^3/hr/m^2$ but it will be a greater challenge with the additional ventilation provision recommended for an airtightness at or better than 5 $m^3/hr/m^2$. It is possible to augment trickle ventilation with other types of natural ventilation provision e.g. closable louvers.

4.55 Mechanical ventilation provides a possible alternative for natural ventilation. There are principally two domestic solutions: (i) continuous mechanical extract ventilation (MEV), and (ii) continuous mechanical ventilation with heat recovery (MVHR). Both consume electrical energy in operation. MVHR has a particular advantage that it transfers part of the heat from the extracted air back to the supply (known as "heat recovery") and thus significantly reduces the energy demand for heat in the home. Due to potential issues in achieving sufficient ventilation in more airtight homes and the benefits that heat recovery affords, a recent Zero Carbon Hub report on MVHR in new homes[63], suggests that MVHR is likely to become the dominant form of ventilation in new homes.

4.56 As an indication of costs, MVHR is the more expensive of the two mechanical ventilation systems at around £1,100 per apartment. However, the benefit of MVHR systems in reducing the heat demand in the building allows other specifications to be relaxed to meet the CO_2 target. The benefit is most notable in electrically heated buildings where the heating fuel is more carbon intensive. For the large electrically heated apartment in our main cost benefit analysis modelling, changing from natural ventilation to MVHR allows the easing of the amount of solar PV by nearly a half, with an estimated cost saving of approximately £850 and thus a net capital cost of the MVHR system of £250.

4.57 It is important to also allow for maintenance costs when considering mechanical ventilation systems. Costs for MVHR are around £75 to change the supply filter annually and £150 to clean the MVHR system every four years. The costs would be less for a MEV system as they do not have a supply filter, they have less ducting to clean and none of the ducting is used to supply air to the dwelling.

[62] [http://webarchive.nationalarchives.gov.uk/20120919132719/http://www.communities.gov.uk/publications/planningandbuilding/partlf2010ia]
[63] Zero Carbon Hub Mechanical ventilation with heat recovery in new homes: July 2013 http://www.zerocarbonhub.org/resourcefiles/ViaqReportFinalJuly2013.pdf

4.58 However, there are new risks associated with mechanical ventilation systems, and in particular MVHR, compared to the use of natural ventilation systems. For example, the Zero Carbon Hub report on MVHR systems highlights that "examples of failures in typical design, installation and commissioning practice are all too common and these will have the effect of reducing the performance of [MVHR] systems". To help address this amended regulations and guidance for the commissioning and testing of ventilation systems were introduced in 2010. However, there is still a need for regular maintenance and as highlighted in the report "many systems have been installed in locations, such as roof spaces, where access for user-maintenance is restricted" and that there are "anecdotal reports that a market for replacement filters does not exist at present, which suggests that even basic maintenance is not being undertaken, possibly because users are not aware of the requirement for it." Concerns are that badly performing systems may not deliver the anticipated energy and carbon savings and, more so, may result in degraded indoor air quality with related consequences for the health of the occupants.

Social Impacts

Health and well-being impacts

4.59 There are potentially beneficial improvements in health and quality of life from the effect of increased energy efficiency on thermal comfort e.g. reduction in cold weather deaths. However, we do need to be mindful of the potential effects that tighter envelopes could have upon indoor air quality and indoor temperatures in summer.

4.60 This is why the ventilation standards in Part F of the Building Regulations were improved in 2010[64] and new requirements and guidance for installation and commissioning of ventilation systems[65] introduced.

4.61 Also as part of Government's wider adaptation work programme DCLG commissioned and published a piece of research to analyse the effects that better insulated envelopes and climate change projections could have upon the risks of overheating[66]. This report identifies the main gaps in the literature on overheating in homes, and recommends areas where further work might be of most value to inform potential policy interventions in future. For similar reasons we are also planning to commission some research into indoor air quality in homes. This will help to inform whether there is a case for intervention including possible future changes to other parts of the Building Regulations.

[64] www.planningportal.gov.uk/buildingregulations/approveddocuments/partf/
[65] www.planningportal.gov.uk/buildingregulations/approveddocuments/partf/associated
[66] https://www.gov.uk/government/publications/investigation-into-overheating-in-homes

Equalities impacts

4.62 The Equality Duty requires public bodies to have due regard to the need to: eliminate unlawful discrimination, harassment, victimisation and any other conduct prohibited by the Equalities Act 2010; advance equality of opportunity between people who share a protected characteristic and those who do not share it; and foster good relations between people who share a protected characteristic and people who do not share it.

4.63 Assessment of the Part L changes involved a screening process which identified no evidence of equalities issues. As set out above, we have commissioned work on overheating in well insulated buildings in a changing climate, given that (longer term) this could particularly affect older and disabled people.

Rural impacts

4.64 Assessing rural impacts means determining whether the impacts on rural areas will be different to those for urban areas, and whether there are specific local or regional effects.

4.65 In Part L 2006 a fuel factor was introduced for new homes which differed between gas, oil, electricity and Liquid Petroleum Gas (LPG). One purpose was to provide some relief in the target applicable to dwellings that are off the gas grid principally those in rural areas. The fuel factor means that if the chosen heating fuel is more carbon intensive than gas (such as oil or LPG), the carbon target / Target Emission Rate is increased making it less demanding. With a reduced fuel factor or the fuel factor removed completely, builders would have to build to higher (and more expensive) fabric and/or services standards in order to meet the same emissions target as homes connected to a gas supply.

4.66 Based on the consultation responses, it was decided that the current fuel factors should be maintained at current levels, rather than moving to reduced or removed fuel factors. Half of the respondents who expressed a preference during the consultation (38 per cent overall) were in favour of the retention of current fuel factors. The principal reason cited for maintaining the fuel factor was that its removal would have a significant negative impact on off gas-grid communities. Other reasons for the retention were likely negative impacts from the removal on the market for heat pumps and other electric heating technologies and a feeling that there was not need to change a system that was well understood. Arguments for the reduction or removal of fuel factors were that this would favour more energy efficiency solutions, lower carbon fuels and technologies and also ease the transition towards zero carbon standards. It can also be expected that smaller builders will be more prevalent in rural areas.

4.67 We have modelled the impact of retaining the fuel factor at current levels on the incremental capital cost for a typical semi detached house heated by different fuel types.

Table 4.5 Cost impact on semi detached house by type of fuel

	Present value of incremental capital, testing and installation cost excl. maintenance and replacement costs (£/building) in 2014
Gas Semi	327
Oil Semi	994
LPG semi	1065
Elec Semi	583
ASHP semi	1179

4.68 The continued role of the fuel factor will be kept under review in the context of wider policies including the move to zero carbon standards, decarbonisation of the grid and fiscal incentives such as the Renewable Heat Incentive.

Environmental Impacts

Greenhouse gas assessment

4.69 The environmental impacts are central to this policy, and are therefore covered in the main body of this impact assessment.

Wider environmental impacts

4.70 Air quality damage costs/benefits have been monetised and included in the main body of this impact assessment.

Administrative burdens

4.71 Administrative burdens are identified as the costs to businesses of legal requirements to provide information. This policy is not proposing to introduce any new mandatory requirements to provide information.

5 SUMMARY AND PROPOSED OPTION

5.1 At consultation, four options were considered. This Impact Assessment has focused on two options.

5.2 **Option 1 Do Nothing.** This would fail to make even modest cost effective contributions towards improving energy efficiency, saving on energy bills and abating carbon in order to meet challenging carbon targets over the next few decades.

5.3 **Option 2. Cost effective energy efficiency changes.** Tighter carbon compliance standards for new homes (differentiated by building type to give an overall 6% improvement on 2010 standards with new mandatory fabric energy efficiency requirements) and non-domestic buildings differentiated to give a 9% improvement on 2010 (with energy efficiency backstops). Tighter standards for existing buildings when certain building work is undertaken, specifically non-domestic building services including fan coil unit, chiller and lighting replacements.

5.4 Option 2 is the selected option. A Summary Box of this proposal is included in the front of the Evidence Base and a summary of selected results from the cost benefit analysis is in Table 1.1 to complement the information in the Summary Sheets. Option 2 is less ambitious than the proposals consulted on in January 2012 but ensures that cost effective momentum is maintained towards cutting energy bills and tackling the long-term climate change challenge whilst respecting deregulatory commitments. The total package will save around 6.4 MtCO2 and deliver a £379 million net present value benefit to society over the apprasial period from 10 years of policy. It will result in an Equivalent annual net benefit to business of £16m.

5.5 Education and training for Part L 2013 needs to assume a high priority in the implementation plan and DCLG has developed a strategy for dissemination and training guidance to provide the necessary support to market participants and training providers to gain the required understanding and knowledge. Such training needs to be industry wide and not just focused on building control bodies. This requires discussions between the building control community, professional bodies, competent persons schemes and others in the industry who both use and provide training. An estimate of the costs of training is built into the transition costs outlined in Section 2.

5.6 The immediate need is to prepare the industry for the Part L 2013 changes but there are longer term requirements relating to the general level of skills and understanding across the industry and this will remain under review as part of an ongoing process of reviewing building regulations and specifically in 2015 with a view to considering further tightening of standards in 2016 and 2019 in line with current policy and EU DIrectives.

6 APPENDIX 1: ADDITIONAL INFORMATION ON BUILDING COSTS, SPECIFICATIONS AND ENERGY USE.

New Domestic Buildings[67]

6.1 Tables 6.1, 6.2, 6.3 and 6.4 provide the incremental fabric costs for different dwelling types.

Table 6.1: Incremental Fabric Costs for Mid-Terrace House

External Walls (u-value)	0.28	0.22	0.2	0.18	0.15	
Cost (£/m²)	£0.00	£5.69	£8.57	£11.42	£18.22	
Party Walls (u-value)	0.5	0.0				
Cost (£/m²)	£0.00	£5.00				
Ground Floor (u-value)	0.2	0.18	0.17	0.15	0.13	
Cost (£/m²)	£0.00	£0.65	£1.16	£2.62	£4.66	
Roof (u-value)	0.16	0.15	0.13	0.11		
Cost (£/m²)	£0.00	£0.30	£1.07	£3.73		
Windows(u-value)	1.8	1.6	1.5	1.4	1.2	0.8
Cost (£/m²)	£0.00	£25.00	£30.00	£32.50	£62.50	£117.25
Doors (u-value)	1.6	1.2	1.0			
Cost (£/m²)	£0.00	£20.00	£80.00			
Airtightness (m³/hr/m²)	7	5				
Cost (per house)	£0.00	£250.00				
Thermal bridging (W/m²K)	0.08	ACDs	Halfway ACDs to ECDs	ECDs	0.04	
Cost (per house)	£0.00	£0.00	£236.00	£386.00	£636.00	

Source: Cyril Sweett

Table 6.2: Incremental Fabric Costs for End-Terrace House

External Walls (u-value)	0.28	0.22	0.2	0.18	0.15
Cost (£/m²)	£0.00	£5.06	£7.61	£10.14	£16.62
Party Walls (u-value)	0.5	0.0			
Cost (£/m²)	£0.00	£5.00			

[67] The costs for houses only (not apartments) were updated in Q4 2012. These new costs were collected as part of the analysis of impact on small builders and included throughout the cost benefit analysis.

Ground Floor (u-value)	0.2	0.18	0.17	0.15	0.13	
Cost (£/m²)	£0.00	£0.65	£1.16	£2.62	£4.66	
Roof (u-value)	0.16	0.15	0.13	0.11		
Cost (£/m²)	£0.00	£0.30	£1.07	£3.73		
Windows(u-value)	1.8	1.6	1.5	1.4	1.2	0.8
Cost (£/m²)	£0.00	£25.00	£30.00	£32.50	£62.50	£117.25
Doors (u-value)	1.6	1.2	1.0			
Cost (£/m²)	£0.00	£20.00	£80.00			
Airtightness (m³/hr/m²)	7	5				
Cost (per house)	£0.00	£250.00				
Thermal bridging (W/m²K)	0.08	ACDs	Halfway ACDs to ECDs	ECDs	0.04	
Cost (per house)	£0.00	£0.00	£251.00	£401.00	£651.00	

Source: Cyril Sweett

Table 6.3: Incremental Fabric Costs for Detached House

External Walls (u-value)	0.28	0.22	0.2	0.18	0.15	
Cost (£/m²)	£0.00	£5.05	£7.58	£10.10	£16.57	
Party Walls (u-value)	n/a	n/a				
Cost (£/m²)	n/a	n/a				
Ground Floor (u-value)	0.2	0.18	0.17	0.15	0.13	
Cost (£/m²)	£0.00	£0.65	£1.16	£2.62	£4.66	
Roof (u-value)	0.16	0.15	0.13	0.11		
Cost (£/m²)	£0.00	£0.30	£1.07	£3.73		
Windows(u-value)	1.8	1.6	1.5	1.4	1.2	0.8
Cost (£/m²)	£0.00	£25.00	£30.00	£32.50	£62.50	£117.25
Doors (u-value)	1.6	1.2	1.0			
Cost (£/m²)	£0.00	£20.00	£80.00			
Airtightness (m³/hr/m²)	7	5				
Cost (per house)	£0.00	£386.00				
Thermal bridging (W/m²K)	0.08	ACDs	Halfway ACDs to ECDs	ECDs		
Cost (per house)	£0.00	£0.00	£352.00	£530.00		

Source: Cyril Sweett

Table 6.4: Incremental Fabric Costs for Apartment Unit

External Walls (u-value)	0.28	0.22	0.2	0.18	0.15
Cost (£/m²)	£0.00	£7.76	£8.44	£9.88	£17.12
Semi-Exposed Walls (u-value)	0.25	0.19	0.17	0.14	
Cost (£/m²)	£0.00	£5.19	£6.37	£8.24	

Party Walls (u-value)	0.5	0.0				
Cost (£/m²)	£0.00	£5.97				
Ground Floor (u-value)	0.2	0.18	0.17	0.15	0.13	
Cost (£/m²)	£0.00	£1.30	£2.68	£5.20	£7.09	
Roof (u-value)	0.16	0.15	0.13	0.11		
Cost (£/m²)	£0.00	£0.78	£1.91	£4.73		
Windows(u-value)	1.8	1.6	1.5	1.4	1.2	0.8
Cost (£/m²)	£0.00	£25.00	£30.00	£32.50	£62.50	£117.25
Doors (u-value)	1.6	1.2	1.0			
Cost (£/m²)	£0.00	£20.00	£80.00			
Airtightness (m³/hr/m²)	7	5				
Cost (per house)	£0.00	£198.00				
Thermal bridging (W/m²K)	0.08	ACDs	Halfway ACDs to ECDs	ECDs	0.04	
Cost (per house)	£0.00	£79.00	£201.00	£340.00	£490	

Source: Cyril Sweett

6.2 Data on domestic solar PV costs is provided in Table 6.5.

Table 6.5: Domestic Solar PV Costs

Initial costs	
4-10 kWp system	£2,269/kWp
10-50 kWp system	£2,011/kWp
Of which inverter cost	11 per cent of total cost for 4-10kWp system 10 per cent of total cost for 10-50kWp system

Maintenance costs	
PV electrical testing (every 5 years)	£75
Inverter replacement (every 12 years)	Reduced in line with learning effects
Panel replacement (every 30 years)	Same as initial costs

Source: Cyril Sweett, DECC

New Non Domestic Buildings

6.3 The full description of the three stage approach used to assess a change in emissions standards for new non-domestic buildings in Part L 2013 is provided below.

6.4 At the first stage, the scope for reducing emissions in a range of new buildings using energy efficiency measures and low and zero carbon technologies was assessed. Cost curves for carbon reduction were compiled using capital cost data from published sources and industry

based estimates. The cost curves prioritise carbon saving measures by lowest capital cost to achieve a unit saving in carbon reflecting the approach that a developer would take in meeting a given carbon reduction target. These cost curves can be found in Figure 6.1 to Figure 6.7 below.

6.5 The second stage involved assessment of the curves to develop an appropriate notional building (or buildings) to achieve a given aggregate target. The national calculation methodology that underpins the Building Regulations is reliant on the principle of comparing the actual design of the building with a notional building of the same shape and size based on a recipe of fabric and services standards. The carbon emissions from this notional building become the target (the Target Emission Rate) by which the carbon emissions from the actual building (the Building Emissions Rate) are compared.

6.6 In 2006, one notional building was defined. In Part L 2010, two notional buildings were defined for top-lit (warehouses) and side-lit (all other) buildings. In Part L 2013 notional buildings are defined for top-lit (warehouses – further sub divided by size), side-lit (heated only) and side-lit (heated and cooled) buildings reflecting the different energy profiles and building services plant likely to be found in these buildings. Seven buildings were considered to inform the notional building specifications: distribution warehouse; deep plan office AC; retail warehouse; shallow plan office AC; 5 star hotel; secondary school; and small warehouse unit. The 5 star hotel was taken as a representative of all hotels and the secondary school as representative of all schools.

6.7 Table 6.7 and Table 6.8 below show the packages of fabric and building services that were modelled to inform calculations of the most cost effective notional building in Part L 2013.

6.8 Fabric elements are grouped in Packages A, B, C and D. Building services elements are grouped in Packages 1 and 2. The packages grouped as A1, A2, B1, B2, etc. to determine the best mix of fabric and fixed services standards.

Table 6.6: Fabric specifications for new non-domestic buildings

Element	Unit	Package A (2010 Notional)	Package B	Package C	Package D
Roof	U-value (W/m2.K)	0.18	0.18	0.16	0.1
Wall	U-value (W/m2.K)	0.26	0.26	0.20	0.20
Floor	U-value (W/m2.K)	0.22	0.22	0.2	0.15
Window	U-value (W/m2.K)	1.8 (10% FF)	1.6 (10% FF)	1.6 (10% FF)	1.4 (10% FF)
Window	G-Value	40%	40%	40%	40%
Window	Light transmittance	71%	71%	71%	71%
Roof-light	U-value (W/m2.K)	1.8 (15% FF)	1.8 (15% FF)	1.6 (15% FF)	1.4 (15% FF)
	G-Value	55%	52%	48%	45%
	Light transmittance	60%	57%	53%	50%
Air-permeability	m3/m2/hour	5	3*	3*	3*

* Following the consultation, air-permeability in Warehouses has been tiered according to size. In all cases, Warehouses less than 3,000 m² have an air-permeability of 7 m³/m²/hr. Those between 3,000 m² and 10,000 m² have an air-permeability of 5 m³/m²/hr. Those greater than 10,000 m² have an air-permeability of 3 m³/m²/hr.
Source: AECOM

Table 6.7: Building Service Specifications for New Non-Domestic Buildings

Element	Unit	Package 1 (2010 Notional)	Package 2
Lighting*	Luminaire lm/watt	55	60
Occupancy control	Yes/no	Yes	Yes
Daylight control	Yes/no	Yes	Yes
Heating efficiency	Heating and hot water (side lit)	88%	91%
Heating efficiency	Heating and hot water (top lit) – i.e. gas-radiant space heating	86%	91%
Central Ventilation	SFP (w/l/s)	1.8	1.8
Terminal Unit	SFP (w/l/s)	0.5	0.3
Cooling	SEER	4.5	4.5
Heat recovery	%	70%	70%
Variable speed control of fans and pumps	Yes/no – multiple sensors	Yes	Yes
Demand control (mech vent only)	Yes/no – CO2 sensing with variable speed	No	Yes

* The lighting densities in each package have been increased by 20% to account for a change in the NCM that includes an additional maintenance factor. The actual building will also include a 20% maintenance factor by default unless changed by the user.
Source: AECOM

6.9 The aggregate reduction in carbon emissions from 2010 for a range of notional buildings, given the assumed build mix, is shown in the bottom row of Table 6.9. This shows that the most stretching notional building analysed (D2) achieves an overall aggregate saving of just over 12 per cent. It is suggested therefore that 12 per cent is about the technical limit of savings possible with improvements only to fabric and services in the notional building.

6.10 Once the actual design (size, shape, etc.) of a particular building is added, each notional building specification produces a target CO2 reduction for the actual building to meet. The values for the range of modelled building types are shown in Table 6.8 below.

Table 6.8: CO_2 Reductions by Building Type and Specification (Percentage Improvement on 2010)

	A1	A2	B1	B2	C1	C2	D1	D2
Warehouse (Distribution)	0.0	4.4	2.5	6.9	5.5	9.9	11.1	15.4
Office (Deep-plan, AN)	0.0	12.0	0.6	12.4	0.8	12.6	1.1	12.7
Warehouse (Retail)	0.0	8.3	0.6	8.8	1.2	9.3	2.0	9.9
Office (Shallow-plan, AN)	0.0	12.6	1.3	13.5	1.9	14.1	2.7	14.6
Hotel (5-star)	0.0	10.5	1.9	12.0	2.7	12.6	4.1	13.7
Secondary School	0.0	7.3	2.0	9.2	2.9	10.0	4.3	11.3
Small warehouse unit	0.0	5.4	-0.7	4.8	2.1	7.6	5.2	10.7
% reduction once applied across the build mix	0.0	8.9	0.9	9.9	2.0	10.9	3.7	12.4

Source: AECOM

6.11 At consultation four overall target improvements over 2010 Building Regulations were then chosen to test a range of options; 8 per cent, 11 per cent, 14 per cent and 20 per cent. For this Final Proposal stage IA two overall targets have been tested, 9 per cent and 20 per cent. As

with the consultation stage IA an area of PV has been added to the roof of the notional building as a proxy, defined as a percentage of floor area to reach the 20 per cent target. The same percentage of floor area is applied to each building to reflect how a notional building might be defined in practice (i.e. package B1 + X per cent floor area, where X per cent is the same in all buildings).

6.12 The choice of 9 per cent and 20 per cent reflects a desire to examine the effect of low and zero carbon technologies in the notional building (particularly at the higher targets where the ability of fabric and services measures to save carbon is becoming exhausted) so that this could be compared to a target based only on fabric and services improvements.

6.13 Because applying one fabric/services package to all building types can result in very different outcomes for different building types, mixes of notional building were examined to see if differentiating between building types resulted in a more cost effective solution. The final selection of notional buildings proposed is shown in Table 2.14.

6.14 As a result of the consultation it is not proposed to push fabric beyond 2010 levels (with the exception of air-tightness) and therefore there is little rationale in differentiating between heated only and heated and cooled buildings in terms of notional buildings as had been proposed during consultation.

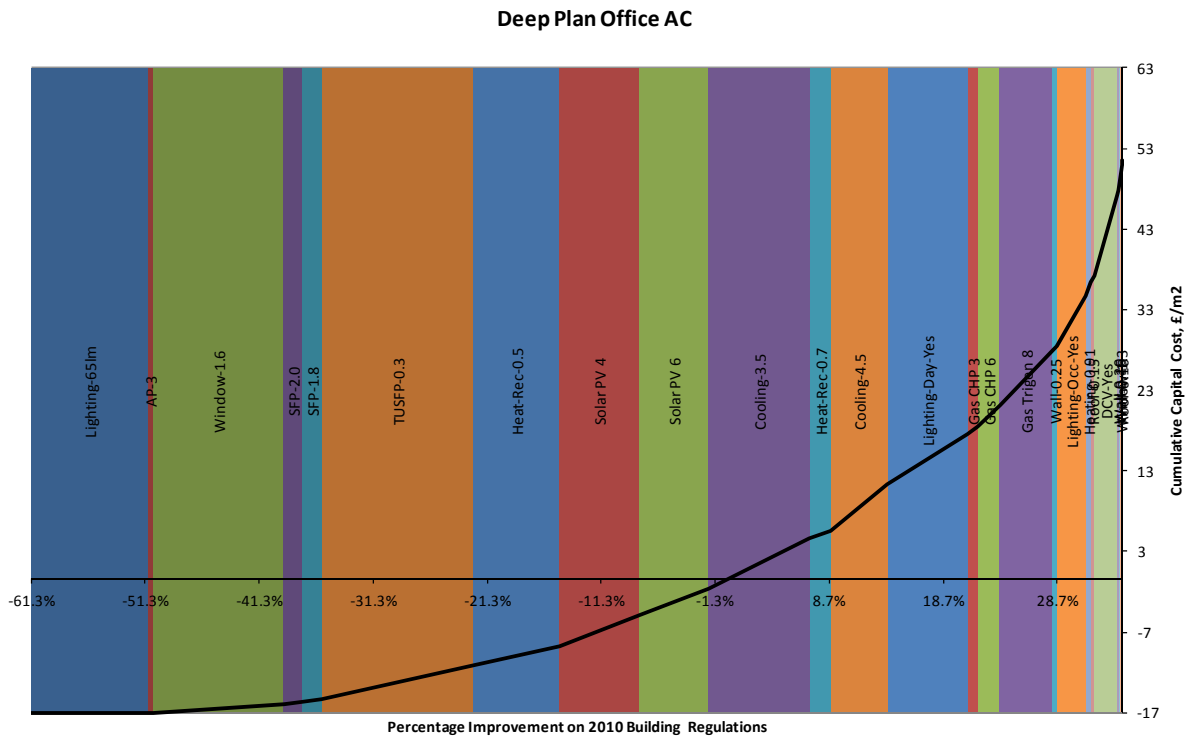
Table 6.9: Specifications for Notional Non-Domestic Buildings

Target aggregate reduction	9%	Resultant target reduction	20%	Resultant target reduction
Warehouse (Distribution) TL	A2	4.4%	A2+5.4%	18.1%
Office (Deep-plan, AN) SL-C	B2	12.4%	B2+5.4%	23.9%
Warehouse (Retail) TL	A2	8.3%	A2+5.4%	16.3%
Office (Shallow-plan, AN) SL-C	B2	12.6%	B2+5.4%	26.0%
Hotel (5-star) SL-H	B2	12.0%	B2+5.4%	15.2%
Secondary School SL-H	B2	9.2%	B2+5.4%	23.0%
Small warehouse unit	A2	2.7%	A2+5.4%	14.2%
PV required on notional building		None	Panel area equivalent to 5.4% of floor area applied to roof of each building	

Source: AECOM

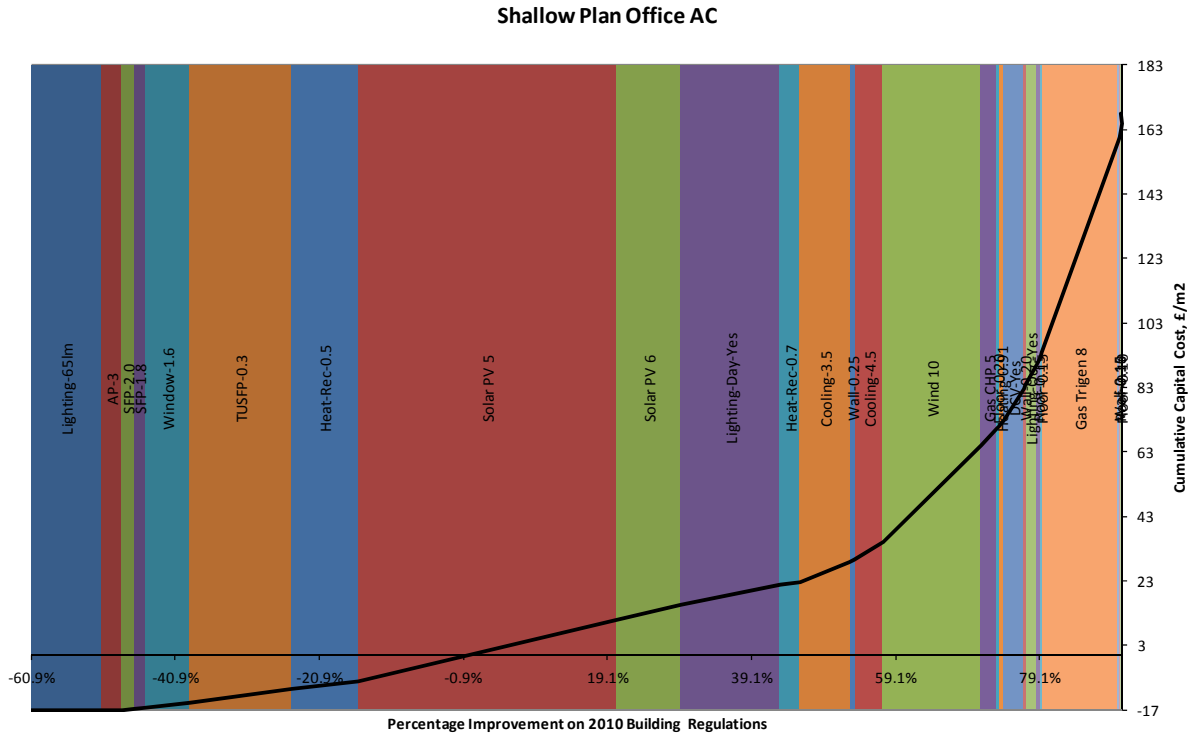
6.15 The target percentage reductions for each building type were then plotted on the cost curves to establish how an actual building would respond to the target. This identifies the least (capital) cost route to achieving a given target. Figure 6.1 to Figure 6.7 below show the cost curves for each building type.

Figure 6.1: Cost Curve for Deep Plan Office



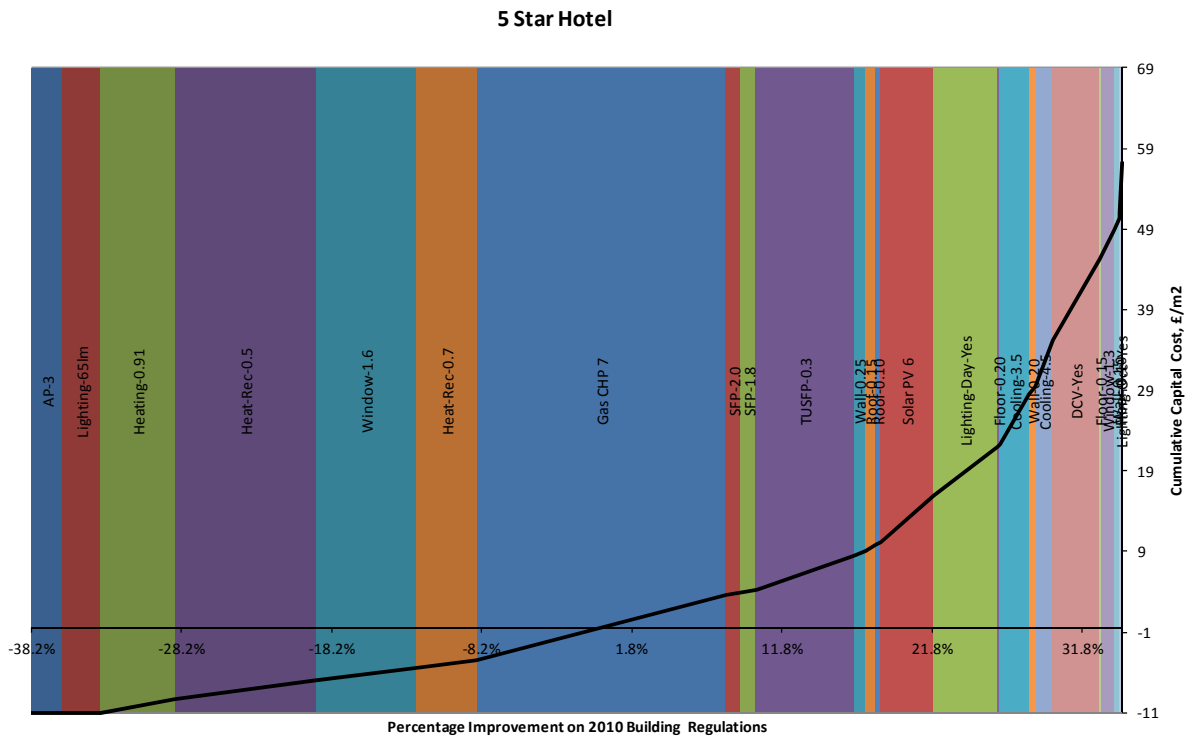
Source: AECOM

Figure 6.2: Cost Curve for Shallow Plan Office



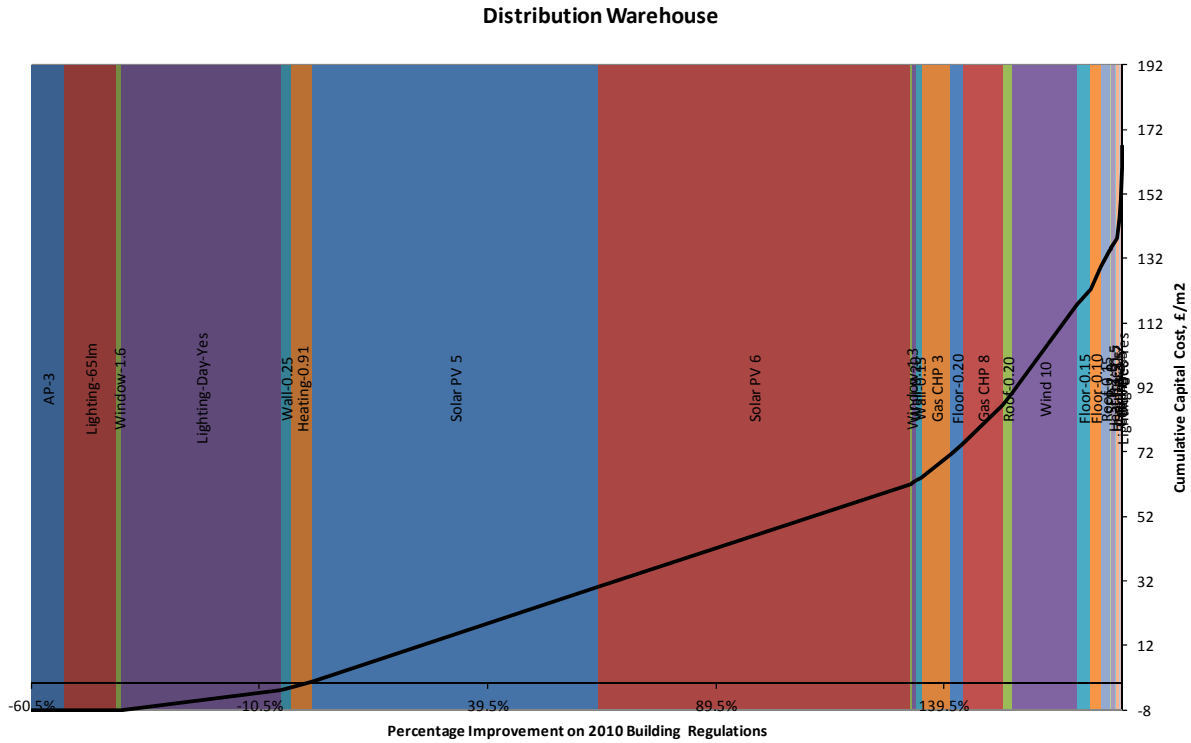
Source: AECOM

Figure 6.3: Cost curve for 5 Star Hotel



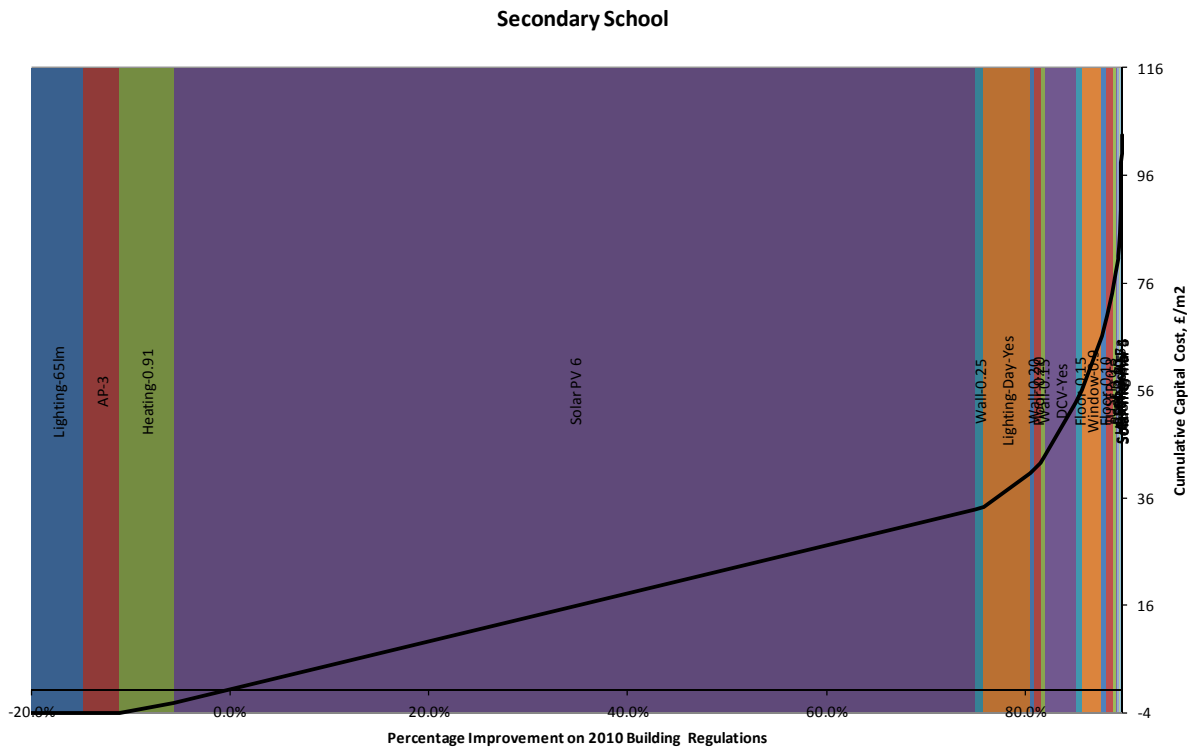
Source: AECOM

Figure 6.4: Cost Curve for Distribution Warehouse



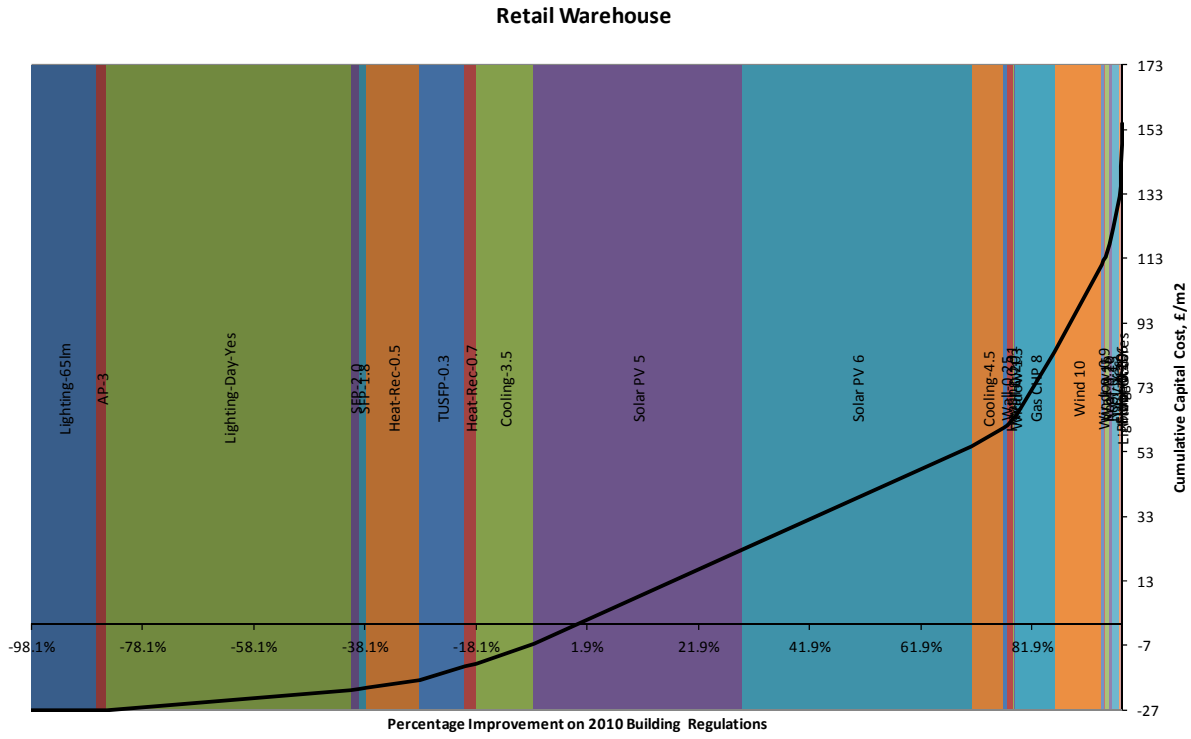
Source: AECOM

Figure 6.5: Cost Curve for Secondary School



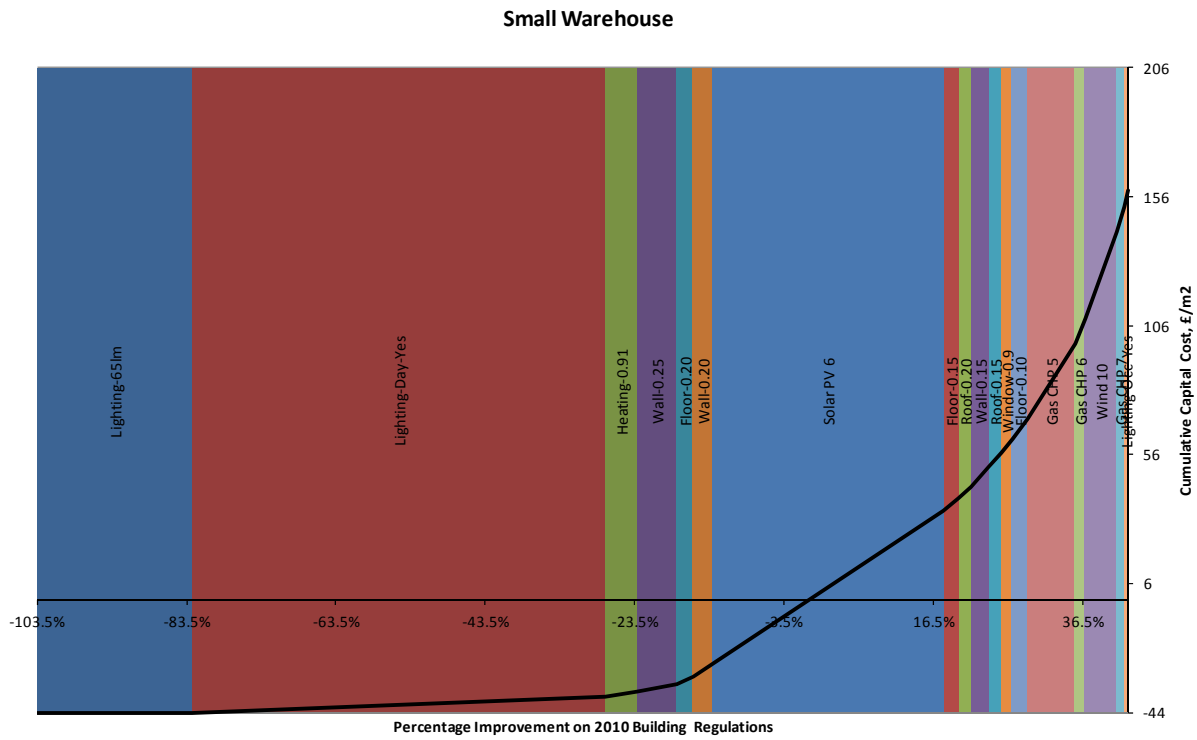
Source: AECOM

Figure 6.6: Cost Curve for Retail Warehouse



Source: AECOM

Figure 6.7: Cost Curve for Small Warehouse



Source: AECOM

6.16 As an example, the notional deep plan office building for a 9 per cent target is A2. This produces a target reduction of 12.4 per cent in the deep plan office. The deep plan office cost curve is on page 38.

6.17 The 20 per cent option requires PV to be incorporated in the notional building. However, it is important to note that whilst the notional building features PV to achieve a 20 per cent aggregate reduction not all buildings would necessarily choose PV to achieve their given target depending on the relative cost effectiveness of PV against other demand-side measures. Conversely a building meeting the 9% standard may include solar pv in preference to some of the energy efficiency measures included in the notional building.

6.18 At the final third stage, the capital costs of achieving these reductions, the energy saved and the associated CO_2 reductions were used as inputs to a cost benefit model. This provided aggregate estimates of social costs and benefits across all new non-domestic buildings.

6.19 The cost curve analysis provides estimates of energy requirements and associated CO2 emissions per square metre of floor area. These can then be applied to assumed build rates for the seven building types considered.

Existing Non-Domestic Buildings (replacement standards for fixed building services)

6.20 The analysis for the change in standards for replacement fixed building services for existing non-domestic buildings was based on five building types: Offices (separated into naturally

ventilated and air conditioned), Warehouses, Retail (separated into general retail and retail warehouses), Education (separated into primary and secondary) and Hotels. These five types comprise 80 per cent of the existing buildings in England.

6.21 To calculate the energy savings, we principally used energy data for existing buildings published in the Energy Conservation Guides (ECON); publications produced following extensive surveys of existing buildings 15 years ago, covering four of the main building types (offices, warehouses, schools and hotels). This data has the advantage of representing the consolidation of measured data from a wide variety of actual buildings, rather than simply using data from one representative building model. Given the low demolition rates, we propose that using the 'best practice' energy data published in the guides would provide a good indication of the current building stock. The energy data contained in the guides, reported by end use, would be adjusted by a factor relating the typical performance parameters for the different building services of interest (from the National Calculation Methodology (NCM) Modelling Guide) with the parameters in either the 2010 or 2013 NDBSCG. Thus, the impact of the most recent updates in the NDBSCG can be determined.

6.22 However, there are some instances where the resolution of the energy data in the ECON Guides is insufficient. In these cases, we have used the energy breakdown from the relevant new-build SBEM model (with the "typical" building performance parameters assigned in the 2008 NCM Modelling Guide) and integrated it with the ECON Guide data. Specifically:

- The Guide for schools does not include a breakdown of gas and electricity energy by end use. We have used the overall gas and electricity usage from the Guide but split into energy end use by the relative breakdown from the 'typical' SBEM modelling results.

- The Guide for hotels does not separate energy use from air conditioning and ventilation. We have determined the relative split from the 'typical' SBEM modelling results.

- The Guide for offices does not separate energy use from fans, pumps and controls. We have determined the relative split from the 'typical' SBEM modelling results.

- There is no data for retail warehouses in the industrial buildings Guide. In this case we pro-rated the energy data for "Large non-food shops" in CIBSE TM 46.

- There is no Guide for general retail units. In this case, we pro-rated the energy data for "General Retail" in CIBSE TM 46.

6.23 Having identified the energy savings for each building type due to the updates in the NDBSCG, we then aggregate the savings to the national scale. This has been based on the existing buildings build mix using by DCLG in the 2007 EPBD Impact Assessment. The build mix data was adjusted as the building categories aggregate certain individual building types of interest. Specifically:

- We have allocated the 'office' build mix between air-conditioned and naturally ventilated offices. We have updated the offices split contained in the 'Non-domestic Energy Fact File' (BRE, 1998) by adjusting for product sales and floor area growth. This information has been compiled for the recent work on the Eco-Design Directive. This analysis gives the 'office' split

as 34 per cent air conditioned and 66 per cent naturally ventilated by area. Furthermore, from the ECON Guide for offices, we have assumed that the naturally-ventilated office is based on the "Naturally ventilated cellular" energy data and the air conditioned office is based on an average of the "standard" and "prestige" air conditioned office energy data.

- Two distinct subdivisions emerge in the 'retail' build mix based on building floor area. We area-weighted the general retail and retail warehouse energy benchmarks to achieve a more representative retail energy profile. General retail was assumed in buildings less than 1,000 m² and retail warehouse used in all other cases.

- The existing build mix has a single category for 'education'; however we needed to identify the floor area associated with Primary and Secondary schools. The Department for Education publish statistics for every school in England and we have cross-referenced the postcodes with the latest full-year from the Display Energy Certificate (DEC) database. This gives the areas for approximately 12,000 school buildings. The area-weighted split of this sample is 46 per cent (Primary) to 54 per cent (Secondary). Please note that the 'education' build mix also includes more than 500 buildings with a floor area greater than 50,000 m². There are no school buildings in this category in the approximately 12,000 records found in the DEC database; hence we assume these are further education establishments. Since the Schools ECON guide data is unlikely to be representative of these much larger buildings, we have omitted them from this analysis. Hence, the analysis for schools is conservative as a whole.

6.24 The number of buildings which have their building service replaced each year was determined by taking the existing building stock and by dividing by the asset lives associated with each of the three building services of interest.

6.25 Davis Langdon provided the incremental costs of going from the 2010 to 2013 NDBSCG for the different building types.

Energy Calculations

6.26 This section discusses in more detail the calculation procedure employed to determine the energy savings.

- **Minimum cooling efficiency (ESEER) from 2.5 to 2.7.**

6.27 Following the NCM Modelling Guide, the system efficiency of a chiller in a typical existing building is 1.17 (i.e. the SSEER). Thus, the delivered cooling required in a building is the chiller electricity multiplied by 1.17 and reduced by 20 per cent to account for standard delivery losses. Incorporating the changes proposed in minimum cooling efficiency, the energy savings achieved in Part L 2013 over Part L 2010 are therefore given by:

$$Q_{Chiller_{Save}} = Q_{Chiller_{ECON}} * ESEER_{1996} * \left(\frac{1}{ESEER_{2010}} - \frac{1}{ESEER_{2013}}\right)$$

- **Initial luminaire efficacy from 55 to 60 lamp lumens per circuit watt.**

6.28 Accounting for the improved lighting standards is complicated by the permutations in minimum efficacy allowed when incorporating additional lighting controls. For simplicity, we only

considered the initial luminaire efficacy. We used the minimum efficacy standard in Part L 1995 as the typical efficacy of lighting installations in existing buildings. This correlates with the 20 year asset life assumed for luminaires. Part L 1995 sets a minimum standard of 50 lamp lumens per circuit watt, so for comparison with the NDBSCG we applied a luminaire light output ratio of 80 per cent, thereby giving a typical minimum standard of 40 luminaire lumens per circuit watt ($Eff_{Light_{1995}}$). The energy savings achieved in Part L 2013 over Part L 2010 are therefore given by:

$$Q_{Light_{2013}} = Q_{Light_{ECON}} * Eff_{Light_{1995}} * \left(\frac{1}{Eff_{Light_{2010}}} - \frac{1}{Eff_{Light_{2013}}}\right)$$

6.29 As a consequence of improving the lighting efficiency, there is a need to increase the gas consumption to account for the increased boiler heating load and reduce the impact on cooling load. To determine this impact, we modelled the "typical" specifications in SBEM and pro-rated the change in cooling load from Part L 2010 to Part L 2013 lighting standards by the lighting density from the ECON Guide data and SBEM model.

- **Minimum fan coil unit specific fan power from 0.6 to 0.5 W/l/s.**

6.30 We needed to divide the auxiliary energy data from the ECON guides into pumps, AHU fans and FCU fans. As outlined above, the proportions were determined by the energy breakdown in the appropriate SBEM model. It is difficult to determine the minimum FCU SFP in existing buildings, since they were not regulated in Part L 1995. Typical fan powers were defined in CIBSE TM 32 (2003), although anecdotal evidence shows that these values were representative of the best available technology, rather typical of installations. For the purpose of this analysis and in lieu of earlier evidence, we assumed that the existing FCU SFP is 0.8 W/l/s, the minimum standard set in the Non-Domestic Heating, Cooling and Ventilation Compliance Guide (2006). The energy savings achieved in Part L 2013 over Part L 2010 are therefore given by:

$$Q_{FCU_{2013}} = \frac{Q_{FCU_{ECON}}}{SFP_{FCU_{2006}}} * (SFP_{FCU_{2010}} - SFP_{FCU_{2013}})$$

6.31 To account for the air conditioning systems that do not use FCUs, we assumed that the savings due to changes in FCU SFP only apply to 50 per cent of existing air conditioned buildings.

Cost Calculations

6.32 This section presents the additional capital costs derived for the updates to the NDBSCG. Table 6.11 records the costs (£/m²) according to building type.

Table 6.10: Capital Costs for Non-Domestic Building Services (£/m²)

	Office (AC)	Office (NV)	Warehouse (Distribution)	Retail	School	Hotel
Cooling Efficiency	0.5			0.5		0.9
Luminaire	0.7	0.7	0.6	0.6	0.7	2.3

	Efficacy							
	FCU SFP	1.3				1.3		1.3

Source: Davis Langdon and AECOM

6.33 To determine the costs for this study, various technology specific assumptions were made:

- **Minimum cooling efficiency (ESEER) from 2.5 to 2.7.**

6.34 The increase in cost associated with improving the ESEER was estimated to be an additional 5 per cent over the base cost. The base cost was calculated assuming a typical peak cooling requirement per unit floor area. For the Office (AC) the base load was calculated as 90 W/m², for Hotel as 150 W/m² and for Retail as 70 W/m².

- **Initial luminaire efficacy from 55 to 60 lamp lumens per circuit watt.**

6.35 The lighting costs were determined at an elemental level by considering the cost of increasing the luminaire efficacy, but to derive the cost per unit floor area typical luminaire spacings were required. Table 6.12 presents these assumptions.

Table 6.11: Luminaire spacing assumptions (m² floor area/luminaire)

	Office (AC)	Office (NV)	Warehouse (Distribution)	Retail	School	Hotel
Luminaire Spacing	7.2	7.2	6.25	6.25	7.2	4

Source: Davis Langdon and AECOM

- **Minimum fan coil unit specific fan power from 0.6 to 0.5 W/l/s.**

6.36 Again, the FCU costs were derived elementally. To find the cost per unit floor area, a typical FCU spacing of 1 unit per 30 m² was assumed in tenanted areas. 80 per cent of the total floor area was assumed to be tenanted. There is some difficulty in costing the improvement from 0.6 to 0.5 W/l/s. In some cases, AC-motor FCU can operate at either 0.6 or 0.5 W/l/s depending on system design; hence, we have applied a cost increase by assuming 1 EC/DC-motor FCU (with SFP = 0.3 W/l/s) for every 2 AC-motor FCUs, thereby creating an area-weighted average of 0.5 W/l/s. This is unlikely to be the approach in practical design, but does give an indication of the potential cost uplift.

6.37 In all cases, the costs allow for removing existing fittings and the installation of the new fittings.

7 APPENDIX 2: SENSITIVITY ANALYSIS

New Homes

Table 7.1: Present Values of Costs and Benefits: New Homes (NPV £m) – Carbon Values and Energy Prices Sensitivities

	Low carbon values and energy prices	Central	High carbon values and energy prices
Energy savings (£m)	205	294	383
Incremental costs (£m)	(301)	(301)	(301)
Net financial benefit/(cost) (£m)	**(96)**	**(6)**	**82**
Carbon savings - non-traded (£m)	110	229	349
Carbon savings - traded (£m)	2	5	8
Total carbon savings (£m)	112	234	357
Air quality savings (£m)	6	6	6
Net benefit/(cost) (£m)	**22**	**234**	**445**
Amount of gas saved (GWh)	*23,562*	*23,562*	*23,562*
Amount of electricity saved (GWh)	*2,084*	*2,084*	*2,084*
Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	*4.35*	*4.35*	*4.35*
Amount of CO_2 saved - traded ($MtCO_2(e)$)	*0.15*	*0.15*	*0.15*
Cost effectiveness – non-traded (£/tCO_2)	*20*	*(1)*	*(22)*
Cost effectiveness – traded (£/tCO_2)	*n/a*	*n/a*	*n/a*
Average capital cost per dwelling (£)*	*453*	*453*	*453*

Source: Europe Economics

*The average capital cost per dwelling is undiscounted value in 2011 price

Table 7.2: Present Values of Costs and Benefits: New Homes (NPV £m) – Build Mix Sensitivities

	Central	10 per cent higher detached houses	50 per cent flats electricity heated
Energy savings (£m)	294	335	385
Incremental costs (£m)	(301)	(385)	(360)
Net financial benefit/(cost) (£m)	**(6)**	**(50)**	**25**
Carbon savings - non-traded (£m)	229	295	226
Carbon savings - traded (£m)	5	4	11
Total carbon savings (£m)	234	299	236
Air quality savings (£m)	6	8	7
Net benefit/(cost) (£m)	**234**	**256**	**268**
Amount of gas saved (GWh)	*23,562*	*30,328*	*23,168*
Amount of electricity saved (GWh)	*2,084*	*1,531*	*4,531*
Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	*4.35*	*5.61*	*4.28*
Amount of CO_2 saved - traded ($MtCO_2(e)$)	*0.15*	*0.11*	*0.32*
Cost effectiveness – non-traded (£/tCO_2)	*(1)*	*7*	*(10)*
Cost effectiveness – traded (£/tCO_2)	*n/a*	*n/a*	*n/a*
Average capital cost per dwelling (£)*	*453*	*563*	*509*

Source: Europe Economics

*The average capital cost per dwelling is undiscounted value in 2011 price

Table 7.3: Present Values of Costs and Benefits: New Homes (NPV £m) – Counterfactual Sensitivities

	Lower percentage already meeting standard under counterfactual	Central	Higher percentage already meeting standard under counterfactual
Energy savings (£m)	345	294	234
Incremental costs (£m)	(351)	(301)	(239)
Net financial benefit/(cost) (£m)	**(6)**	**(6)**	**(5)**
Carbon savings - non-traded (£m)	270	229	182
Carbon savings - traded (£m)	6	5	4
Total carbon savings (£m)	275	234	186
Air quality savings (£m)	7	6	5
Net benefit//(cost) (£m)	**276**	**234**	**185**
Amount of gas saved (GWh)	*27,702*	*23,562*	*18,656*
Amount of electricity saved (GWh)	*2,451*	*2,084*	*1,650*
Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	*5.12*	*4.35*	*3.45*
Amount of CO_2 saved - traded ($MtCO_2(e)$)	*0.17*	*0.15*	*0.12*
Cost effectiveness – non-traded (£/tCO_2)	*(1)*	*(1)*	*(1)*
Cost effectiveness – traded (£/tCO_2)	*n/a*	*n/a*	*n/a*
Average capital cost per dwelling (£)*	*453*	*453*	*453*

Source: Europe Economics

*The average capital cost per dwelling is undiscounted value in 2011 price

Table 7.4: Present Values of Costs and Benefits: New Homes (NPV £m) – Learning Rate Sensitivities

	Central	Reduced learning rate for thermal bridging and solar PV	Reduced learning rate for thermal bridging	Reduced learning rate for solar PV
Energy savings (£m)	294	294	294	294
Incremental costs (£m)	(301)	(355)	(346)	(310)
Net financial benefit/(cost) (£m)	**(6)**	**(61)**	**(52)**	**(16)**
Carbon savings - non-traded (£m)	229	229	229	229
Carbon savings - traded (£m)	5	5	5	5
Total carbon savings (£m)	234	234	234	234
Air quality savings (£m)	6	6	6	6
Net benefit//(cost) (£m)	**234**	**180**	**189**	**225**
Amount of gas saved (GWh)	*23,562*	*23,562*	*23,562*	*23,562*
Amount of electricity saved (GWh)	*2,084*	*2,084*	*2,084*	*2,084*
Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	*4.35*	*4.35*	*4.35*	*4.35*
Amount of CO_2 saved - traded ($MtCO_2(e)$)	*0.15*	*0.15*	*0.15*	*0.15*
Cost effectiveness – non-traded (£/tCO_2)	*(1)*	*11*	*9*	*1*
Cost effectiveness – traded (£/tCO_2)	*n/a*	*n/a*	*n/a*	*n/a*
Average capital cost per dwelling (£)*	*453*	*502*	*495*	*459*

Source: Europe Economics

*The average capital cost per dwelling is undiscounted value in 2011 price

Table 7.5: Present Values of Costs and Benefits: New Homes (NPV £m) – Compliance Sensitivities (wider performance sensitivities are outside the scope of this impact assessment)

	Central	90% Compliance – costs and benefits	90% Compliance – benefits only
Energy savings (£m)	294	265	265
Incremental costs (£m)	(301)	(271)	(301)
Net financial benefit/(cost) (£m)	**(6)**	(6)	**(36)**
Carbon savings - non-traded (£m)	229	207	207
Carbon savings - traded (£m)	5	4	4
Total carbon savings (£m)	234	211	211
Air quality savings (£m)	6	6	6
Net benefit//(cost) (£m)	**234**	**211**	**181**
Amount of gas saved (GWh)	*23,562*	21,206	*21,206*
Amount of electricity saved (GWh)	*2,084*	1,876	*1,876*
Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	*4.35*	3.92	*3.92*
Amount of CO_2 saved - traded ($MtCO_2(e)$)	*0.15*	0.13	*0.13*
Cost effectiveness – non-traded (£/tCO_2)	*(1)*	(1)	*6.6*

Cost effectiveness – traded (£/tCO$_2$)	n/a	n/a	*n/a*
Average capital cost per dwelling (£)*	*453*	*408*	*453*

*The average capital cost per dwelling is undiscounted value in 2011 price

New Non-domestic Buildings

Table 7.6: Present Values of Costs and Benefits: New Non-Domestic Buildings (NPV £m) – Carbon Values and Energy Prices Sensitivities

	Low carbon values and energy prices	Central	High carbon values and energy prices
Energy savings (£m)	556	604	652
Incremental costs (£m)	(604)	(604)	(604)
Net financial benefit/(cost) (£m)	**(49)**	**(0)**	**48**
Carbon savings - non-traded (£m)	1	3	6
Carbon savings - traded (£m)	25	55	85
Total carbon savings (£m)	26	59	91
Air quality savings (£m)	16	16	16
Net benefit/(cost) (£m)	**(6)**	**74**	**154**
Amount of gas saved (GWh)	*159*	*159*	*159*
Amount of electricity saved (GWh)	*17,582*	*17,582*	*17,582*
Amount of CO$_2$ saved - non-traded (MtCO$_2$(e))	*0.03*	*0.03*	*0.03*
Amount of CO$_2$ saved - traded (MtCO$_2$(e))	*1.64*	*1.64*	*1.64*
Cost effectiveness – non-traded (£/tCO$_2$)	*258*	*n/a*	*n/a*
Cost effectiveness – traded (£/tCO$_2$)	*19*	*(11)*	*(42)*

Source: Europe Economics

Existing Non-domestic Buildings – Replacement services

Table 7.7: Present Values of Costs and Benefits: Existing Non-Domestic Buildings (NPV £m) – Carbon Values and Energy Prices Sensitivities

	Low carbon values and energy prices	Central	High carbon values and energy prices
Energy savings (£m)	252	269	286
Incremental costs (£m)	(199)	(199)	(199)
Net financial benefit/(cost) (£m)	**53**	**70**	**87**
Carbon savings - non-traded (£m)	(9)	(20)	(31)
Carbon savings - traded (£m)	9	19	30
Total carbon savings (£m)	(1)	(1)	(1)
Air quality savings (£m)	6	6	6
Net benefit/(cost) (£m)	**59**	**76**	**92**
Amount of gas saved (GWh)	*(1,898)*	*(1,898)*	*(1,898)*
Amount of electricity saved (GWh)	*7,614*	*7,614*	*7,614*
Amount of CO$_2$ saved - non-traded (MtCO$_2$(e))	*(0.39)*	*(0.39)*	*(0.39)*
Amount of CO$_2$ saved - traded (MtCO$_2$(e))	*0.59*	*0.59*	*0.59*
Cost effectiveness – non-traded (£/tCO$_2$)	*N/A*	*N/A*	*N/A*
Cost effectiveness – traded (£/tCO$_2$)	*(84)*	*(95)*	*(105)*

Source: Europe Economics

Table 7.8: Present Values of Costs and Benefits: Existing Non-Domestic Buildings (NPV £m) – Lifetime of Service Elements Sensitivities

	Low lifetime	Central	High Lifetime
Energy savings (£m)	336	269	224
Incremental costs (£m)	(249)	(199)	(166)
Net financial benefit/(cost) (£m)	**88**	**70**	**59**
Carbon savings - non-traded (£m)	(25)	(20)	(17)
Carbon savings - traded (£m)	24	19	16
Total carbon savings (£m)	(1)	(1)	(1)
Air quality savings (£m)	8	6	5
Net benefit/(cost) (£m)	**95**	**76**	**63**
Amount of gas saved (GWh)	*(2,373)*	*(1,898)*	*(1,582)*
Amount of electricity saved (GWh)	*9,517*	*7,614*	*6,345*
Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	*(0.48)*	*(0.39)*	*(0.32)*
Amount of CO_2 saved - traded ($MtCO_2(e)$)	*0.74*	*0.59*	*0.49*
Cost effectiveness – non-traded (£/tCO_2)	*N/A*	*N/A*	*N/A*
Cost effectiveness – traded (£/tCO_2)	*(95)*	*(95)*	*(95)*

Source: Europe Economics

Table 7.9: Present Values of Costs and Benefits: Existing Non-Domestic Buildings (NPV £m) – Counterfactual of Service Elements Sensitivities

	Low counterfactual	Central	High counterfactual
Energy savings (£m)	128	269	411
Incremental costs (£m)	(88)	(199)	(310)
Net financial benefit/(cost) (£m)	**40**	**70**	**101**
Carbon savings - non-traded (£m)	(10)	(20)	(30)
Carbon savings - traded (£m)	9	19	29
Total carbon savings (£m)	(1)	(1)	(1)
Air quality savings (£m)	3	6	10
Net benefit/(cost) (£m)	**42**	**76**	**109**
Amount of gas saved (GWh)	*(949)*	*(1,898)*	*(2,847)*
Amount of electricity saved (GWh)	*3,626*	*7,614*	*11,602*
Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	*(0.19)*	*(0.39)*	*(0.58)*
Amount of CO_2 saved - traded ($MtCO_2(e)$)	*0.28*	*0.59*	*0.90*
Cost effectiveness – non-traded (£/tCO_2)	*N/A*	*N/A*	*N/A*
Cost effectiveness – traded (£/tCO_2)	*(116)*	*(95)*	*(89)*

8 APPENDIX 3: LEARNING RATES

Table 8.1: Learning Rates Applied to the Cost Benefit Analysis

	Core rates		Halved rates for sensitivity analysis	
	Solar PV*	Thermal bridging**	Solar PV	Thermal bridging
2012	100%	67%	100%	100%
2013	90%	50%	95%	80%
2014	81%	33%	90%	60%
2015	77%	17%	86%	40%
2016	74%	0%	81%	20%
2017	71%	0%	79%	0%
2018	68%	0%	77%	0%
2019	66%	0%	76%	0%
2020	63%	0%	74%	0%
2021	61%	0%	73%	0%
2022	59%	0%	71%	0%
2023	58%	0%	70%	0%
2024	56%	0%	68%	0%
2025	55%	0%	67%	0%

* Extrapolation after 2025 using the formula Learning Rate = -0.173 x ln(Number of Years After 2014) + 1.0108

** Higher standards are assumed for thermal bridging of y= 0.06 or better. This rate is only applied to those additional activities required to achieve the higher standards and that would be expected to significantly reduce cost from repeat building to the higher standard e.g. it is assumed that, for example, design changes (for thermal bridging) would be subject to learning but the need for additional materials or testing would not.

Sources: DECC, Cyril Sweett, Zero Carbon Hub, AECOM