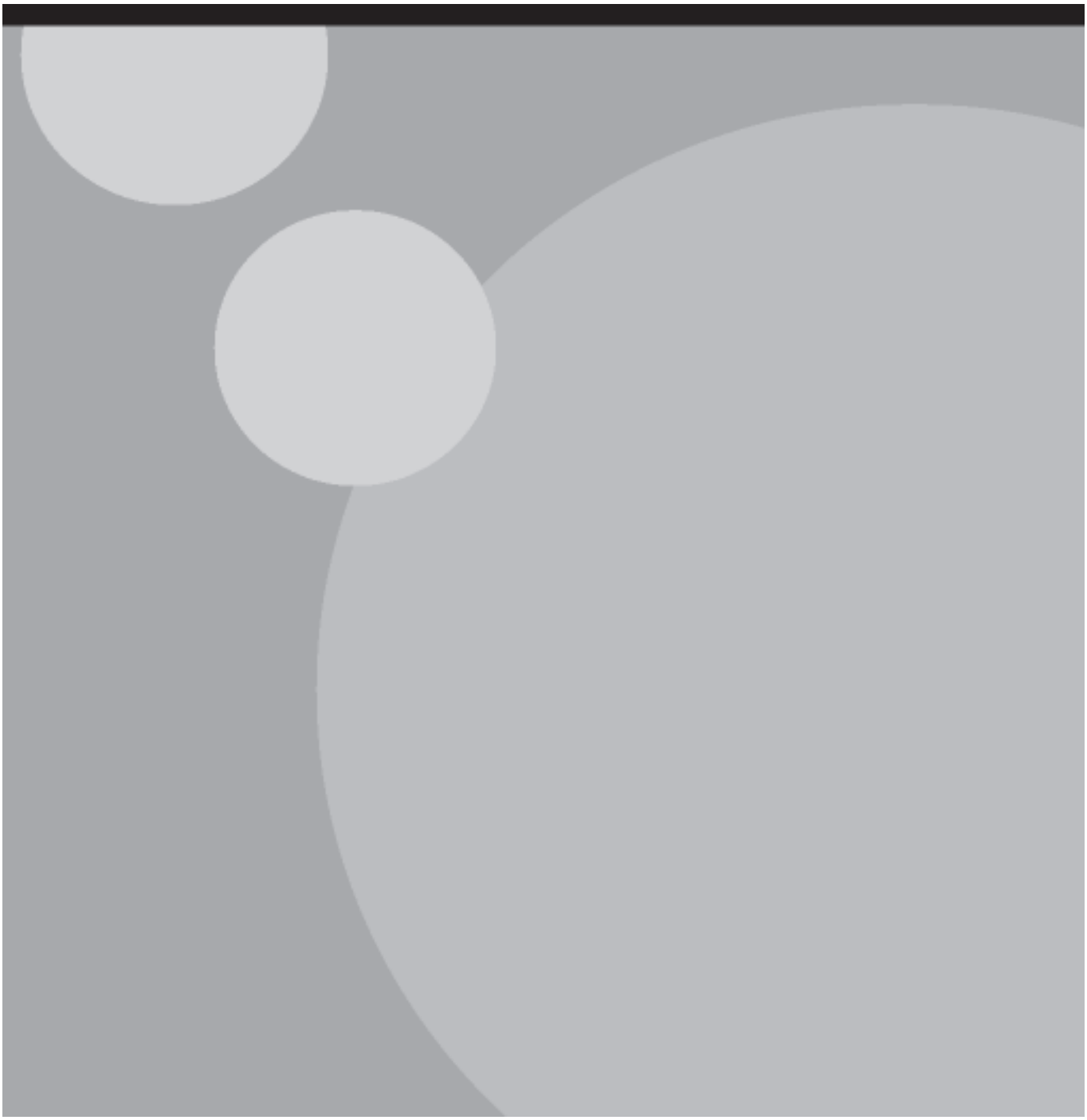
Communities and Local Government

Proposed changes to Part L (Conservation of fuel and power) of the Building Regulations 2012/13 in England

Consultation stage impact assessment



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January 2012
Department for Communities and Local Government

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Title:	Impact Assessment (IA)
Proposed changes to Part L of the Building Regulations 2012/13 **IA No: DCLG/0086** **Lead department or agency:** Communities and Local Government **Other departments or agencies:**	**Date: 08/12/2011** **Stage: Consultation** **Source of intervention: Domestic** **Type of measure: Secondary legislation** **Contact for enquiries**: Paul DeCort David Craine

Summary: Intervention and Options

RPC: Amber

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, One-Out?**	**Measure qualifies as**
£11,953m	£62m	-£7m	Yes	Zero net cost

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

Reducing carbon emissions from the building stock is essential for the UK to meet its Climate Change Act targets. Building Regulations should be used 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 'locks in' low carbon technologies and efficient design, reducing energy/heat demand. Regulation also has a role in ensuring that where renovations are taking place, owners use this opportunity to improve the energy performance of their buildings.

What are the policy objectives and the intended effects?

The Government has announced that from 2016 all new homes, and from 2019 all new non-domestic buildings, in England will be built to zero carbon standards. The expectation is that Part L will be the regulatory vehicle for the energy and carbon elements of the standards. The changes for 2013 should provide learning to aid the transition to zero carbon from 2016/19. To reduce emissions from the existing stock, Government has announced a 'Green Deal' to provide occupiers with finance for energy efficiency improvements, paid back through energy bills. The proposal is that Part L could require consequential improvements where work is planned and Green Deal finance can remove the barrier of up-front costs.

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 based on a fabric energy efficiency standard with efficient services. New non-domestic buildings target of 11% aggregate improvement on 2010 levels. Tighter standards for changes to existing buildings and consequential improvements phased-in from Oct 2012.
Option 3: High case. New homes target based on the halfway point to zero carbon targets (with fabric energy efficiency standard). New non-domestic buildings target of 20% improvement on 2010. Tighter standards for changes to existing buildings and all consequential improvements introduced in Oct 2012.
Option 4: Hybrid case. New homes target based on fabric energy efficiency standard with efficient services. New non-domestic buildings target of 20% improvement on 2010. Tighter standards for changes to existing buildings and phase in of consequential improvements from Oct 2012. This is the preferred approach.

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:**		**Non-traded:**

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 Andrew Stunell Date: 14 December 2011

Summary: Analysis & Evidence

Policy Option 2

Description: Central case standards for new buildings, tighter standards for changes to existing buildings and phased requirement for consequential improvements

FULL ECONOMIC ASSESSMENT

Price Base Year 2011	PV Base Year 2011	Time Period Years 70	Net Benefit (Present Value (PV)) (£m)		
			Low: 2,832m	High: 20,921m	Best Estimate: 12,025m

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	Optional		222m	**5,768m**
High	Optional		271m	**7,050m**
Best Estimate			246m	**6,409m**

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

Increased building costs. New dwellings £1,192m; existing domestic £585m; domestic consequentials £3,674m. New non-domestic buildings £898m; existing non-domestic £51m; non-domestic consequentials £9m. Costs borne initially by developers (capital cost and quality assurance process) but costs of maintenance and replacement borne by landowners and owners/users of buildings.

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

No account taken of the effect of increased costs on the demand for new buildings or on the supply of land for development. No account taken of cost of consequential improvements arising from replacement of controlled services in existing non-domestic buildings.

BENEFITS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low	Optional		331m	**8,600m**
High	Optional		1,076m	**27,971m**
Best Estimate			709m	**18,434m**

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

Energy savings. New dwellings, £559m; existing dwellings £572m; domestic consequentials £8,827m. New non-domestic buildings, £951; existing non-domestic buildings £58m; non-domestic consequentials £28m. Benefits accrue to occupiers of new buildings. Carbon and other savings. New dwellings, £328m; existing dwellings £430; domestic consequentials £6,503m. New non-domestic buildings, £148m; existing non-domestic £8m; non-domestic consequentials £22m.

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

The savings to individual consumers will be greater than shown above because of reduced payments for network charges and VAT. No allowance made for the contribution of reduced energy demand to fuel security, the potential increase in business and employment opportunities from the development of new energy saving materials and technologies. No account taken of benefits of consequential improvements arising from replacement of controlled services in existing non-domestic buildings

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

Sensitivity to future energy and carbon values has been tested using the Interdepartmental Analysts Group recommended high and low values. For new dwellings, sensitivity analysis has also been carried out to assess the impact of removing the fuel factor altogether, or including a full fuel factor.

BUSINESS ASSESSMENT (Option 2)

Direct impact on business (Equivalent Annual) £m:			In scope of OIOO?	Measure qualifies as
Costs: 214	Benefits: 196	Net: -18	Yes	IN

Summary: Analysis & Evidence

Policy Option 3

Description: High case standards for new buildings, tighter standards for changes to existing buildings and consequential improvements all introduced from October 2012.

FULL ECONOMIC ASSESSMENT

Price Base Year 2011	PV Base Year 2011	Time Period Years 70	Net Benefit (Present Value (PV)) (£m)		
			Low: 2,246m	**High: 25,586m**	**Best Estimate: 14,363m**

COSTS (£m)	Total Transition (Constant Price) Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	Optional	357m	**9,277m**
High	Optional	436m	**11,339m**
Best		396m	**10,308m**

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

Increased building costs. New dwellings £3,522m; existing domestic £585m; domestic consequentials £4,330m. New non-domestic buildings £1,811m; existing non-domestic £51m; non-domestic consequentials £9m. Costs borne initially by developers (capital cost and quality assurance process) but costs of maintenance and replacement borne by landowners and owners/users of buildings.

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

No account taken of the effect of increased costs on the demand for new buildings or on the supply of land for development. No account taken of cost of consequential improvements arising from replacement of controlled services in existing non-domestic buildings.

BENEFITS (£m)	Total Transition (Constant Price) Years	Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low	Optional	443m	**11,523m**
High	Optional	1,420m	**36,925m**
Best		949m	**24,671m**

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

Energy savings. New dwellings, £2,311m; existing dwellings £572m; domestic consequentials £10,924m. New non-domestic buildings, £1,648m; existing non-domestic buildings £58m; non-domestic consequentials £28m. Benefits accrue to occupiers of new buildings. Carbon and other savings. New dwellings, £478m; existing dwellings £430; domestic consequentials £7,900m. New non-domestic buildings, £292m; existing non-domestic £8m; non-domestic consequentials £22m.

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

The savings to individual consumers will be greater than shown above because of reduced payments for network charges and VAT. No allowance made for the contribution of reduced energy demand to fuel security, the potential increase in business and employment opportunities from the development of new energy saving materials and technologies. No account taken of benefits of consequential improvements arising from replacement of controlled services in existing non-domestic buildings.

Key assumptions/sensitivities/risks **Discount** 3.5%

Sensitivity to future energy and carbon values has been tested using the Interdepartmental Analysts Group recommended high and low values. For new dwellings, sensitivity analysis has also been carried out to assess the impact of removing the fuel factor altogether, or including a full fuel factor.

BUSINESS ASSESSMENT (Option 3)

Direct impact on business (Equivalent Annual) £m:			In scope of OIOO?	Measure qualifies as
Costs: 511	**Benefits: 327**	**Net: -184**	Yes	IN

Summary: Analysis & Evidence

Policy Option 4

Description: New domestic FEES plus services, new non-domestic 20%, tighter standards for changes to existing buildings and phased requirements for consequential improvements.

FULL ECONOMIC ASSESSMENT

Price Base Year 2011	**PV Base Year** 2011	**Time Period Years** 70	**Net Benefit (Present Value (PV)) (£m)**		
			Low: 2,388m	**High:** 21,075m	**Best Estimate:** 11,953m

COSTS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Cost** (Present Value)
Low	Optional		239m	**6,590m**
High	Optional		293m	**8,054m**
Best Estimate			266m	**7,322m**

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

Increased building costs. New dwellings £1,192m; existing domestic £585m; domestic consequentials £3,674m. New non-domestic buildings £1,811m; existing non-domestic £51m; non-domestic consequentials £9m. Costs borne initially by developers (capital cost and quality assurance process) but costs of maintenance and replacement borne by landowners and owners/users of buildings.

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

No account taken of the effect of increased costs on the demand for new buildings or on the supply of land for development. No account taken of cost of consequential improvements arising from replacement of controlled services in existing non-domestic buildings.

BENEFITS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Benefit** (Present Value)
Low	Optional		326m	**8,978m**
High	Optional		1,059m	**29,129m**
Best Estimate			700m	**19,275m**

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

Energy savings. New dwellings, £559m; existing dwellings £572m; domestic consequentials £8,827m. New non-domestic buildings, £1,648m; existing non-domestic buildings £58m; non-domestic consequentials £28m. Benefits accrue to occupiers of new buildings. Carbon and other savings. New dwellings, £328m; existing dwellings £430m; domestic consequentials £6,503m. New non-domestic buildings, £292m; existing non-domestic £8m; non-domestic consequentials £22m.

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

The savings to individual consumers will be greater than shown above because of reduced payments for network charges and VAT. No allowance made for the contribution of reduced energy demand to fuel security, the potential increase in business and employment opportunities from the development of new energy saving materials and technologies. No account taken of benefits of consequential improvements arising from replacement of controlled services in existing non-domestic buildings.

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

Sensitivity to future energy and carbon values has been tested using the Interdepartmental Analysts Group recommended high and low values. For new dwellings, sensitivity analysis has also been carried out to assess the impact of removing the fuel factor altogether, or including a full fuel factor.

BUSINESS ASSESSMENT (Option 4)

Direct impact on business (Equivalent Annual) £m:			**In scope of OIOO?**	**Measure qualifies as**
Costs: 320	**Benefits:** 327	**Net:** 7	Yes	ZERO

EVIDENCE BASE

1 OUTLINE OF PROPOSED CHANGES

Background and scope of proposals

1.1 Under the Climate Change Act 2008, the UK has committed to legally binding greenhouse gas emissions reduction targets of at least 34% by 2020 and at least 80% by 2050 (relative to 1990 levels), with 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 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 (SI 2010/2214). 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 it impacts on 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. 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. Options for changes to the regulations in 2013 have been developed to act as an interim step on the trajectory towards achieving zero carbon standards from 2016/19.

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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

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

1.4 Recent research[4] on 2016 emissions targets for zero carbon homes has proposed that action is needed by industry and Government to investigate and tackle the perceived gap between the energy performance of new homes as calculated at the design stage, and the as built performance of the same buildings. There are also concerns, often anecdotal, about the level of compliance (whether wilful or due to lack of awareness or technical factors in the construction process) with the regulations. This is a different issue to that of discrepancy between performance as measured at the design stage and on completion, but the two are linked, and action to address one may help deal with the other. While this work is at an early stage, this impact assessment reflects the proposed introduction of an enabling framework to incentivise housebuilders to develop and adopt quality processes and makes an initial assessment of how this might impact on developers building to the 2013 standards.

1.5 The Green Deal is the Government's flagship policy designed to significantly reduce emissions from **existing buildings** through promoting an increase in retrofit activity. The Green Deal will create a new financing mechanism to enable private firms to offer domestic and non-domestic consumers energy efficiency improvements to their buildings at no upfront cost, and to recoup payments through a charge in instalments on the energy bill. Part L already places a requirement for additional 'consequential' energy efficiency improvements on certain renovation and replacement works in buildings over 1000m^2. This impact assessment looks at options for extending these requirements where availability of Green Deal finance could offset the upfront cost to the building owner of meeting these requirements. It also looks at options for strengthening the performance standards for certain works to existing buildings.

1.6 Reducing energy demand through strengthened energy efficiency requirements not only helps to reduce UK carbon emissions it also helps to reduce people's fuel bills and depletion of energy resources.

Rationale for intervention

1.7 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.

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[4] http://www.zerocarbonhub.org/resourcefiles/CC_TG_Report_Feb_2011.pdf. The Zero Carbon Hub is a body established to facilitate the delivery of zero carbon homes from 2016. The Hub works closely with Government.

[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

1.8 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.

1.9 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 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. For these reasons the basic principle of the zero carbon standards (and interim regulatory steps) is a **'fabric first'** approach, with energy efficient fabric and services prioritised over renewable generation technologies. This said,

adopting a performance based approach, which involves setting an overall carbon emissions or energy demand target without prescribing how this is met, gives the designer choice in the combination of elements they adopt to meet this standard. This approach, through giving flexibility in how the outcomes are achieved, stimulates innovation in the construction process.

1.10 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 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

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

(a) The **Green Deal** is at the heart of the Government's policy for improving the energy performance of existing buildings. We are proposing options for extending the requirements for consequential improvements on existing buildings where work is already planned and Green Deal finance is available.

- The new requirements would be implemented via the Building Regulations. In this impact assessment we have claimed 100% of the savings, however for the final impact assessment we will work with Department for Energy and Climate Change to reconsider the allocation of costs and benefits between the Building Regulations and the Green Deal. The regulatory requirements would be subject to the existing limitation whereby consequential improvements are not required if the works are not functionally, technically and economically feasible. So for example the requirement would not apply where a building owner was unable, on the grounds of cost-effectiveness, to secure Green Deal finance to meet the up-front costs. This should mean up-front costs for the improvement measures can be avoided by households or businesses. Further analysis for the final impact assessment will look at associated costs including hidden costs and finance costs. This is discussed further in section 2.

(b) The **EU Emissions Trading Scheme** (ETS) addresses carbon emissions associated with the generation of electricity. To a great extent, the building-related emissions from homes are associated with space and water heating

using gas fired appliances, and thus fall 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 2013 standards for new buildings prioritise 'locked-in' fabric and fixed services efficiency. The preferred option for standards for new homes can be met without the need to install renewable energy technologies, largely avoiding overlap with the ETS.[6] For new non-domestic buildings, all the options suggest some traded carbon savings, as all the options assume higher standards for fixed services including electric lighting, and the higher options assume the installation of photovoltaic (PV) panels in many building types.

(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 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 boilers) then the Regulations provide the enabling installation arrangements (for example requiring commissioning and controls upon installation of boilers).

(d) The recast **EU Energy Performance of Buildings Directive (2010/31/EU)** requires Member States to improve the energy performance of new and existing buildings in a variety of ways, and must be transposed into national law no later than 9 July 2012, with the provisions introduced by 9 July 2013.

- Part L played an important role in transposing the original 2002 Energy Performance of Buildings Directive, in particular on the setting of minimum energy performance requirements for new and refurbished buildings. In many respects the current Regulations already meet the requirements of the recast Directive, meaning that these will have a zero or limited cost/benefit impact.

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6 As noted in the latest DECC guidance (Valuation of energy use and greenhouse gas emissions for appraisal and evaluation, June 2010), 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

- Part L and the Building Regulations will have a key role in implementation of some of the new 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[8], and the costs and benefits have been examined in DCLG impact assessments on the zero carbon standards. Proposals for transposition of these provisions are discussed in the main Part L consultation proposals, and national plans for evaluation by the European Commission will be finalised by July 2012. However, these plans do not impose costs or benefits from 2013, and as such are not discussed in this impact assessment, except in so much as the 2013 changes are a step on the trajectory towards zero carbon standards in the future.

(e) 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. The lower options for Part L 2013 new build standards in this impact assessment should be achievable by most buildings without the need for renewables. The higher options for levels of uplift from 2013 (and potentially later standards post-2013) would be likely to result in more building-integrated renewables, where this is cost effective. The main costs and benefits of transposition and implementation of the Directive are assessed by Department for Energy and Climate Change.

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 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 Government has previously committed to introducing a Fabric Energy Efficiency Standard (FEES) for zero carbon homes, but has not stated when or how this will be introduced into regulation. FEES is a performance target measured in terms of total space heating and cooling load, and was developed by the Zero

[8] 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.

Carbon Hub in November 2009[9]. It is differentiated by building type and expressed as a maximum delivered energy demand by floor area. Apartment blocks and mid terrace houses have a maximum energy demand of 39 kWh/m²/yr, and semi-detached, end of terrace and detached houses have a maximum energy demand of 46 kWh/m²/yr. The options for 2013 standards are all set on the basis of different standards for different home types (as was introduced for non-domestic buildings in 2010).

1.14 This IA assumes that the 2016 carbon emissions limits[10] for new homes will be those proposed by the Zero Carbon Hub[11]. The assumption behind these targets is that over and above the FEES, new homes will have renewable energy generation technologies installed to further reduce carbon emissions (to a cost-effective level). The proposed targets are:

(a) Detached houses: 60% reduction of regulated emissions from a 2006 baseline (or absolute target of 10 kg.CO_2/m^2/yr – see paragraph 1.16 below)

(b) Attached houses (mid and end terraced houses): 56% (11 kg.CO_2/m^2/yr)

(c) Low rise apartment blocks: 44% (14 kg.CO_2/m^2/yr)

(d) High rise apartment blocks: the Zero Carbon Hub did not recommend a 2016 target for these buildings, suggesting that more work was needed on this. High rise blocks have a small roof area compared to floor area, meaning that there is limited potential for PV panels (which are the main renewable technology used as a ***proxy*** in the Hub's modelling) and thus limited potential for further reductions without resorting to communal solutions (ie district heating or community-scale renewables).

1.15 The options for new homes examined in this IA (which are explained in more detail in the following section) are to:

(a) Do nothing

(b) Introduce CO_2 emission standards equivalent to introducing the FEES 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 is the preferred approach***.

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9 *Defining an energy efficiency standard for zero carbon homes*, Zero Carbon Hub, November 2009 http://www.zerocarbonhub.org/resourcefiles/ZCH-Defining-A-Fabric-Energy-Efficiency-Standard-Task-Group-Recommendations.pdf

10 For the purposes of this work, these absolute values have been rebased (with the cooperation of the Zero Carbon Hub) to reflect proposed changes in carbon emission factor. The relative values (% improvements) remain unchanged.

11 *Carbon Compliance: setting an appropriate limit for zero carbon new homes* February 2011, http://www.zerocarbonhub.org/definition.aspx?page=8

(c) Introduce CO_2 emission standards equivalent to a 'halfway' point towards the recommended 2016 carbon compliance standards (see above).

1.16 ***Any change in the domestic new build standards would come into force from October 2013, subject to any transitional arrangements***.

1.17 The Zero Carbon Hub has recommended that from 2016, standards for energy efficiency and carbon emissions should be set on an 'absolute' basis (kWh/m^2/year and kg.CO_2/m^2/year), regardless of size and shape of the actual building, with standards differentiating only by building type (so all detached houses would meet the same energy demand standard per m^2, regardless of the shape of the building). However, for Part L 2013 carbon compliance targets we propose to retain the 'notional building' approach of calculating standards, which is based on a recipe of fabric and services standards (walls, windows, boiler etc.), with the final target tailored to the size and shape of the actual building. In order to prepare for a potential move to absolute standards from 2016, it is proposed that absolute delivered energy targets will be built into the calculation methodology, and builders will be required to meet these.

New non-domestic buildings

1.18 As for new homes, a 2013 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 2013 the emphasis has been on setting challenging on-site targets based on an assessment of what levels of improvement would be cost-effective in 2013.

1.19 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.

1.20 The options for new non domestic buildings examined in this IA are:

(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 is the preferred approach.***

1.21 ***Any change in the non-domestic new build standards would come into force from October 2013, subject to any transitional arrangements***.

Existing buildings

Raising standards for works to existing buildings

1.22 Much has been done through previous Part L amendments to strengthen energy efficiency standards when building owners carry out building work to existing properties. Although this is approaching the point of diminishing return, there remains some potential to further raise performance standards eg for extensions and replacement windows and potential improvements in controlled services. This IA assess the impact of:

(a) Raising performance standards for domestic and non-domestic extensions, and

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

1.23 ***Any changes to the standards for works to existing buildings would come into force from October 2013***.

Consequential improvements

1.24 The impact of introducing 'consequential' energy efficiency improvements for existing buildings is also assessed. The options all assume that requirements for consequential improvements would be limited to situations where work is already planned and the up-front cost of installing energy efficiency measures to meet the new requirements can be met by the Green Deal (though building owners would be free to use an alternative funding mechanism). In determining the relationship between triggers and required energy efficiency measures, what is reasonable and proportionate are important considerations. The intention is therefore to adopt a dual approach, explained below, recognising the considerable differences of scale and cost between the proposed trigger works.

1.25 Currently consequential improvements are required where an existing building over 1000m^2 is being extended. This IA assesses the impact of applying these requirements below this threshold for both homes and non-domestic buildings, and two options for the timing of these changes. This would mean that an extension or an increase in habitable space (ie a loft or integral garage conversion) would trigger a requirement for consequential improvements elsewhere in the building. The regulatory proposal is limit the requirement to what is 'technically, functionally and economically feasible' and retain the current approach of using 10% of the cost of the original works as a guide to what would be reasonable, although a building owner could choose to go further, for example if additional measures could be included under the Green Deal.

1.26 The IA also proposes introducing the replacement of specified controlled components or fixed services as a trigger for consequential improvements, with two

options on timing. It is assumed that these works will be comparatively cheaper than an extension, thus it would be reasonable to expect the nature/cost of consequential improvements to be proportionally lower:

(a) For homes, this would mean replacement of a boiler or windows could trigger a requirement to install additional energy efficiency improvements. For this trigger, the proposal is to limit the requirement to standard energy efficiency measures (draught proofing, loft insulation, cavity wall insulation and hot water cylinder insulation)

(b) For non-domestic buildings, appropriate options for triggers and improvement measures can be identified on a case by case basis, but are likely to vary widely according to type, size and use of the building. The IA includes some case studies, and we are seeking consultees' views on how such requirements could be introduced.

1.27 On timing, there is a strong driver to introduce some of the new consequential improvement requirements from October 2012 as part of the Government's commitment to promote and support the Green Deal. The Green Deal framework is due to be in place in October 2012. The options considered are:

(a) Do nothing

(b) Introduce all new consequential improvement requirements from October 2012

(c) Introduce new consequential improvement requirements on a phased basis. In October 2012 the requirements relating to domestic extensions and increases in habitable space would come into force. In April 2014 all the other changes would come into force (non-domestic extensions, and specific components and fittings in homes and non-domestic buildings). ***This is the preferred approach.***

Compliance and performance

1.28 The Government welcomes 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[12]. For new homes, it is proposed that a quality assurance process be developed by industry and incentivised through the regulations to encourage continual process improvement. 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 (and references to a PAS in this document should be read in that context)

[12] http://www.zerocarbonhub.org/definition.aspx?page=8

to encourage continual improvement. This could be supported by sample testing to create feedback loops and help gather energy performance data to inform the zero carbon step.

1.29 The IA includes a preliminary estimate of the costs associated with incentivising adoption of such a quality process. It is expected that this will lead to additional reductions in CO_2 and better evidence about the energy performance of new homes but this is more difficult to predict at this stage. Given the uncertainty about the content and timetable for this work and the scale of improvement that might be achieved, these additional reductions are not taken into account in the main analysis.

Summary of options

1.30 The four options covered in this impact assessment are summarised below:

1. ***Do nothing***. This means no change to the 2010 Part L regulations

2. ***Central case***. This means the 'FEES plus efficient services' option for new homes and an 11% aggregate improvement on 2010 standards for new non-domestic buildings plus tighter standards for works to existing buildings (window energy ratings raised from C to B and fabric performance for extensions strengthened) and introduction of requirements for consequential improvements phased in between October 2012 and April 2014

3. ***High case***. This means the 'halfway point' standard for new homes and a 20% aggegate improvement on 2010 standards for new non-domestic buildings plus tighter standards for works to existing buildings (windows and extensions) and introduction of all requirements for consequential improvements in October 2012

4. ***Hybrid case***. 'FEES plus efficient services' for new homes and a 20% aggegate improvement on 2010 standards for new non-domestic buildings plus tighter standards for works to existing buildings (windows and extensions) and introduction of all requirements for consequential improvements phased in between October 2012 and April 2014. ***This is the preferred approach.***

Regulatory burden: 'One In One Out'

1.31 'One In One Out' is the Government's commitment[13] that any new regulatory cost introduced by a department (an In) will at least be matched by cuts to the cost of

[13] www.bis.gov.uk/policies/better-regulation/better-regulation-executive/reducing-regulation-made-simple/one-in-one-out

existing regulations (Outs). Only costs and benefits to businesses and civil society organisations are included in One In One Out calculations.

1.32 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.

1.33 In the 2010 Comprehensive Spending Review[14] 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). Like the One In One Out rule, this means that any new regulation must be **at least** matched by deregulatory measures of the same value. 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.

Impacts on business

1.34 The costs and benefits of the different individual scenarios are shown below, with an indication of the option to which they relate. The net benefits to business overall are slightly higher than the net cost to business so the IA is in effect zero for One In One Out purposes for the preferred consultation option, although the final net impact will depend on policy decisions made in response to consultees' views and the outcome of more detailed analysis.

1.35 The assessment period for calculating the impact upon business is 10 years and for the overall NPV calculation it is 70 years.

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

Table 1.1: Cost and benefits to business

	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	Options 2 and 4	FEES + efficient services	(103)	0	**(103)**
	Option 3	Halfway point	(294)	0	**(294)**
New non-domestic buildings	Option 2	11%	(104)	180	**75**
	Options 3 and 4	20%	(210)	311	**101**
Existing non-domestic buildings – raising standards eg extensions	Options 2, 3 and 4	11%	(6)	11	**5**
Existing non domestic - consequential improvements	Options 2, 3 and 4[15]	n/a	(1)	5	**4**

1.36 The overall impacts of the summary options are shown in Table 1.2.

Table 1.2: Business assessment summary (£m)

	Equivalent annual cost (£m)	**Equivalent annual benefit (£m)**	**Net (£m)**
Option 1	0	0	0
Option 2	(214)	196	(18)
Option 3	(511)	327	(184)
Option 4	(320)	327	7

1.37 The overall impact of the preferred Option 4 is an equivalent annual net benefit to business of £7m, which breaks down as follows.

[15] Because of the relatively small number of extensions to buildings under 1000m^2, for consultation stage we have not examined the difference in costs and benefits between the requirements coming into force in October 2012 and April 2014, as over 10 years this will not result in a significant difference.

Table 1.3: Breakdown of costs and benefits of preferred option

	Equivalent annual net (cost) or benefit to business (£m)
Changes to standards for new homes	(103)
Changes to standards for new non-domestic buildings	101
Improved fabric standards for extensions to existing non-domestic buildings	5
Requirements for consequential improvements in non-domestic buildings	4
Total	**7**

2 ESTIMATION OF COSTS AND BENEFITS

Overview

2.1 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 2012/13 compared with a baseline of costs and energy use implied by the 2010 standards which are now in place[16]. We have reviewed four types of building development:

(a) New homes, broken down between detached, semi-detached/end-terraced, mid-terraced houses and four storey apartment blocks

(b) Extensions, window and boiler replacements and a range of energy efficiency improvements to existing homes (to assess the impact of raising window and extension standards and introducing consequential improvements)

(c) New non-domestic buildings represented by the building types which represent 70% to 80% of the new build mix: distribution and retail warehouses, deep plan and shallow plan air conditioned offices, hotels and secondary schools. Although this does not cover every non-domestic building type, this breakdown is intended to give an indication of the impact for the non-domestic stock as a whole

(d) Extensions, replacement of key components and a range of energy efficiency improvements in existing non-domestic buildings (to assess the impact of raising standards for extensions and introducing additional consequential improvements).

2.2 We have taken a common set of assumptions on fuel prices, traded and non-traded carbon values, emissions factors and the value of avoided renewables from Department for Energy and Climate Change guidance "Valuation of energy use and greenhouse gas emissions for appraisal and evaluation, July 2010". This guidance was updated in October 2011 and will be reflected in the implementation stage impact assessment. A discount rate of 3.5% has been used for the first 30 years of building life and 3% for subsequent years. This is in line with guidance in HM Treasury's Green Book - Appraisal and Evaluation in Central Government.[17]

2.3 The figures in the following analysis are all based on central estimates, though ranges have also been calculated, as shown in the summary sheets.

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[16] This IA has been prepared by DCLG with supporting technical and economic analysis from an AECOM consortium including Europe Economics.

[17] http://www.hm-treasury.gov.uk/d/green_book_complete.pdf

New homes

2.4 Work has been undertaken to assess the costs and benefits of improvement in energy efficiency and reductions in carbon emissions. For each dwelling type a number of packages of measures (fabric, fixed services and low and zero carbon technologies) have been evaluated.

2.5 The model for new homes has been run under the following policy scenarios:

(a) A CO_2 target based on full FEES and the use of efficient services ('FEES + efficient services' in the following tables).

(b) A CO_2 target which is half way between the Part L 2010 target and the full carbon compliance target being proposed by Zero Carbon Hub for 2016 ('Halfway point' in the following tables).

2.6 The four house types modelled are the same core dwelling models used by the Zero Carbon Hub for both the previous Fabric Energy Efficiency and Carbon Compliance work.

2.7 All dwellings were modelled with three different fabric specifications. These were developed in discussions with a group of industry representatives (including homebuilders and product manufacturers) in spring/summer 2011, in the context of identifying a cost-effective step that aided the transition towards zero carbon standards from 2016. Options that introduced technologies or design solutions which were deemed at risk of becoming obsolete from 2016 were rejected on the grounds that they would not aid learning in building to 2016 standards.

2.8 The majority view of this industry group was that the most sensible option for the Part L 2013 carbon target was the 'FEES plus efficient services' compliance option. While it is possible to set a lower fabric standard (interim FEES), the industry representatives' view was that if the FEES is a certainty for introduction in 2016, only by introducing it in full in 2013 will the industry gain meaningful experience in building to this standard. Hence those that favoured any change in 2013[18] favoured the introduction of FEES. The three compliance options are:

(a) 'Interim FEE' – An example interim fabric energy efficiency specification

(b) 'FEES' – The Fabric Energy Efficiency Standard for zero carbon homes

[18] Some housebuilder representatives favoured no change, though acknowledged that if a change was made, then the FEES plus efficient services was the most sensible option.

(c) A fabric only specification that exceeds the FEES specification (only used for the 'Halfway point' scenario and electric heated flats in the 'FEES + efficient services scenario). This was developed to test the costs of going to a halfway point towards zero carbon without the use of renewable energy generation technologies (see Appendix 1 for further details).

2.9 The issue of whether to set mandatory energy targets at the full or interim levels is discussed in the consultation document. This IA assumes that builders would go with the most cost effective choice, which is building to full FEES levels, hence the modelled costs and benefits are the same regardless of whether the regulatory targets are set at the higher or lower levels.

2.10 All dwellings were modelled with an efficient package of services including a 90% efficient gas boiler and 100% low energy lighting.

2.11 Each of the fabric and services scenarios leads to the achievement of a particular level of carbon emissions. Where this combination of fabric and services failed to meet the target being modelled for, photovoltaic panels were used as a ***proxy*** for on-site electricity generation in order to achieve the required target[19]. PV is used as a proxy because this technology can be applied to a wide variety of building types.

2.12 The model makes an assessment of the most cost-effective way of meeting these standards, given today's technologies and assumed learning rates. Designers would be free to choose alternative technologies to meet the required outcome.

2.13 Estimates of the effects of the different options for CO_2 targets in terms of percentage uplifts on 2010 standards are shown and discussed in the consultation document.

2.14 All modelling was carried out in SAP 2009. SAP is the responsibility of the Department for Energy and Climate Change (DECC) and is currently under review although significant changes are not expected. The modelling in this IA uses the following emission factors to rebase both the Part L 2010 and proposed 2016 emission standards.

(a) Gas: 0.202 kgCO_2/kWh.

(b) Electricity: 0.523 kgCO_2/kWh.

[19] For the fabric only specification, it was possible to meet with half-way point without any PV.

Part L 2013 will use the updated SAP methodology and CO_2 factors, which are being consulted upon by Department for Energy and Climate Change and will be published following consultation[20].

2.15 Part L currently includes a "fuel factor" to provide some relief in the carbon compliance target for those who use more carbon intensive fuels eg to heat homes that are off the gas grid or in blocks of flats where a gas service to each apartment is not preferred for safety reasons.

2.16 The consultation seeks views on options to retain, reduce or remove the fuel factor. As a central case, a 'reduced' fuel factor has been used in the main modelling for this impact assessment, but this will be reviewed for the final stage impact assessment.

2.17 Reducing or removing the fuel factor does however increase the incremental capital costs for homes heated by fuels more carbon intensive than gas and in turn influences the cost benefit analysis as the use of MVHR systems in electrically heated flats is assumed by the modelling. This is explained in more detail in the fuel factor sensitivities at Appendix 2 and the rural impacts analysis in Section 4, and also in the consultation document.

2.18 For better performing homes, reducing the fuel factor would help to guard against a home heated by an electric heat pump being constructed to a lesser fabric specification than one heated by gas. It could also help the transition towards zero carbon standards by encouraging developers with no access to gas to seek alternative low-carbon heating solutions.

2.19 The continued role of the fuel factor will be kept under review in the context of wider policies including decarbonisation of the grid and fiscal incentives such as the Renewable Heat Incentive.

2.20 To complement this modelling, the costs associated with achieving these steps have been determined. 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). This is of particular importance for low and zero carbon technologies such as PV but also for fabric. The learning rates used here are updated from those used in the analysis of zero carbon homes. The same learning benefits have been assumed for both the interim FEE and Full FEES compliance options but it is possible that there will be some additional benefit from adopting the Full FEES standard in 2013. This is the approach that builders will be expected to follow in 2016 when the zero carbon standard is introduced. If Full FEES is mandated in

[20] http://www.decc.gov.uk/en/content/cms/consultations/sap/sap.aspx

2013 then the industry may be better prepared for the 2016 changes. If interim FEE is adopted in 2013 then additional learning may be required in 2016, although it is expected that even with these less demanding interim targets, builders will still choose to build to the full FEES level, as the most cost-effective option. This issue is discussed further in the main consultation proposals, and we will explore quantification of learning benefits following consultation.

2.21 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[21]. The split between dwelling types is shown in Table 2.1.

Table 2.1: Assumption on new build by dwelling type

Building type	% in build mix	Annual number of new dwellings						
		2014	2015	2016	2017	2018	2019	2020
Detached house	16%	20,800	22,400	22,400	24,000	25,600	28,800	30,400
Semi-detached house	32%	41,600	44,800	44,800	48,000	51,200	57,600	60,800
Terraced house	13%	16,250	17,500	17,500	18,750	20,000	22,500	23,750
Flats (gas heated)	20%	25,350	27,300	27,300	29,250	31,200	35,100	37,050
Flats (electrically heated)	20%	25,350	27,300	27,300	29,250	31,200	35,100	37,050

2.22 There is a relationship between regulatory costs and housing supply, though the overall impact of the cost increases attributable to the 2013 changes is likely to be minimal. However, 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.

2.23 In addition, the following phasing assumptions have been made about the numbers of new homes which will be built to the new 2013 standards.

Table 2.1.1: Phase-in assumptions

	2014	**2015**	**2016**	**2017**	**2018**	**2019**
Phase in (% dwellings captured by Part L 2013)	40%	60%	90%	100%	100%	100%

[21] These new build rates are based on the historical housebuilding statistics (England only) which can be seen at http://www.communities.gov.uk/documents/housing/xls/1473581.xls and are an estimate of future supply which takes into account past performance in the market across housing market cycles, including appropriate rates of recovery. These estimates are consistent with those used in other DCLG impact assessments, including the May 2011 Zero Carbon Homes impact assessment.

2.24 Of those homes built to the new standards, the modelling also assumes that 15% of these would have been built to a higher standard in the absence of a regulatory change, due to overlaps such as the Code for Sustainable Homes.

2.25 On the basis of the SAP modelling and the common assumptions noted above we have estimated the following expressed as net present values (NPV) over the life of the buildings:

(a) Volume of energy savings (GWh) – split into electricity and gas savings.

(b) Volume of carbon savings ($tCO_{2(e)}$).

(c) Value of energy savings (£m) – split into electricity and gas savings.

(d) Value of carbon savings – non-traded (£m).

(e) Value of carbon savings – traded (£m).

(f) Avoided renewables (£m).

(g) Incremental building and other costs (£m).

2.26 The costs and benefits for the FEES + efficient services target and the two compliance options, compared with continuation of the existing 2010 standards, are shown in Table 2.2 first with the reduced fuel factor and then with the full fuel factor The costs and benefits for the three options for the Halfway point target are shown in Table 2.3.

2.27 For the **FEES plus efficient services target**, the Full FEES compliance option provides the lowest overall cost and the lowest regulatory cost to housebuilders when compared to the Interim FEE + PV option. For more details on assumed fabric costs see Appendix 1. The analysis shows a net benefit where the fuel factor is retained at current levels and the costs new quality assurance process are not counted. When the fuel factor is reduced, the use of a mechanical ventilation and heat recovery system (MVHR) is assumed for electric heated apartments, and this has a bearing on the NPV numbers.

2.28 For the **Halfway point target**, all of the compliance options show a net cost, even after taking CO_2 reduction into account. Interim FEE + PV has the lowest net cost of just over £600 million. Full FEES + PV is slightly higher at £734 million. This is partly because PV has a high fixed cost, so very small arrays are not cost effective. The Interim FEE option requires more PV on each building, hence has a lower cost for the energy saved. The full fabric option (which includes MVHR) is much more costly with a net NPV cost of over £3 billion. The use of MVHR also results in a significant decrease in gas use but increase in electricity use.

One In One Out policy

2.29 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 One 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 One Out policy, the tables below present the present value net cost to business based on the incremental capital costs for developers of building new homes to tighter standards, assuming first a reduced fuel factor and then a full fuel factor. Note that the central case figures used for the summary options and sensitivity analysis assume the reduced fuel factor.

Table 2.2: Aggregate approach – FEES plus efficient services target with reduced fuel factor[22]

	Interim FEE + PV	Full FEES
Energy savings (£m)	753	559
Incremental costs (£m)	(1,643)	(1,079)
Quality Process (PAS) (£m)	(113)	(113)
Sub-total (£m)	**(1,003)**	**(633)**
Carbon savings - non-traded (£m)	65	304
Carbon savings - traded (£m)	56	20
Total carbon savings (£m)	121	323
Net benefit/cost excl. avoided renewables (£m)	**(882)**	**(310)**
Avoided renewables (£m)	3	5
Net benefit/cost incl. avoided renewables (£m)	**(879)**	**(304)**
Amount of gas saved (GWh)	7,307	34,244
Amount of electricity saved (GWh)	15,967	5,596
Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	1.34	6.29
Amount of CO_2 saved - traded ($MtCO_2(e)$)	1.76	0.62
Present value net cost to business (£m)	993	887
Annual equivalent net cost to business (£m)	115	103
Average capital cost per dwelling (£) excluding PAS	1,094	795
Cost effectiveness – non-traded (£/tCO_2)	706	98
Cost effectiveness – traded (£/tCO_2)	533	534

Source: Europe Economics

[22] The costs in this table all include an allowance of £100 per dwelling to represent the cost of introducing a new quality assurance process (see section 3 below) apart from the average cost per dwelling, which is purely the increased build cost. All costs are in 2014 prices.

Aggregate approach – FEES plus efficient services target with full fuel factor

	Interim FEE + PV	Full FEES
Energy savings (£m)	577	384
Incremental costs (£m)	(1,477)	(642)
PAS (£m)	(113)	(113)
Sub-total (£m)	**(1,013)**	**(372)**
Carbon savings - non-traded (£m)	65	304
Carbon savings - traded (£m)	42	5
Total carbon savings (£m)	106	309
Net benefit/cost excl. avoided renewables (£m)	**(907)**	**(63)**
Avoided renewables (£m)	3	5
Net benefit/cost incl. avoided renewables (£m)	**(904)**	**(58)**
Present value net cost to business (£m)	(866)	(756)
Annual equivalent net cost to business (£m)	(101)	(88)
Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	1.34	6.29
Amount of CO_2 saved - traded ($MtCO_2(e)$)	1.31	0.17
Cost effectiveness – non-traded (£/tCO_2)	724	58
Cost effectiveness – traded (£/tCO_2)	725	407

Table 2.3: Aggregate approach – Halfway point target[23]

	Interim FEE+PV	Full FEES + PV	Fabric only
Energy savings (£m)	2,507	2,311	1,491
Incremental costs (£m)	(3,269)	(3,409)	(5,760)
Quality Process (PAS) (£m)	(113)	(113)	(113)
Sub-total (£m)	**(875)**	**(1,211)**	**(4,382)**
Carbon savings - non-traded (£m)	65	304	1,309
Carbon savings - traded (£m)	200	163	9
Total carbon savings (£m)	264	467	1,318

[23] The costs in this table all include an allowance of £100 per dwelling to represent the cost of introducing a new quality assurance process (see section 3 below) apart from the average cost per dwelling, which is purely the increased build cost. All costs are in 2014 prices.

Net benefit/cost excl. avoided renewables (£m)	**(611)**	**(745)**	**(3,063)**
Avoided renewables (£m)	9	11	21
Net benefit/cost incl. avoided renewables (£m)	**(602)**	**(734)**	**(3,043)**
Amount of gas saved (GWh)	7,307	34,244	147,673
Amount of electricity saved (GWh)	56,853	46,440	2,688
Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	1.34	6.29	27.11
Amount of CO_2 saved - traded ($MtCO_2(e)$)	6.27	5.12	0.30
Present value net cost to business (£m)	2272	2533	2920
Annual equivalent net cost to business (£m)	264	294	339
Average capital cost per dwelling (£) excluding PAS	2662	2866	2902
Cost effectiveness – non-traded (£/tCO_2)	503	167	161
Cost effectiveness – traded (£/tCO_2)	129	177	10371

Source: Europe Economics

Sensitivity tests

2.30 We have carried out sensitivity tests using higher and lower values of future energy prices and CO_2 values using the range of values in the Department for Energy and Climate Change Interdepartmental Analysts' Group guidance. Higher energy prices and carbon values reduce the net cost (or increase the net benefit) of the different scenarios. For the FEES + efficient services scenario the net cost of the interim FEE option falls to just over £700 million NPV and the Full FEES option shows a net benefit of just over £200 million NPV. For the Halfway point target both the Interim FEE and Full FEES options show small net costs and the net cost of the Fabric only option falls to just under £2 billion NPV.

2.31 Lower energy prices and carbon values result in increased net costs. For FEES + efficient services, the Interim FEE option has a net cost of £1.2 billion NPV and Full FEES a net cost of just over £400 million NPV. For the Halfway point target both Interim FEE and Full FEES options have a net cost of about £2 billion NPV and Fabric only has a net cost of over £4.5 billion NPV. The full cost benefit tables for these sensitivity tests are set out in Appendix 2.

2.32 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% reduction in the number of new homes would reduce costs and benefits by 10%. We have not included full cost benefit tables to support this simple scaling factor.

2.33 Part L 2013 will adopt updated CO_2 factors to be published by Department for Energy and Climate Change following consultation. The modelling in this IA reflects

the Department for Energy and Climate Change proposals at the time this modelling was carried out (summer-autumn 2011) – that is, factors based on a three year system average. For the FEES + efficient services scenario we have assessed the effects of all three options (retaining, reducing or removing in full) for the fuel factor (see Section 4 for results).

2.34 We have also considered the impact of lower learning rates on the costs of new homes. AECOM has estimated the incremental capital cost compared to a 2010 compliant building for new building types for each scenario with different specifications of fabric and low and zero carbon technologies. These estimates incorporate the impact of learning effects on costs (see Appendix 3). If the assumed learning is halved then this incremental capital cost increases by between 10% and 15%. This has not been subject to full cost benefit analysis but as a general indication the incremental costs shown in Table 2.2 and Table 2.3 should be increased by these percentage amounts.

Existing homes

Performance standards for extensions and replacement windows

2.35 For existing homes we have estimated the costs and benefits of for the following changes. Energy savings are valued at the variable rate in accordance with the Green Book guidance. These are the key categories of works on existing buildings where it is proposed that 2013 **performance** standards should differ from those now in place under the 2010 Regulations:

(a) Replacement of windows with 5.8 million units replaced a year. Currently Part L guidance says that replacement windows should be the equivalent of a Window Energy Rating[24] Band C or better (broadly equivalent to a whole window unit U value of 1.6 W/m^2.K). The option of raising this to Band B equivalent (U value of around 1.4) has been assessed. We assume that 25% of windows being replaced would be replaced to a standard of 1.4 in the absence of any changes to the Part L standards; therefore, we assume that 4.3 million units are replaced a year to tighter standards as a result of the changes to Part L.

(b) Extensions averaging 12m^2, with 150,000 extensions a year. The proposal is to strengthen fabric performance standards and window performance standards as follows: walls would be built to a U value of 0.2; roofs to 0.15; floors to 0.17; windows to 1.4; and doors to 1.2. There is an argument that the fabric standards for extensions should be consistent with the proposed 2013 new build

[24] The British Fenestration Rating Council's energy efficiency labelling scheme for windows, which is recognised in the Building Regulations as one way of demonstrating the performance of windows - http://www.bfrc.org/trade/energyRatings.aspx

standards. However to allow for some flexibility eg aligning floor levels, extension standards broadly similar to those modelled for Part L 2010 new homes are proposed and reflected in this IA.

2.36 We have also assumed that the cost of replacement windows (and replacement windows in extensions) will decrease over time. The following learning rates for replacement windows have been assumed:

Table 2.4: Learning rates for replacement windows

2011	2012	2013	2014	2015
100%	100%	100%	75%	50%

Source: AECOM, Cyril Sweett and Zero Carbon Hub

2.37 Table 2.5 shows the results of this analysis. Energy savings are slightly smaller than the incremental costs and with added benefits from CO_2 savings there is a net benefit of over £0.4 billion NPV.

Table 2.5: Extensions and window replacement in existing buildings

	Total	Extensions	Replacement Windows
Energy savings (£m)	572	223	349
Total incremental cost (£m)	585	369	216
Total financial cost/benefit (£m)	**(13)**	**(146)**	**133**
Carbon savings - non-traded (£m)	418	204	214
Carbon savings - traded (£m)	0	0	0
Total carbon savings (£m)	418	204	214
Net benefit/cost exc. avoided renewables (£m)	**405**	**58**	**347**
Avoided renewables (£m)	12	4	8
Net benefit/cost incl. avoided renewables (£m)	**417**	**62**	**355**
Amount of gas saved (GWh)	*49,151*	*23,400*	*25,751*
Amount of electricity saved (GWh)	*0*	*0*	*0*
Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	*9.03*	*4.30*	*4.73*
Amount of CO_2 saved - traded ($MtCO_2(e)$)	*0.00*	*0.00*	*0.00*
Average capital cost per dwelling (£)	n/a	274	47
Cost effectiveness – non-traded (£/tCO_2)	*1*	*34*	*(28)*
Cost effectiveness – traded (£/tCO_2)	na	na	na

Source: Europe Economics

Consequential improvements

2.38 The consultation is proposing options for extending and expanding the regulatory requirement for additional 'consequential' energy efficiency improvements where

defined building work takes place in an existing building. The guiding principles in developing these proposals are that:

(a) Consequential improvements should be required only when defined notifiable building work is already planned.

(b) Green Deal finance should be an option to offset any upfront costs (should the building owner wish to choose this financing route).

(c) The consequential measures must be in proportion to the nature and cost of the original work. The consultation proposes that as with current regulatory requirements for consequential improvements, only what is 'technically, functionally and economically feasible' should be required[25].

2.39 The Green Deal is the Government's flagship policy for achieving significant reductions in emissions from existing buildings, and is designed to encourage a step change in retrofit activity. The framework for the Green Deal is due to be in place in October 2012. The Green Deal will create a new financing mechanism to enable private firms to offer domestic and non-domestic consumers energy efficiency improvements to their buildings at no upfront cost, and to recoup payments through a charge in instalments on the consumer's energy bill. We have developed two options for the timing of the introduction of these requirements, and these are discussed below. Both assume that at least some new requirements should be introduced in October 2012.

2.40 While the Building Regulations requirements for consequential improvements will not be explicitly linked to the Green Deal, it is an important element of this policy to ensure that any measures which are required under the Building Regulations have the potential to be provided at no upfront cost, as part of a Green Deal offer.

2.41 In order to identify possible points at which requirements should be triggered, consideration has been limited to particular works which are already notifiable under the Building Regulations. This should ensure that only reasonably significant works are caught and minor property improvements (such as decorating or replacement of minor fixtures and fittings like a kitchen fan) are avoided.

2.42 The consultation document proposes that consequential improvements should be required in the scenarios outlined below. More detailed discussion on these options can be found in the consultation document, and DCLG is considering how best to engage consumers on these issues as part of the consultation exercise.

[25] Regulation 28 of the Building Regulations 2010.

(a) **Extensions and increases in habitable space**. Consequential improvements are already required for buildings over 1000m^2 which have an extension added[26]. These existing requirements apply to both homes and non-domestic buildings, though in practice there are very few homes which are larger than 1000m^2. As such, this requirement excludes the vast majority of extensions and conversions carried out each year, most of which are in homes. We are therefore proposing to apply the requirements for consequential improvements to all existing buildings which undergo works to add an extension or provide an increase in habitable space (ie loft and integral garage conversions).

The assumption for consultation is that 10% of the value of the original works would serve as a guide to the value of consequential improvements to be carried out. It is assumed that in practice this would mean that building owners would assess, possibly in consultation with their builder or architect, what consequential improvements were needed, and that the work would be carried out at a similar time to the main building work. While this would increase the cost of the overall project, the consultation proposes that if the building occupier could demonstrate that they were unable to obtain Green Deal finance to cover the upfront cost because the measures were not cost-effective, there would be a strong case that no further measures were required.

(b) **The replacement of specified controlled services or fittings**:

For **homes** we propose to limit this to the replacement of a boiler or multiple windows. It is proposed that the required improvements would be a specified list of standard, relatively cheap energy efficiency measures, and the homeowner would assess which were necessary for their building. Where a homeowner did not wish to use the Green Deal, or posses a valid Energy Performance Certificate, information would be available via the Planning Portal, DirectGov and the planned Green Deal Advice Unit to help them reach a view about which measures it would be cost-effective to install. The practical application of these changes would be different to those for extensions, as most window and boiler replacements are done by 'Competent Persons Schemes', many of whom are specialists in their particular field and would not be suitable contractors to carry out the consequential works. As such it is proposed that these contractors would provide information to homeowners on where to find guidance on meeting the requirements for consequential improvements, and local authorities would have the opportunity (but not the obligation) to follow up where they deemed necessary. The consultation acknowledges that further work is needed

[26] As required under Regulation 28 of the Building Regulations. For buildings over 1000m2, there would be no change to the current requirements, and these requirements are not discussed further in this impact assessment.

to assess how this process could work, and highlights the potential impact of hidden costs in these cases.

For **non-domestic buildings**, a number of case studies are outlined below and we are seeking views on whether there are appropriate trigger points which could apply across the board to non-domestic buildings.

(c) **The initial provision of a fixed building service, or an increase to the installed capacity of a fixed building service only in buildings over 1000m^2**. These triggers are already in the Regulations. We do not propose to change these or extend these requirements to smaller buildings, and as such these are not discussed further in this impact assessment.

2.43 The analysis is based on assumptions of 200,000 extensions and loft or integral garage conversions per year; replacement of windows in approximately 1 million dwellings per year and replacement of a boiler in approximately 1.4 million homes per year.[27]

2.44 It is important to note that if a building has already undergone energy efficiency improvements (a modern boiler, loft insulation, filled cavities), or if it is a relatively new building with a high energy performance, then there would be no further requirement.

Timing

2.45 We have considered two scenarios for the introduction of these requirements:

(a) ***A single commencement date with all requirements introduced in October 2012***, in tandem with the planned introduction of the Green Deal framework. This would start to have an effect from 2013[28]. This approach maximises the benefits of cost effective regulatory abatement and provides a strong degree of certainty to the Green Deal market about the Government's commitment to retrofit (with a means for avoiding up-front costs for consumers). However, it would represent a significant change in regulatory requirements for works to existing buildings which would have to be implemented over a relatively short timescale. Doing this alongside introduction of the Green Deal framework means that key players in the supply chain (eg product manufacturers, installers, building control officers) would need to adapt and plan in readiness

[27] These assumptions are based on work carried out for the Impact Assessment of changes to Part L 2010. The estimate of numbers of extensions is derived from DCLG Planning statistics: http://www.communities.gov.uk/planningandbuilding/publications/statistics/ and the Replacement boiler and window volumes come from Heating and Hot Water Information Council sales statistics and Glass and Glazing Federation 2008 market research respectively.

[28] Since the modelling only operates from 2013 it does not include any allowance for the period October to December 2012 in either option (a) or (b).

for the changes, to avoid capacity issues and mitigate against risk of non-compliance due to lack of understanding about the new requirements.

(b) ***A phased scenario. From October 2012, consequential improvements would be triggered where a home is extended or has its energy use or habitable space increased. From April 2014 the same requirements in relation to extensions and increases in habitable space would be applied to smaller non-domestic buildings, along with requirements for consequential improvements where domestic boilers or windows, and non-domestic components or services (to be specified) are replaced***. Under this incremental approach, the modelled benefits remain significant but are realised on a slower basis as boilers and windows provide the majority of trigger opportunities in homes. This would limit the short term potential of the policy and provide a more limited, but still tangible, signal to the Green Deal market for October 2012. A phased approach provides opportunity to understand how providers are organising and innovating in response to the Green Deal. It would also allow more time for industry to adapt to the Green Deal scheme, and time to consider detailed arrangements and potential changes to, for example, reporting and communication arrangements between Gas Safe registered installers and Competent Persons schemes (who carry out the majority of boiler and window replacements), building owners and building control bodies, who are responsible for assessing Building Regulations compliance.

Further policy / cost considerations

2.46 Department for Energy and Climate Change's analysis on the Green Deal takes account of the impact of hidden costs. We have not yet monetised hidden costs for the introduction of consequential improvements in the Building Regulations, but these are likely to have an impact – for example where the proposed works (eg a boiler replacement) are not naturally linked to the required consequential improvement (eg cavity wall insulation). These will be monetised for the final impact assessment in light of further work with Department for Energy and Climate Change on the Green Deal evidence base[29].

2.47 Department for Energy and Climate Change are also looking at the impact of comfort taking, with current analysis suggesting that this could have a significant effect on the calculated energy saving benefits. Comfort taking has not been

[29] In preparing the final stage impact assessment for Part L, we will consider updated DECC analysis, including the November 2011 DECC Green Deal impact assessment: http://www.decc.gov.uk/en/content/cms/consultations/green_deal/green_deal.aspx#ia, which contains (among other things) updated assumptions on hidden costs and comfort taking.

factored into the costs and benefits for this work, but will be included at implementation stage.

2.48 At this stage, the costs to householders and businesses of the financing of the Green Deal loan repayment have not been incorporated into the analysis. Although Green Deal availability is an important factor in the proposals for consequential improvements, it is not compulsory for those carrying out the work to use Green Deal finance, for instance where cheaper finance is available, which may particularly be the case for non-domestic buildings. We will also consider what costs consumers may incur in identifying whether there is a requirement for consequential improvements, and if so, what measures might be required. Where the conclusion is that no measures are required, this could constitute an extra cost without benefits. For the final stage this will be considered further, and we will ensure that this analysis is consistent with Department for Energy and Climate Change's analysis on finance costs.

2.49 We will also want to consider how the requirements may be viewed by consumers who are planning works, in particular more significant extension works, and whether the proposals will affect their decision to continue with the work. If the proposals were to reduce the number of extensions and small (domestic and non-domestic) building projects then this would have impacts for business which would need to be considered.

2.50 Overlaps between consequential improvements, the Green Deal and the new Energy Company Obligation are also a significant issue. We have used estimates from the December 2010 published Department for Energy and Climate Change Green Deal impact assessment[30] for the proportion of properties that would, in each year, already have taken a particular measure using Green Deal finance and hence would not be required to make a consequential improvement even though it was triggered. Further work will be done on overlaps for the final stage impact assessment.

2.51 The introduction of changes on a phased basis is the preferred approach on the basis that this provides some certainty to the Green Deal market, but allows more time to consider how the arrangements would apply in practice to the other trigger events. However, further refinement is needed on this analysis as explained above, and we also need to take account of views from consultees.

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[30] Impact Assessment for the Green Deal Elements of the Energy and Climate Change Bill, published in December 2010 - http://www.decc.gov.uk/assets/decc/legislation/energybill/1002-energy-bill-2011-ia-green-deal.pdf

2.52 As explained above, DCLG is considering further consumer engagement, and the results of this work (plus any relevant responses to the main consultation) will inform the final stage impact assessment.

Modelling of options

2.53 For consultation stage, the modelling has aimed to make an assessment of the overall impact of the new requirements. To assess the impact of requirements on extensions and conversions, it assumes a number of trigger events, then for each measure listed in Table 2.6 we have made an assumption of how many homes would have the measure installed as a result of this policy. These assumptions are based on factors such as construction type (eg the proportion of the building stock that has cavity walls) and existing take up (eg the number of cavities that would already have been filled).

2.54 For extensions and conversion works, all of the measures below are assumed to be feasible (as 10% of the average cost of an extension could accommodate any of these works). For the replacement of boilers and windows, only a smaller set of low-cost improvement measures is used (so even if a solid walled home had its windows replaced, the model would not assume that solid wall insulation was installed, on grounds of cost and proportionality). For modelling purposes, the measures linked to replacement boilers and windows are loft, cavity wall and hot water cylinder insulation and draught proofing.

2.55 The assumptions about how many dwellings could benefit from these measures are based on work by Department for Energy and Climate Change on Green Deal potential and take-up. For example, the modelling assumes that there are 200,000 extension/loft or garage conversions per year, and that 20% of these homes would have a G-rated boiler. It therefore assumes that a requirement for a new A-rated boiler would be triggered in the majority of these cases, and calculates the costs and benefits of this.

2.56 The modelling assumes that over time, an increasing number of measures would be installed on a voluntary basis, because of the availability of the Green Deal and other policies.

2.57 To ensure consistency with the Department for Energy and Climate Change December 2010 Green Deal Impact Assessment[31] we have used the same data on

[31] Much of the analysis in this impact assessment was carried out in summer and autumn 2011, meaning that it draws on what was the most recently published Green Deal impact assessment (December 2010) at the time. For final stage impact assessments this work will be updated to take account of more recent analysis by DECC, including the published November 2011 impact assessment: http://www.decc.gov.uk/en/content/cms/consultations/green_deal/green_deal.aspx#ia..

asset lives, costs and energy savings per improvement, where available. The key cost and energy input assumptions are shown in Table 2.6.

Table 2.6: Key input assumptions

Measure	Asset Life (years)	Incremental capital cost per improvement (£)	Energy saving per improvement (kWh per annum)
Loft insulation (to 300mm if < 150mm)			
Currently with none	42	409	5,879
Currently with 50mm or less	42	409	2,605
Currently with 75mm	42	409	1,057
Currently with 100mm	42	409	768
Cavity wall insulation			
Pre-76 cavity insulation	42	447	6,492
Post -76 cavity insulation	42	447	3,928
Hot water cylinder insulation to >75mm			
Currently with no insulation	30	15	1,962
Currently with 25mm insulation	30	15	813
Currently with 50mm insulation	30	15	201
Draughtproofing	10	104	459
TRVs	15	240	600
Boiler	12	2,594	11,116
Solid Wall internal	36	8,400	9,316
Solid Wall external	36	10,976	8,701

Source: DEPARTMENT FOR ENERGY AND CLIMATE CHANGE

2.58 The Green Deal Impact Assessment provided estimates for a low-uptake scenario and a high-uptake scenario. The results presented below are based on high uptake of the Green Deal. This means that the scale of benefits obtained through consequential improvements is lower than in the case where low direct uptake of the Green Deal is assumed.

2.59 Each table of results presented below includes estimates of the monetised value of energy and carbon savings and total capital costs. Monetised results are presented in present value terms and take into account improvements to existing buildings undertaken between 2013 and 2022 inclusive and the energy savings that would occur over the full asset life of installed measures.

2.60 The tables also include estimates of the total energy and carbon savings. These savings are not discounted and hence show the total achieved through the policy. The results show the total amount achieved over the full asset life of consequential measures installed over the 10-year lifetime of the policy between 2013 and 2022.

The lifetime carbon savings attached to each trigger/measure are shown in Table 2.6.1.

2.61 Table 2.7 sets out the costs and benefits of consequential improvements if all requirements are introduced in October 2012. This shows substantial net benefits of over £14 billion NPV over the life of the improvements. These benefits almost all come from the installation of the soft energy efficiency measures. Cavity wall insulation is the most beneficial form of energy saving in the analysis. Measures such as solid wall installation have a net cost.

2.62 Table 2.8 shows the equivalent estimates for the phased scenario (ie the domestic windows and services triggers operational from April 2014). This results in a reduction in the net benefit to just under £12 billion NPV.

2.63 These results are very sensitive to the number of trigger events assumed. Halving the number of consequential improvements in houses with window replacements (to 500,000 a year) reduces the net benefit of the phased approach from nearly £12 billion to about £9.5 billion. Halving the number of consequentials triggered by boiler replacements (to 700,000 a year) would reduce the net benefit of the phased approach from nearly £12 billion to about £8.5 billion.

2.64 These numbers will be updated and refined as analysis on the Green Deal develops and further work is done to refine the legal and policy approach for introducing consequential improvements.

One In One Out policy

2.65 For existing homes, the energy savings and the incremental costs associated with tightening of Part L of the Building Regulations accrue to private citizens rather than businesses; therefore, the costs and benefits presented above are not in the scope of the One In One Out policy.

Table 2.6.1: Consequential improvements – domestic buildings phased scenario – lifetime carbon savings

	Amount of carbon savings ($MtCO_{2(e)}$)			
	Total	Extensions	Boilers	Windows
Loft insulation (to 300mm if < 150mm)				
Currently with none	12.4	1.2	6.5	4.7
Currently with 50mm or less	2.8	0.3	1.5	1.1
Currently with 75mm	0.2	0.0	0.1	0.1
Currently with 100mm	13.5	1.3	7.1	5.1
Cavity wall insulation				
Pre-76 cavity insulation	55.1	5.0	29.2	20.9
Post -76 cavity insulation	29.6	2.7	15.7	11.2
Hot water cylinder insulation to >75mm				
Currently with no insulation	4.3	0.4	2.3	1.6
Currently with 25mm insulation	0.6	0.1	0.3	0.2
Currently with 50mm insulation	0.6	0.0	0.3	0.2
Draughtproofing	1.0	0.1	0.5	0.4
TRVs	1.7	0.1	0.9	0.6
Boiler	2.1	2.1	0.0	0.0
Solid Wall internal	6.8	6.8	0.0	0.0
Solid Wall external	1.6	1.6	0.0	0.0
Total: Soft Measures	**119.9**	**11.0**	**63.5**	**45.4**
Total: All Measures	**130.4**	**21.5**	**63.5**	**45.4**

Note: Soft measures are loft insulation, cavity wall insulation, hot water cylinder insulation and draught proofing

Source: Europe Economics

Table 2.7: Consequential improvements – existing dwellings – all requirements introduced in October 2012

	Total energy savings (£m)	Total capital cost (£m)	Net benefit exc carbon (£m)	Traded carbon savings (£m)	Non-traded carbon savings (£m)	Net benefit inc carbon, (£m)	Avoided renewables (£m)	Total net benefit (£m)	Amount of energy savings (GWh)	Amount of carbon savings ($MtCO_{2(e)}$)
Loft insulation (to 300mm if < 150mm)										
Currently with none	1096	(144)	952	0	777	1729	28	**1757**	88,600	16.3
Currently with 50mm or less	249	(74)	175	0	176	351	6	**357**	20,083	3.7
Currently with 75mm	19	(14)	5	0	13	19	1	**19**	1,537	0.3
Currently with 100mm	1196	(1204)	(8)	0	847	840	31	**870**	96,645	17.8
Cavity wall insulation										
Pre-76 cavity insulation	4,436	(575)	3,861	0	3,194	7,056	112	**7,168**	363,623	66.9
Post -76 cavity insulation	2,381	(510)	1,871	0	1,715	3,586	60	**3,646**	195,175	35.9
Hot water cylinder insulation to >75mm										
Currently with no insulation	365	(6)	359	0	218	577	11	**588**	26,259	4.8
Currently with 25mm insulation	52	(2)	50	0	31	82	2	**83**	3,773	0.7
Currently with 50mm insulation	47	(8)	39	0	28	68	1	**69**	3,404	0.6
Draughtproofing	107	(129)	(22)	0	47	25	7	**32**	5,992	1.1
TRVs	172	(257)	(85)	0	78	(7)	8	**1**	10,175	1.9
Boiler	202	(213)	(11)	0	90	79	12	**91**	11,601	2.1
Solid Wall internal	487	(899)	(412)	0	313	(99)	14	**(85)**	36,700	6.8
Solid Wall external	114	(294)	(180)	0	73	(107)	3	**(104)**	8,581	1.6
Total: Soft Measures	**9,949**	**(2,667)**	**7,283**	**0**	**7,047**	**14,330**	**260**	**14,590**	**805,091**	**148.1**
Total: All Measures	**10,924**	**(4,330)**	**6,594**	**0**	**7,602**	**14,196**	**298**	**14,493**	**861,972**	**158.6**

Note: Soft measures are loft insulation, cavity wall insulation, hot water cylinder insulation and draught proofing

Source: Europe Economics

Table 2.8: Consequential improvements – existing dwellings – requirements phased in from October 2012

	Total energy savings (£m)	**Total capital cost (£m)**	**Net benefit exc carbon (£m)**	**Traded carbon savings (£m)**	**Non-traded carbon savings (£m)**	**Net benefit inc carbon, (£m)**	**Avoided renewables (£m)**	**Total net benefit (£m)**	**Amount of energy savings (GWh)**	**Amount of carbon savings ($MtCO_{2(e)}$)**
Loft insulation (to 300mm if < 150mm)										
Currently with none	809	(106)	703	0	592	1295	20	**1315**	67,225	12.4
Currently with 50mm or less	183	(54)	129	0	134	263	5	**268**	15,238	2.8
Currently with 75mm	14	(10)	4	0	10	14	0	**14**	1,167	0.2
Currently with 100mm	882	(881)	1	0	645	646	22	**668**	73,330	13.5
Cavity wall insulation										
Pre-76 cavity insulation	3,572	(460)	3,112	0	2,638	5,749	89	**5,838**	299,402	55.1
Post -76 cavity insulation	1,917	(408)	1,509	0	1,416	2,925	48	**2,972**	160,704	29.6
Hot water cylinder insulation to >75mm										
Currently with no insulation	317	(5)	312	0	193	505	9	**514**	23,178	4.3
Currently with 25mm insulation	46	(2)	44	0	28	71	1	**73**	3,330	0.6
Currently with 50mm insulation	41	(7)	34	0	25	59	1	**60**	3,004	0.6
Draughtproofing	93	(111)	(18)	0	41	23	6	**29**	5,289	1.0
TRVs	149	(222)	(72)	0	68	(4)	7	**3**	8,982	1.7
Boiler	202	(213)	(11)	0	90	79	12	**91**	11,601	2.1
Solid Wall internal	487	(899)	(412)	0	313	(99)	14	**(85)**	36,700	6.8
Solid Wall external	114	(294)	(180)	0	73	(107)	3	**(104)**	8,581	1.6
Total: Soft Measures	**7,875**	**(2,045)**	**5,830**	**0**	**5,721**	**11,551**	**201**	**11,752**	**651,868**	**119.9**
Total: All Measures	**8,827**	**(3,674)**	**5,154**	**0**	**6,265**	**11,419**	**238**	**11,658**	**708,749**	**130.4**

Note: Soft measures are loft insulation, cavity wall insulation, hot water cylinder insulation and draught proofing

Source: Europe Economics

New non-domestic buildings

2.66 We have adopted a three stage approach to assessing a change in emissions standards for new non-domestic buildings in 2013. 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.

2.67 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.

2.68 In 2006, one notional building was defined. In 2010, two notional buildings were defined for top-lit (warehouses) and side-lit (all other) buildings reflecting the different energy profiles of these buildings. As target percentages are pushed harder there is rationale in differentiating the notional building further, for example not pushing the fabric standard so far in buildings that are predominantly cooled.

2.69 A number of permutations of notional building are therefore proposed for 2013. Table 2.9 and Table 2.10 summarise the packages of fabric and building services that have been modelled to inform calculations of the most cost effective notional building in 2013. Fabric elements are grouped in Packages A, B, C and D. Building services elements are grouped in Packages 1, 2 and 3. The packages grouped as A1, A2, A3, B1, B2, B3 etc. to determine the best mix of fabric and fixed services standards.

Table 2.9: Fabric specifications for new non-domestic buildings

Fabric					
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)	1.8 (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

Source: AECOM

Table 2.10: Building service specifications for new non-domestic buildings

Building Services				
Element	Unit	Package 1 (2010 Notional)	Package 2	Package 3
Lighting	Luminaire lm/watt	55	65	65
Occupancy control	Yes/no	Yes	Yes	Yes
Daylight control	Yes/no	Yes	Yes	Yes
Heating efficiency	Heating and hot water (side lit)	88%	91%	91%
Heating efficiency	Heating and hot water (top lit) – ie gas-radiant space heating	86%	91%	91%
Central Ventilation	SFP (w/l/s)	1.8	1.8	1.8
Terminal Unit	SFP (w/l/s)	0.5	0.4	0.3
Cooling	SEER	4.5	4.5	4.5
Heat recovery	%	70%	70%	70%
Variable speed control of fans and pumps	Yes/no – multiple sensors	Yes	Yes	Yes
Demand control (mech vent only)	Yes/no – CO_2 sensing with variable speed	No	Yes	Yes

Source: AECOM

2.70 The assumed build rates are outlined in the table below[32]. These build rates are assumed to apply for the 10 year policy period covered in the cost benefit analysis.

[32] Non-domestic build rate estimates have been based on the non-domestic stock model of the Building Research Establishment. Numbers from this model were also used for the 2010 Part L changes and the November 2009 impact assessment on zero carbon standards for new non domestic buildings (plus subsequent updates to the evidence base on zero carbon non domestic buildings).

Table 2.11: Build rate assumptions

	Build rate in 2014 (m^2)	Build mix
Distribution warehouse	2,321,068	30%
Deep plan office AC	2,067,025	26%
Retail warehouse	993,544	13%
Shallow plan office AC	1,378,016	18%
5 star hotel	272,048	3%
Secondary school	830,874	11%

2.71 Assumptions on numbers of buildings which will be built to the new 2013 standards are shown below. The phasing-in is assumed to take longer for new non-domestic buildings than for new homes, given the longer development lead times.

Table 2.11.1: Phase-in assumptions

	2014	2015	2016	2017	2018	2019
Phase in (% of all new non-domestic buildings caught by Part L 2013	0%	40%	60%	90%	100%	100%

2.72 The aggregate reduction in carbon emissions from 2010 for each notional building, given the build mix (see Table 2.11), is shown in the bottom row of Table 2.12. This shows that the most onerous specification (D3) achieves an overall aggregate saving of just under 20%. It is suggested therefore that 20% is about the technical limit of savings possible with improvements only to fabric and services in the notional building.

2.73 Once the actual design (size, shape, etc.) of a particular building is added, each notional building specification produces a target CO_2 reduction for the actual building to meet. The values for the range of modelled building types are shown in Table 2.12 below.

Table 2.12: CO_2 reductions by building type and specification (% improvement on 2010)

	A1	A2	A3	B1	B2	B3	C1	C2	C3	D1	D2	D3
Warehouse (Distribution)	0.0	5.6	8.0	3.4	8.9	11.4	8.2	13.6	16.1	14.7	20.0	22.6
Office (Deep-plan, AN)	0.0	11.9	19.5	0.3	12.2	19.7	1.0	12.8	20.4	1.4	13.0	20.6
Warehouse (Retail)	0.0	6.8	10.9	1.3	8.0	12.0	2.9	9.5	13.6	4.3	10.8	15.0
Office (Shallow-plan, AN)	0.0	12.2	18.9	1.3	13.2	20.0	2.4	14.2	21.0	3.4	15.0	21.8
Hotel (5-star)	0.0	8.8	11.6	1.0	9.7	12.4	2.7	11.0	13.8	4.2	12.2	14.9
Secondary School	0.0	8.3	10.6	1.4	9.7	12.0	2.8	11.0	13.3	4.1	12.2	14.6
% reduction once applied across the build mix	*0.0*	*8.8*	*13.5*	*1.6*	*10.3*	*15.0*	*3.8*	*12.3*	*17.1*	*6.2*	*14.7*	*19.4*

Source: AECOM

2.74 Four overall targets over 2010 Building Regulations were then chosen to test a range of options; 8%, 11%, 14% and 20%. Where a package was not able to meet a given target (eg B1 in all cases) a fixed amount of on-site electricity generation using PV as a ***proxy*** for this was added to the roof of each building until the target was met. The fixed amount of PV was defined as a percentage of floor area. The same percentage of floor area was applied to each building to reflect how a notional building might be defined in practice (ie package B1 + X% floor area, where X% is the same in all buildings). This means that tall buildings would have a large percentage of their roof covered in PV and single storey buildings would have a smaller percentage. This was done for the purposes of modelling the notional building only. In practice, a designer could choose to go further with fabric and services rather than install PV.

2.75 It was decided 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 this could be compared to a target based only on fabric and services improvements.

2.76 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 2.13. The table shows differentiation between top-lit (TL) and side-lit buildings (as 2010) but also between predominantly cooled buildings (SL-C) and

predominantly heated buildings (SL-H). The IA modelling has assessed a range of typical buildings based on the types which dominate the build mix. In practice, a building under consideration would be matched to one of these categories by the national calculation methodology (even if not listed here) in order to determine a Target Emission Rate for the particular building.

Table 2.13: Selected specifications for notional buildings

Target aggregate reduction	**8%**	**Resultant target reduction**	**11%**	**Resultant target reduction**	**14%**	**Resultant target reduction**	**20%**	**Resultant target reduction**
Warehouse (Distribution) **TL**	A2	5.6%	B2	8.9%	C3	16.1%	C3+1.6%	20.1%
Office (Deep-plan, AN) **SL-C**	A2	11.9%	A2	11.9%	A2	11.9%	A3+1.6%	23.4%
Warehouse (Retail) **TL**	A2	6.8%	B2	8.0%	C3	13.6%	C3+1.6%	16.2%
Office (Shallow-plan, AN) **SL-C**	A2	12.2%	A2	12.2%	A2	12.2%	A3+1.6%	23.1%
Hotel (5-star) **SL-H**	A2	8.8%	C2	11.0%	C2	11.0%	C3+1.6%	15.0%
Secondary School **SL-H**	A2	8.3%	C2	11.0%	C2	11.0%	C3+1.6%	17.4%
PV required on notional building	None		None		None		Panel area equivalent to 1.6% of floor area applied to roof of each building	

Source: AECOM

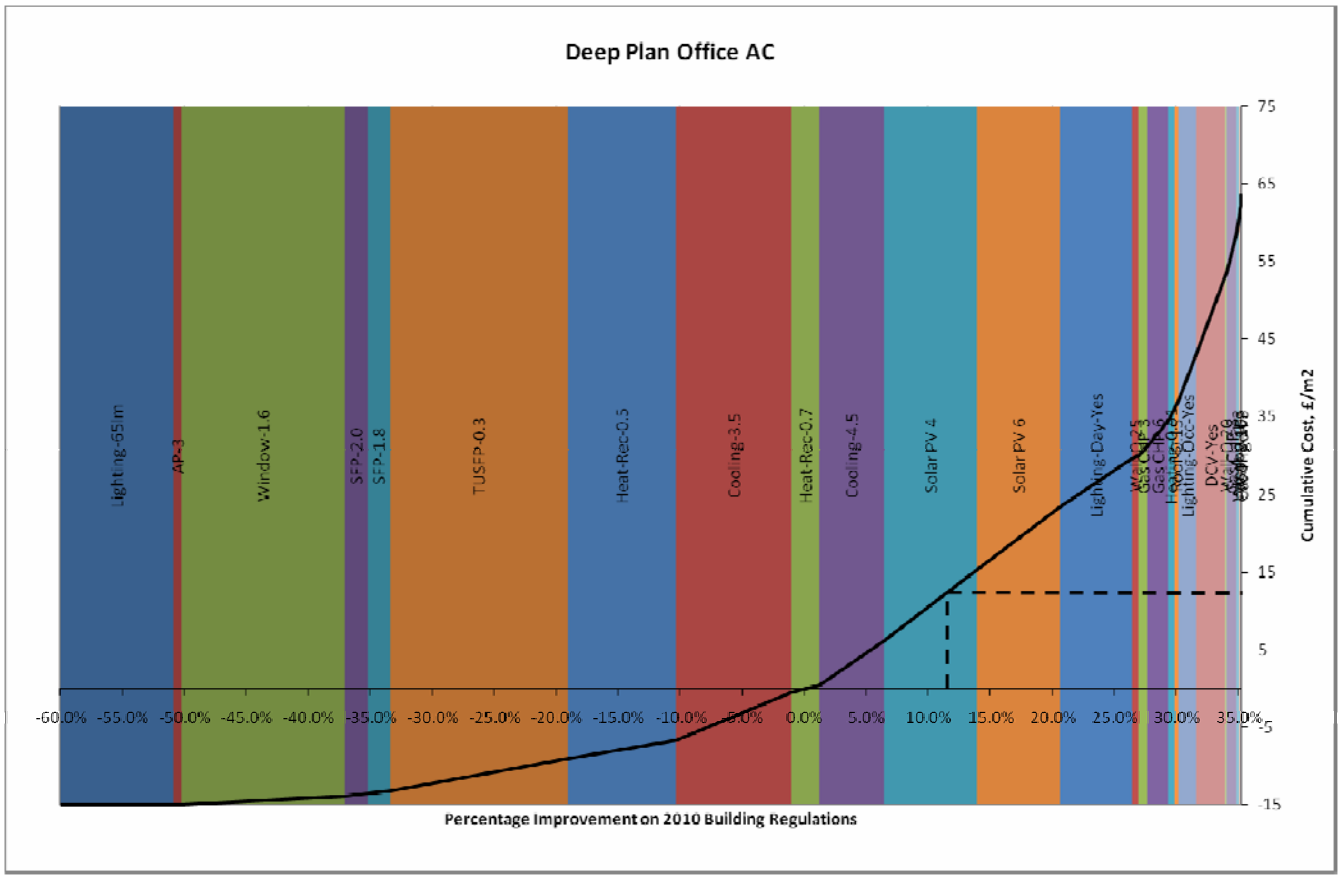
2.77 The target percentage reductions for each building type were then plotted on the cost curves to establish how an actual building would respond to the target. This identifies the least (capital) cost route to achieving a given target[33]. Figure 2.1 shows the cost curve for the deep plan office. The notional building for an 11% target is A2. This produces a target reduction of 11.9% in the deep plan office. The cumulative cost of achieving this target (£/m^2) is shown plotted on the curve.

2.78 The 20% 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% aggregate reduction not all buildings would necessarily choose PV to

[33] Lifecycle cost curves have also been developed, to give a sense of any differences between the measures a developer would prioritise and those an occupier would prefer over time. However, the cost benefit analysis is based on the capital cost curves, given that these are what would primarily drive developers' decisions.

achieve their given target depending on the relative cost effectiveness of PV against other demand-side measures.

Figure 2.1: Example of cost curve – deep plan office



2.79 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. For the consultation stage impact assessment, the cost-benefit analysis for new non-domestic buildings does not take into account any potential overlaps arising from factors including the use of BREEAM[34], the Carbon Reduction Commitment Energy Efficiency Scheme[35] and the EU ETS. We will look to develop assumptions on overlaps post-consultation; we anticipate

[34] The Building Research Establishment Environmental Assessment Method is a voluntary rating tool for non-domestic buildings, covering energy use, water use, waste and other factors. It is used by some specifiers (public and private sector) and hence will be driving the levels of performance to which some non-domestic buildings are constructed.

[35] The Carbon Reduction Commitment Energy Efficiency Scheme is a mandatory scheme aimed at improving energy efficiency and cutting emissions in large public and private sector organisations, administered by DECC - http://www.decc.gov.uk/en/content/cms/emissions/crc_efficiency/crc_efficiency.aspx

that these overlaps will have a proportionate effect on the cost-benefit ratio presented in the results below.

2.80 The cost curve analysis provides estimates of energy requirements and associated CO_2 emissions per square metre of floor area. These can then be applied to assumed build rates for the six building types considered.

2.81 Table 2.14 sets out the results of this modelling for these scenarios. At the level of costs and benefits to society (energy savings less incremental costs) only the 20% reduction target shows a net cost. When carbon savings are taken into account all four policy options show a net benefit. For the 8% and 11% targets around 70% of the savings come from reduction in consumption of electricity. Gas savings make up about half of the total savings in the 14% scenario and around 40% of the savings under the 20% scenario.

Table 2.14: Present values of costs and benefits: new non-domestic buildings (NPV £m)

	8%	**11%**	**14%**	**20%**
Energy savings (£m)	837	951	1,119	1,648
Incremental costs (£m)	(781)	(898)	(1,095)	(1,811)
Sub-total (£m)	55	52	24	(163)
Carbon savings - non-traded (£m)	34	62	150	150
Carbon savings - traded (£m)	76	87	94	142
Total carbon savings (£m)	111	148	243	292
Net benefit/cost (£m)	166	201	267	129
volume of CO2 saved - ETS ($MtCO_{2(e)}$)	2.4	2.8	3.0	4.5
volume of CO2 saved - non-ETS ($MtCO_{2(e)}$)	0.7	1.2	3.1	3.1
Cost effectiveness (£/tCO2)				
- traded	(37)	(41)	(58)	3
- non-traded	(199)	(113)	(38)	7

Source: Europe Economics

Sensitivity tests

2.82 Sensitivity tests have been carried out for higher and lower variable energy prices and carbon values using the Department for Energy and Climate Change Interdepartmental Analysts' Group ranges. With the higher energy prices and carbon values the net benefits shown in Table 2.14 increase by around £200 million NPV for the 8% and 11% options. Both the 14% and 20% targets show net benefits in the region of £600 million NPV.

2.83 With lower energy prices and carbon values each of the targets shows a net cost. For the 8% and 11% targets this net cost is in the region of £300 million NPV. For the 14% target it is about £400 million NPV and for 20% target this rises to a net cost of over £800 million NPV. The full cost benefit tables for these sensitivity tests are in Appendix 2.

2.84 Part L 2013 will adopt updated CO_2 factors to be published by Department for Energy and Climate Change following consultation. The modelling in this IA reflects the Department for Energy and Climate Change proposals at the time this modelling was carried out (summer-autumn 2011).

One In One Out policy

2.85 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 One In One Out policy, we have valued the energy savings at the retail price to show the benefit to business from the changes to Part L These are set out in Table 2.15 and show significant net benefits for each of the target levels, rising as the target improvement rises.

Table 2.15: Energy savings valued at retail prices (NPV £m)

	8%	**11%**	**14%**	**20%**
Energy savings (£m)	1,361	1,547	1,821	2,680
Incremental costs (£m)	(781)	(898)	(1,095)	(1,811)
Sub-total (£m)	580	649	725	869
Equivalent annual net benefit to business (£m)	*67*	*75*	*84*	*101*

Source: Europe Economics

Consultation options

2.86 Two options are offered for consultation: 11% and 20% aggregate uplift. We have rejected the 8% uplift because the cost benefit analysis suggests that a higher uplift can be achieved cost effectively. We have also ruled out the 14% option as this is largely identical to the 11% option, but with a more demanding improvement in warehouses. Therefore the 11% uplift represents a more consistent / fairer distribution of requirements between building types than the 14% uplift.

2.87 The technical modelling suggests the 11% uplift should be achievable with only fabric and fixed services improvements for most building types. It is also worth noting that (on the basis of current modelling) this is likely to be around the limit of fabric and services efficiency, with improvements beyond this becoming very expensive for very little benefit in energy or carbon. Thus the modelling suggests that in practice these fabric and services improvements would also be achieved

under the 20% uplift scenario, but with the addition of renewable energy technologies as well. The cost curves in Appendix 1 give an indication of what developers might do to meet the performance levels required to meet a 20% aggregate improvement, showing that most building types would have PV panels, and the five star hotel would install combined heat and power plant.

2.88 When assessed for One In One Out calculations using retail energy prices, both the 11% and 20% options represent a benefit to business, with the 11% giving a £75m annual benefit to rising to a £101m annual benefit for the 20% uplift. However, it is important to note that the cost of any change will come upfront, on construction, and the benefits will accrue to occupiers over a longer period of time.

2.89 When assessed using variable energy prices (which are appropriate when assessing costs at the level of overall costs and benefits to society) and looking at costs and energy savings only, the 20% option carries a net present cost of £163m, while the 11% option remains positive, with a £52m net present benefit. Including carbon, the 11% improvement represents a net present benefit of £201m and the 20% improvement a lower £129m benefit.

2.90 Looking at the percentage increase in build cost, neither option carries a significant increase, with around a 0.5% average increase (in the most common building types) for the 11% uplift and around a 2% average increase for the 20% improvement (see Table 2.21). These costs are for the main building types only though, and the costs will vary in practice. For example, building to tighter fabric standards can be more challenging in some smaller buildings. It is also likely that different sectors' price elasticity and ability to absorb a rise in build costs will differ. We will look for further evidence on the impact of these increases through consultation.

2.91 On balance, the 20% scenario is the preferred option for consultation on the basis that this gives the highest long-term benefits to business through significant energy savings for building occupants, and results in over twice the carbon savings of the 11% option. This will provide a significant learning step for non-domestic buildings in the trajectory towards zero carbon, since (as explained above) as well as taking fabric and services standards close to the limits of likely 'zero carbon' levels, renewables will also start to be needed in most instances. Given the preference for a standard for new homes based on fabric and services efficiencies, this would also provide incentives for innovation in the renewable energy technology market, helping to reduce longer term costs for both the domestic and non-domestic sectors.

Existing non-domestic buildings

Performance standards for extensions

2.92 The diversity of non-domestic building types acknowledged above also applies in considering extensions to existing buildings. These can take many forms – from a

new wing on a school or a hospital, or a small extension to a Victorian house used as a doctor's surgery. We have estimated the costs and benefits for an average extension of 100m^2. In order to give an indication of the scale of costs and benefits that might be incurred we have made the simplifying assumption that such an extension would have the same energy requirements per unit floor area as a new building of the same type but to allow for some flexibility have based compliance solutions on the 2013 11% improvement option. The 11% improvement was thought more appropriate as a standard for extensions than the 20% option, as a fabric and services standard is likely to be more readily applicable to the wide range of non-domestic extensions. We have assumed that extensions will be made to between 0.1 and 0.8 per cent of the existing stock of buildings each year depending on type.

2.93 The results of this analysis are shown in Table 2.16. For the lower carbon targets there are small net savings at the business level with energy savings greater than installation costs. For the higher targets installation costs exceed the energy savings. However each of the policy options shows a net saving when carbon reductions are taken into account to assess the net cost to business. However given the uncertainties in the assumptions underlying the analysis the differences shown here between options cannot be taken to be significant.

Table 2.16: Present values of costs and benefits: extensions to non-domestic buildings (NPV £m)

	8%	**11%**	**14%**	**20%**
Energy savings (£m)	43	58	81	105
Incremental costs (£m)	35	51	83	112
Sub-total (£m)	8	7	(2)	(8)
Carbon savings - non-traded (£m)	2	2	5	5
Carbon savings - traded (£m)	5	6	8	11
Total carbon savings (£m)	7	8	13	16
Net benefit/cost (£m)	15	15	12	8
volume of CO_2 saved - ETS ($MtCO_{2(e)}$)	0.2	0.2	0.3	0.3
volume of CO_2 saved - non-ETS ($MtCO_{2(e)}$)	0.0	0.0	0.1	0.1
Cost effectiveness (£/tCO_2)				
- traded	(64)	(42)	(13)	6
- non-traded	(386)	(465)	(69)	(31)

Source: Europe Economics

One In One Out policy

2.94 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 One Out purposes. The results are shown below:

Table 2.17: Energy savings valued at retail prices (NPV £m)

	8%	11%	14%	20%
Energy savings (£m)	71	94	132	171
Incremental costs (£m)	35	51	83	112
Sub-total (£m)	36	44	49	58
Equivalent annual net benefit to business (£m)	*4.2*	*5.1*	*5.7*	*6.7*

Source: Europe Economics

Consequential improvements

2.95 For a non-domestic building with a floor area greater than 1000m^2, consequential improvements are required under current Part L if one of the following is carried out:

(a) An extension or increase in habitable area,

(b) The initial provision of fixed building services, or

(c) An increased capacity of fixed building services.

2.96 This impact assessment considers whether the requirement for consequential improvements should be introduced where smaller buildings have an extension or new habitable space added.

2.97 It is assumed that the majority of extensions to buildings below 1,000m^2 will be to domestic style construction. About 80% of buildings with floor area below 1,000m^2 are below 250m^2. Offices of that size are mainly converted Victorian houses used for professional businesses. Hotels of that size will be B&Bs or small boarding houses. Health facilities will be doctors or dentists surgeries. Retail units and warehouses below 1,000m^2 are unlikely to be extended – the occupier is much more likely to trade up to a bigger unit than extend an existing one. Thus, as a first approximation for consultation, we assume that the amount of energy use is more reflective of dwellings than non-domestic buildings.

2.98 We have therefore adapted the model described above for estimating the impact of consequential improvement in dwellings to apply to smaller non-domestic buildings.

2.99 For the purpose of this analysis we assume that these non-domestic buildings have the same pattern of existing energy efficiency measures installed (eg levels of insulation) as the domestic housing stock but that they are, on average, larger

than the typical domestic building. We have assumed an average floor area of 170 m^2 compared with 95 m^2 in the domestic building model.

2.100 Costs and energy savings per building have been increased pro rata from the domestic model to adjust for this larger building size. It has been assumed that small non-domestic buildings are more akin to dwellings than to larger commercial buildings. This is because the level of occupancy density is usually much more domestic in scale, and although appliances in use will be different (computers rather than televisions for example), the impact in terms of heat gain will be similar. However the time of day and length of occupancy may differ between domestic and non-domestic use of such buildings. We have therefore carried out a sensitivity test with the energy demand is 25% above or below the domestic scenario; the results are presented in Appendix 2.

2.101 The modelling of extensions to non-domestic buildings described above has been used to estimate the number of extensions to smaller buildings that might trigger consequential improvements. This suggests that there may be about 4,300 extensions a year.

2.102 Because of the relatively small number of extensions to buildings under 1000m^2, for consultation stage we have not examined the difference in costs and benefits between the requirements coming into force in October 2012 and April 2014, as over 10 years this will not result in a significant difference. We will consider this further for the final stage impact assessment.

2.103 Estimates of the costs and benefits of extending the consequential improvements requirement to non-domestic buildings of less than 1000m^2, triggered by building of extensions are shown in Table 2.18. As with consequentials in existing homes the option shows a net benefit but, at just over £40 million NPV, this is on a much smaller scale. This is principally because of the relatively small number of trigger events that has been assumed. Taking a lower level of energy use in non-domestic buildings, reflecting lower occupancy time compared with a domestic building, and, therefore, less potential for energy saving reduces the net benefit of this option to £31 million NPV.

Table 2.18: Consequential improvements – non-domestic buildings under 1000m^2

	Total energy savings (£m)	**Total capital cost (£m)**	**Net benefit exc carbon (£m)**	**Traded carbon savings (£m)**	**Non-traded carbon savings (£m)**	**Net benefit inc carbon, (£m)**	**Avoided renewables (£m)**	**Total net benefit (£m)**	**Amount of energy savings (GWh)**	**Amount of carbon savings ($MtCO_{2(e)}$)**
Loft insulation (to 300mm if < 150mm)										
Currently with none	3	0	3	0	2	5	0.1	**5**	262	0.0
Currently with 50mm or less	1	0	0	0	1	1	0.0	**1**	59	0.0
Currently with 75mm	0	0	0	0	0	0	0.0	**0**	5	0.0
Currently with 100mm	3	4	0	0	3	2	0.1	**2**	286	0.1
Cavity wall insulation										
Pre-76 cavity insulation	12	2	11	0	9	20	0.3	**20**	1,076	0.2
Post -76 cavity insulation	7	2	5	0	5	10	0.2	**10**	578	0.1
Hot water cylinder insulation to >75mm										
Currently with no insulation	1	0	1	0	1	2	0.0	**2**	78	0.0
Currently with 25mm insulation	0	0	0	0	0	0	0.0	**0**	11	0.0
Currently with 50mm insulation	0	0	0	0	0	0	0.0	**0**	10	0.0
Draughtproofing	0	0	0	0	0	0	0.0	**0**	18	0.0
Low energy lighting	1	1	(1)	0	0	(1)	0.0	**(1)**	7	0.0
Total	28	9	19	0	21	40	0.8	41	2,383	0.4

Note: Soft measures are loft insulation, cavity wall insulation, hot water cylinder insulation, draught proofing and low energy lighting

One In One Out policy

2.104 The energy savings from consequential improvements valued at retail energy prices are outlined below:

Table 2.19: Energy savings valued at retail prices (NPV £m)

Energy savings (£m)	45
Incremental costs (£m)	9
Sub-total (£m)	**36**
Equivalent annual net benefit to business (£m)	*4.1*

Source: Europe Economics

Replacement of controlled fittings and services

2.105 The modelling above is based on the building of an extension being the trigger for consequential improvements. For homes, both fabric (windows) and services (boiler replacement) have also been assessed as potential triggers for consequential works. For non-domestic, both fabric and services changes were initially assessed.

2.106 Looking at case studies on non-domestic building refurbishment (a school and an office) a wide disparity was found in refurbishment costs. In one case refurbishing the walls and windows cast £67/m^2 of gross internal floor area, on the other it was £279/m^2. Similarly, in one case the roof renovation was £41/m^2, in the other it was less than £4/m^2, a ratio of 10:1. Part of the cost differences may be due to aesthetic improvements geared at improving asset value, but this is an important driver in the market place. Because of the huge variability in costs, our initial view is that it would be complex to make a generally applicable requirement for consequential improvements (given the uncertainty as to what would be an appropriate additional level of work to require) linked to fabric refurbishments.

2.107 We then considered the replacement of a controlled service as a trigger for a consequential improvement. This has not been fully modelled because of the vast range of replacement services options in non-domestic buildings, but for consultation stage the options are reviewed here on the basis of hypothetical case studies.

2.108 It is important to understand the relative costs of different triggers and the consequential measure that might be required. It must be stressed that costs are much more variable in the refurbishment context, and so feedback from consultees on the appropriateness of the indicative data used below would be particularly welcome.

2.109 The following triggers have been considered:

(a) **Boiler replacement**; the indicative costs for such work is ~£35/kW for the boiler, plus a further £60/kW for associated flues, pipework and valves giving a total cost of around £95/kW. Assuming the typical installed boiler capacity of 100W/m^2, this means that the cost of a boiler replacement is £9.50/m^2

(b) **Chiller replacement**; the indicative cost for replacing a chiller with a high efficiency water cooled vapour compression machine is between £180-300/m^2, plus a further £100/kW for pipework and valves etc. Assuming a design cooling load of 80W/m^2, the pipework costs convert to £80/m^2, giving an overall cost of typically £320/m^2

(c) **Air handling unit replacement**; the indicative cost for replacing a centralised air handling unit is £130-240/m^2; a typical value would therefore be £185/m^2

(d) **Lighting replacement**; the indicative cost of replacing general office lighting is between £40-70/m^2, but a re-lamping (ie retaining existing luminaires) would be of the order of £10/m^2.

2.110 For modelling purposes it has been assumed that the consequential measure should cost around 10% of the primary works. On that basis, the chiller and air handling unit replacements could trigger other controlled services measures that would fit within the limit of cost proportionality as follows:

(a) **Chiller replacement**; as given above, typical cost might be £320/m^2, and so consequential measures costing up to £32/m^2 might be considered reasonable. Boiler replacement and lighting improvements (both whole system replacement and re-lamping) could come within that budget. Improving the lighting efficiency would be particularly appropriate, since this is likely to reduce the peak cooling load and hence the capacity required for the new chiller, and this may reduce the cost of the new cooling system compared to the situation where the lighting was not improved. On the basis of cost alone, a boiler change might also be considered as a consequential when changing the chiller, but the practicalities of changing both simultaneously would need careful consideration, and consultees' views on this would be welcome. The relative cost/benefit would be maximised if only the lead boiler were replaced with a high efficiency unit

(b) **Air handing unit replacement**; as given above, typical cost might be £185/m^2, and so consequential measures costing up to £18/m^2 might be considered reasonable. Lamp replacement (but not lighting system replacement) and boiler upgrades come within that range, but there is less synergistic benefit between the primary and consequential measures. However, as re-lamping and lead boiler replacement can be very cost effective measures, such consequential measures could be considered as being a reasonable requirement.

2.111 In both cases described above, it would only make sense to require a consequential lighting or boiler improvement if the efficiency of the existing installations were below a defined threshold. Appropriate thresholds might be lamp efficacy less than 50 lumens/circuit watt, and boiler efficiency of less than 78% at maximum heat output. Consultees' views on these thresholds would be welcome, along with views on whether any consequential requirement should only apply within certain capacity ranges, or whether there should be a cap on the absolute cost of a consequential improvement. For example, if a very large chiller was being replaced, 10% of the cost of the chiller could still be a very significant sum.

2.112 As mentioned earlier, costs can vary substantially depending on context. As an example, costs would escalate dramatically if there were concerns about disturbing asbestos (old pipework lagging, some forms of ceiling tiles). In such cases, the generally applicable caveat of only requiring measures that are technically, functionally and economically feasible would be especially relevant.

2.113 Subject to views from the consultation on triggers, capacity ranges and caps, we will undertake further analysis on overall costs and benefits of consequential improvements linked to works in non-domestic buildings for the implementation stage impact assessment.

Distribution of costs and benefits

2.114 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.

2.115 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 2.20 and Table 2.21.

Table 2.20: New homes – incremental capital cost relative to 2010 compliant building (%)

	FEES + efficient services		Halfway point		
	Interim FEE + PV	Full FEES	Interim FEE + PV	Full FEES + PV	Fabric only
Detached	3.0%	3.0%	5.0%	5.6%	5.7%
Semi-detached	1.2%	0.9%	3.3%	3.5%	3.9%
Terraced	1.0%	0.4%	3.1%	3.1%	3.5%
Flat – gas heated	(0.5)%	0.0%	1.3%	1.9%	3.2%
Flat – electric heated[36]	2.4%	0.9%	5.0%	4.9%	2.4%

Source: Europe Economics

2.116 For non-domestic buildings, retail warehouses and secondary schools 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 low and zero carbon technology combinations which have been selected as representing the least cost way of achieving each energy reduction target. It is notable that for the 5* 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.[37] However this is offset by greater savings on electricity costs.

[36] These costs would reduce to the same levels as for the gas heated apartments if the fuel factor is retained in 2013.
[37] The technologies adopted to meet the different carbon compliance levels are chosen based on their relative cost-effectiveness. For the carbon compliance levels modelled, gas CHP only appears in the 5* hotel.

Table 2.21: New non-domestic buildings – incremental capital cost relative to 2010 compliant building (%)

Aggregate improvement	8%	11%	14%	20%
Distribution warehouse	0.3%	1.0%	3.1%	4.1%
Deep plan office AC	0.1%	0.3%	0.8%	1.0%
Retail warehouse	0.3%	1.0%	3.0%	3.8%
Shallow plan office AC	0.1%	0.3%	0.6%	0.7%
5 star hotel	0.1%	0.1%	0.4%	0.5%
Secondary school	0.2%	0.4%	1.0%	1.3%

Source: Europe Economics

2.117 Energy savings have also been estimated using the retail price of gas and electricity. These are shown in Table 2.22 and Table 2.23.

Table 2.22: New homes – incremental annual energy savings relative to 2010 compliant building (£/building)

	FEES + efficient services				Halfway point					
	Interim FEE + PV		Full FEES		Interim FEE + PV		Full FEES + PV		Fabric only	
	Gas	Electricity	Gas	Electricity	Gas	Electricity	Gas	Electricity	Gas	Electricity
Detached	40	37	72	0	40	114	72	77	170	(34)
Semi-detached	1	24	22	0	1	106	22	82	112	(22)
Terraced	(3)	16	11	0	(3)	91	11	75	95	(22)
Flat – gas heated	(11)	12	0	0	(11)	61	0	49	56	(15)
Flat – electric heated	0	44	0	44	0	117	0	117	0	117

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)

Aggregate improvement	8%		11%		14%		20%	
	Gas	Electricity	Gas	Electricity	Gas	Electricity	Gas	Electricity
Distribution warehouse	0.07	0.00	0.17	0.00	0.44	0.01	0.44	0.17
Deep plan office AC	0.02	0.86	0.02	0.86	0.02	0.86	0.01	1.41
Retail warehouse	0.11	0.39	0.11	0.57	0.11	1.01	0.11	1.28
Shallow plan office AC	0.03	1.22	0.03	1.22	0.03	1.22	0.03	1.76
5 star hotel	(1.84)	3.67	(2.63)	5.04	(2.63)	5.04	(3.03)	5.45
Secondary school	0.00	0.10	0.00	0.25	0.00	0.25	0.00	0.55

Source: Europe Economics. Energy at retail prices

3 COMPLIANCE, PERFORMANCE AND ENFORCEMENT ISSUES

Existing compliance and performance issues

3.1 The 2010 review of Part L recognised the potential for a gap between the energy and carbon performance of buildings as modelled and their as-built performance. Two classes of issue were identified. Firstly, direct non-compliance through the wilful or inadvertent substitution of substandard specifications or poor construction practice and secondly, underperformance that occurs even when regulatory guidance is followed diligently. In tackling this problem a number of measures were introduced in Part L 2010 including treating party walls for heat loss, the introduction of a design stage as well as an as-built energy performance calculation and increased airtightness testing.

3.2 It is too early to evaluate the impact of the Part L 2010 changes, however further work on the nature of the problem, particularly in housing, has been undertaken by the Zero Carbon Hub[38]. Recent case evidence continues to add support to the existence of a performance gap[39] but no clear quantification as to its extent.

3.3 The cost benefit estimates given in the previous section are therefore based on the designed performance standards of each building being achieved on construction. They do not include any allowance for wilful or inadvertent disregard of the proposed design or for buildings underperforming against that design standard.

3.4 Given this lack of evidence we can only use hypothetical examples to give an idea of the scale of the problem. If, as an example, we assume that on average new homes built to Part L 2013 standards under-perform against their design energy specification by 15%, this will reduce both the energy savings and CO_2 reductions that have been included in the cost benefit analysis by 15% or £132 million NPV (in the case of the Full FEES option under the FEES + efficient services scenario) but with the same level of incremental costs. The actual average level of underperformance may be above or below this illustrative 15% level.

3.5 The extent of underperformance in the non-domestic sector is even less clear than it is for new homes but similar concerns about underperformance apply and the estimates for new non-domestic buildings shown in the previous section should be treated with the same degree of caution about potential over-estimation of benefits from energy savings as we have outlined for dwellings.

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[38] Carbon compliance for tomorrow's new homes: A review of the modelling tool and assumptions. - Topic 4: Closing the Gap Between Designed and Built Performance www.zerocarbonhub.org.

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

Proposed measures to improve compliance and performance

3.6 There is no single, simple solution to reducing the discrepancy between as designed and as built performance. In its February 2011 report, the Zero Carbon Hub predicted that it would take until 2020 to reach 90% of dwellings performing better than the designed energy/carbon performance.[40]

3.7 Industry acknowledges their role in delivering compliant buildings and Government welcomes their commitment to the Zero Carbon Hub recommendations that from 2020 at least 90% of new dwellings would meet or better their designed energy/carbon performance.

3.8 For new homes, it is proposed that a quality assurance process be developed by industry potentially in the form of a Publicly Available Standard (PAS) or similar to codify best practice in the design and construction of new homes (and references to a PAS in this document should be read in that context). This could be supported by sample testing to create feedback loops and help gather energy performance data to inform the zero carbon step.

3.9 To incentivise builders to adopt the PAS route it is proposed that the Part L 2013 regulations would include a framework whereby house builders that are accredited under the PAS, or have their own equivalent quality assurance processes in place, benefit from reduced or avoided sample testing and/or where the PAS is not adopted confidence factors would be applied to the design. The effect of this approach will be that by adopting the PAS, a developer would not have to over-specify their construction in order to cover the risk of underperformance. Those who did not adopt the PAS will incur the costs associated with over-specification. There will be a cost associated with adopting the PAS, but the assumption is that this will be lower than the alternative (more testing or having to apply confidence factors). The £100 is therefore a broad average.

3.10 The IA includes a preliminary estimate of £100 per dwelling associated with encouraging adoption of the PAS and the inclusion of associated low volumes of sample testing. This will lead to better evidence about the energy performance of new homes. It is expected that there will be additional reductions in CO_2 but these are more difficult to predict at this stage. If the proposed measures were to reduce underperformance from the hypothetical level of 15% discussed above to 10%, then the lost energy and carbon savings would be valued at £88m NPV rather than the £132m loss of energy and CO_2 savings if the level of underperformance was 15%. Given the uncertainty about the timetable for the PAS and the scale of

[40] Carbon Compliance: setting an appropriate limit for zero carbon new homes. http://www.zerocarbonhub.org/definition.aspx?page=8.

improvement that might be achieved, these additional reductions are not taken into account in the main analysis.

3.11 In the non-dwelling sector and in the case of existing buildings no parallel proposals involving the application of confidence factors are proposed. In these areas the measures implemented in 2010 will continue. However, the experience gained from the implementation of the measures proposed for new dwellings will be evaluated and included in any review for 2016.

3.12 Alongside the technical changes to the Building Regulations, we are also consulting on changes to the building control system to make it more effective and to reduce burdens. Proposals under consideration include changes to Local Authority and Approved Inspector processes, including removal of the Warranty Link Rule, strengthening of enforcement procedures and the potential for the introduction of Appointed Persons and/or specialist third party certification schemes (eg for structural engineering, fire protection installation).

3.13 Finally it is expected that a substantial dissemination and training programme will be provided by those who support the industry and its professions at all levels to address not only the Part L 2013 changes but also the wider issues relating to performance issues and the application and continuous development of the quality process.

Local authority burdens

Consequential improvements

3.14 The policy will affect building control bodies, who will be responsible for checking compliance and (in the case of local authority building control) enforcing compliance with the policy. Building control bodies will need to ensure their staff are familiar with the new policy (eg through the provision of training).

3.15 Building control bodies already check compliance and enforce requirements for consequential improvements where buildings over 1000m^2 undertake certain defined building work. The proposal to introduce consequential improvements for extensions in homes and smaller non-domestic buildings would lead to a potential increase in building control activity, albeit within an existing area of their responsibility covered by building control fees. However, local authorities would need to find funding if they chose to pursue prosecutions for non-compliance, although current practice suggests that such cases are likely to be very rare.

3.16 By contrast, compliance with Building Regulation requirements for replacement windows and boilers is largely dealt with through self-certification by Gas Safe registered installers and members of Competent Persons schemes who simply notify a building control body within 30 days of installation. It would not be appropriate to compel such businesses to offer to install consequential improvements although many may choose to do this as a business decision. Therefore we intend to agree an arrangement with Competent Persons Schemes and Gas Safe Installers whereby they inform a building owner that consequential

improvements may be required and signpost sources of additional information and advice.

3.17 Local authorities would continue to receive notification of boiler and window replacements as now and would be under no obligation to follow-up to ensure the consequential improvements had been completed. However, they would be free to do so and we anticipate some local authorities, in particular those planning to operate as Green Deal providers, will consider how best to use this information in responding to demand in their area. Working within the current building control system should ensure a balance between effective compliance and the avoidance of new processes and burdens for local authorities and installers.

3.18 We will use the forthcoming consultation to build up a better understanding of these issues and the practical implications for building control bodies and how these might be offset through opportunities such as the introduction of the Green Deal and plans to open up Energy Performance Certificate data.

4 WIDER IMPACTS

Economic and financial impacts

Competition

4.1 The principal markets affected by the 2013 policy are the markets for the development of new domestic and non-domestic buildings and the refurbishment of existing buildings, along with the supply chains for the production of construction materials used in those developments.

4.2 As a result of higher standards for new buildings from 2013, **building developers** would have to comply with the lower (ie more stringent) building emission targets and as a result would see costs rise. **Landowners** will bear some of these costs in reduced purchase prices for land due to reduced land value uplift unless some of the costs can be passed through to purchasers of buildings. As the increase in costs will affect all developers equally and any proportion that cannot be passed on is likely to be small when compared to the overall costs of construction, any competitive effects in the market for building development are likely to be negligible.

4.3 There could be some effects on the number of **manufacturers / suppliers of construction products and materials** in the market due to the increased demand for higher specification construction materials, in particular higher performing windows, where it is proposed to raise the standards for replacement windows, but these are not thought to be significant.

4.4 The preferred policy options for 2013 all assume improved fabric and services specifications. For new homes, had a fabric energy efficiency target been introduced in isolation, this could have given manufacturers of products which impact on fabric performance (insulation, windows) an advantage over those involved in manufacturing and supplying building services (boilers and lighting). The options for 2013 both assume a level of service efficiency over and above the fabric energy efficiency target to ensure this is not the case. Businesses involved in the manufacture, design and installation of fabric solutions and systems are therefore the parts of the market most likely to be impacted by these changes. The flexibility provided in the way that builders meet the higher standards should ensure that no one product or manufacturer can dominate any part of the market.

Innovation

4.5 There should 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. The flexibility to choose building specifications to meet the compliance targets should encourage innovation among manufacturers.

4.6 The options for more ambitious improvements in standards would likely result in an increased use of **low and zero carbon generation technologies**, particularly

PV in dwellings and for some non-domestic building types, combined heat and power plant. There is competition in the supply of renewable technologies with a mix of large and small suppliers. As the cumulative production of technologies such as PV rises, so learning effects coupled with competition should bring down the unit cost. This learning effect has been built into our modelling of costs.

Small businesses

4.7 The UK construction industry is dominated by small firms. The Department for Business Innovation and Skills publishes its Construction Statistics Annual every year[41]. This shows that in 2010 there were 244,795 private contractors in the UK; 95% of which had less than 14 employees and 99% had less than 60 employees.

4.8 Views gathered in response to the 2010 Part L proposals suggested low awareness and understanding of the proposed changes to the regulations among small firm representatives, with most describing them as "very complex" and "difficult to understand". The overall view was that the proposals would lead to increased costs for small firms although the extent of the increase was largely unclear due to uncertainty about what the final changes would be as well as how much of the costs would be absorbed by others. Areas where costs were thought likely to disproportionately affect small firms included familiarisation of staff with the policy, altering design specifications, and training staff in new techniques.

4.9 Parties affected by the proposals for 2013 would include in particular small firms involved in the construction of new buildings and extensions, manufacturers and installers of replacement windows, boilers and other products, and installers of energy efficiency measures such as loft and cavity wall insulation. There are a number of ways in which small firms may be disproportionately affected by the proposals when compared to larger firms.

4.10 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 to switch to producing higher specification construction materials than larger manufacturers. However, this risk will be limited by the fact that we are not proposing major changes to the product performance standards for 2013, partly because experience of manufacturing/specifying to the current standards is limited (as these were only introduced in 2010).

4.11 The main exception to this is the proposed improvement in recommended performance standards for windows. Discussions with representatives of the larger window manufacturers suggest that these companies are ready to respond to higher performance requirements, and are using the windows energy rating

[41] ONS: Construction Statistics Annual 2011.

system[42] as a way of differentiating their products from those of their competitors. This is less likely to be the case for those micro and small businesses that operate in small/local markets and do not compete in this way. However, the change in standards is not likely to involve a major change in technology (for example, it should not require a move to triple rather than double glazing) so provided there is sufficient notice of the change, small businesses should be able to adapt. We will test this assumption at consultation.

4.12 The changes in the way standards are set for new homes in 2013 (the introduction of a fabric energy efficiency target) risks a disproportionate impact on small builders who may be more accustomed to the previous standard setting method. Small builders carrying out loft and garage conversions and extensions will also need to adjust their practices and designs to meet the new standards. However, building on experience from the implementation of the 2010 changes, before implementation of any 2013 changes DCLG will consider working with industry to develop guidance aimed at small builders on model design solutions to meet the 2013 standards. A similar guide was published by DCLG and the NHBC Foundation shortly after publication of the 2010 changes[43].

4.13 The more ambitious option for changes in standards for new non-domestic buildings may impact more on those building small buildings, in particular small warehouses, which may be more likely to be occupied by small or start-up businesses. Further evidence on this will be gathered through the consultation.

4.14 The proposal to extend the requirement for consequential improvements to domestic and smaller non-domestic buildings could create a significant new (or increased) market for smaller firms. Consequential improvements generally require relatively small scale works involving additional insulation and plumbing work. Much of this will either fall within or be similar to work that small firms are already carrying out, and coupled with the Green Deal could provide significant extra work for small and micro-enterprises. It is also likely to create additional demand for Green Deal assessments, where building owners opt for Green Deal finance to meet the requirements, many of which may be carried out by small businesses.

4.15 On the other hand, the new regulation could also introduce a new duty for those carrying out window and boiler replacements to inform householders about requirements for consequential works, which would require these businesses to become familiar with the new arrangements. As explained in section 2, we will also want to test whether the new requirements could dissuade some homeowners and businesses from carrying out small building projects, as this would have an impact on small businesses.

[42] http://www.bfrc.org/trade/energyRatings.aspx
[43] http://www.planningportal.gov.uk/buildingregulations/approveddocuments/partl/bcassociateddocuments9/wheretostart

Micro businesses

4.16 Micro businesses, which employ fewer than 10 full time equivalent employees, make up around 90% of firms for the sector as a whole, employ around 34% of staff and undertake around 17% of work done according to the BIS construction statistics[44].

4.17 A number of the issues above for all small firms, including product development, are clearly relevant to micro businesses. We estimate that under 10% of new buildings are built by micro businesses with other micro businesses likely to be sub-contracted for particular pieces of work by the larger builders. Micro businesses will benefit from occupying commercial buildings with lower energy bills.

4.18 For existing homes, the costs fall on home owners and occupants, although micro businesses may benefit from additional work. For existing non-domestic buildings, higher standards will be a cost to micro businesses where they are liable for refurbishing the building although they will typically benefit from lower energy bills even where they are not liable for the costs.

4.19 Further evidence gathering on the impact on both small and micro businesses will be undertaken during the consultation.

Social impacts

Health and well-being impacts

4.20 There are potentially beneficial improvements in health and quality of life from the effect of increased energy efficiency on thermal comfort. 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.

4.21 This is why the ventilation standards in Part F of the Building Regulations were improved in 2010[45] and new requirements and guidance for installation and commissioning of ventilation systems[46] introduced.

4.22 Also as part of Government's wider adaptation work programme we have commissioned a piece of research to analyse the effects that better insulated envelopes and climate change projections could have upon the risks of overheating. 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

[44] http://www.bis.gov.uk/policies/business-sectors/construction/construction-statistics
[45] http://www.planningportal.gov.uk/buildingregulations/approveddocuments/partf/
[46] http://www.planningportal.gov.uk/buildingregulations/approveddocuments/partf/associated

case for intervention including possible future changes to other parts of the Building Regulations.

Equalities impacts

4.23 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.

4.24 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

4.25 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.

4.26 In Part L 2006 a fuel factor was introduced which differed between gas, oil, electricity and 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. Without the fuel factor, 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.

4.27 The consultation seeks views on options to retain, reduce or remove the fuel factor. As a central case, the reduced fuel factor has been used for the main modelling, but this will be reviewed for the final stage impact assessment.

4.28 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.

4.29 Reducing the factor would essentially reduce the relief provided to off-gas grid homes. It is estimated that reducing the contribution from fuel factors will increase the cost of building homes in off-gas grid areas, though it would also result in lower fuel bills for occupiers. The costs (over and above Part L 2010) to meet the 'FEES plus efficient services' target in an end of terrace house are set out in Table 4.1 (assuming that the house is built to the full 46kWh/m^2/year FEES energy target, not the interim FEES target of 52 kWh/m^2/year), with the impacts of retaining, reducing or removing the fuel factor. There is no impact where a heat pump is used because this overshoots the FEES plus efficient services target, thus the fuel factor provides no relief.

4.30 The Government does not have a preference for the level of the fuel factor in 2013. Although reducing the fuel factor could aid the transition to zero carbon standards, it also increases the construction costs for off-gas homes and results in the use of (according to modelling) MVHR systems in electrically heated apartments, and the increased maintenance costs of this affect the NPVs of the new homes policy (see section 2).

Table 4.1: Cost impacts of the fuel factor[47]

Fuel	Retain Fuel Factor	Reduce Fuel Factor	Remove Fuel Factor	Impact of reducing the fuel factor (as against same fuel with the full fuel factor)	Impact of removing the fuel factor (as against same fuel with the full fuel factor)
Mains Gas	£950	£950	£950	£0	£0
LPG	£1,098	£1,589	£1,991	£491	£893
Oil	£825	£1,426	£3,350	£601	£2,525
Heat Pump	£2,903	£2,903	£2,903	£0	£0
Direct Electric	£739	£1,640	£5,731	£901	£4,992

Environmental impacts

Greenhouse gas assessment

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

Wider environmental impacts

4.32 Air quality damage costs/benefits have not been monetised for consultation stage, but benefits are expected due to reduced energy demand. This will be subject to further work and will be included in the implementation stage impact assessment.

4.33 Avoided renewables have been included in the costs and benefits calculations and the cost-effectiveness calculations, in accordance with current published Interdepartmental Analysts' Group guidance. This may be revisited for the final stage impact assessment if updated Interdepartmental Analysts' Group guidance is available at the time of development.

[47] Costs shown are in 2013, and are undiscounted.

Administrative burdens

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

4.35 The proposal to introduce a quality process (PAS) is a voluntary arrangement. Using the PAS will create an administrative cost for developers, and this would be a proportion of the implementation cost of the overall PAS process.

APPENDIX 1: COSTS FOR DWELLINGS AND NON-DOMESTIC BUILDINGS

Fabric costs for dwellings

Incremental fabric costs for mid-terrace house

Element						
External Walls (u-value)	0.28	0.22	0.2	0.18	0.15	
Cost (£/m^2)	£0.00	£6.57	£7.74	£10.40	£15.02	
Party Walls (u-value)	0.5	0.0				
Cost (£/m^2)	£0.00	£5.97				
Ground Floor (u-value)	0.2	0.18	0.17	0.15	0.13	
Cost (£/m^2)	£0.00	£1.30	£2.68	£5.20	£7.09	
Roof (u-value)	0.16	0.15	0.13	0.11		
Cost (£/m^2)	£0.00	£0.78	£1.91	£4.73		
Windows(u-value)	1.8	1.6	1.5	1.4	1.2	0.8
Cost (£/m^2)	£0.00	£0.00	£30.00	£32.50	£62.50	£117.25
Doors (u-value)	1.6	1.2	1.0			
Cost (£/m^2)	£0.00	£20.00	£80.00			
Airtightness (m^3/hr/m^2)	7	5	3	1		
Cost (per house)	£0.00	£250.00	£615.00	£1,240.00		
Thermal bridging (W/m^2K)	0.08	0.06	0.05	0.04		
Cost (per house)	£0.00	£100.00	£394.00	£1,094.00		

Incremental fabric costs for detached house

Element						
External Walls (u-value)	0.28	0.22	0.2	0.18	0.15	
Cost (£/m^2)	£0.00	£5.92	£6.75	£9.08	£13.36	
Party Walls (u-value)	0.5	0.0				
Cost (£/m^2)	£0.00	£5.97				
Ground Floor (u-value)	0.2	0.18	0.17	0.15	0.13	
Cost (£/m^2)	£0.00	£1.30	£2.68	£5.20	£7.09	
Roof (u-value)	0.16	0.15	0.13	0.11		
Cost (£/m^2)	£0.00	£0.78	£1.91	£4.73		
Windows(u-value)	1.8	1.6	1.5	1.4	1.2	0.8
Cost (£/m^2)	£0.00	£0.00	£30.00	£32.50	£62.50	£117.25
Doors (u-value)	1.6	1.2	1.0			
Cost (£/m^2)	£0.00	£20.00	£80.00			
Airtightness (m^3/hr/m^2)	7	5	3	1		
Cost (per house)	£0.00	£386.00	£923.00	£1,848.00		
Thermal bridging (W/m^2K)	0.08	0.06	0.05	0.04		
Cost (per house)	£0.00	£155.00	£730.00	£1,317.00		

Incremental fabric costs for apartment unit

Element						
External Walls (u-value)	0.28	0.22	0.2	0.18	0.15	
Cost (£/m^2)	£0.00	£7.76	£8.44	£9.88	£17.72	
Party Walls (u-value)	0.5	0.0				
Cost (£/m^2)	£0.00	£5.97				
Ground Floor (u-value)	0.2	0.18	0.17	0.15	0.13	
Cost (£/m^2)	£0.00	£1.30	£2.68	£5.20	£7.09	
Roof (u-value)	0.16	0.15	0.13	0.11		
Cost (£/m^2)	£0.00	£0.78	£1.91	£4.73		
Windows(u-value)	1.8	1.6	1.5	1.4	1.2	0.8
Cost (£/m^2)	£0.00	£0.00	£30.00	£32.50	£62.50	£117.25
Doors (u-value)	1.6	1.2	1.0			
Cost (£/m^2)	£0.00	£20.00	£80.00			
Airtightness (m^3/hr/m^2)	7	5	3	1		
Cost (per house)	£0.00	£198.00	£498.00	£1,009.00		
Thermal bridging (W/m^2K)	0.08	0.06	0.05	0.04		
Cost (per house)	£0.00	£79.00	£247.00	£795.00		

Service costs for dwellings

Capital costs of heating systems compared to individual gas boilers

	House (end terrace)	Apartment
Direct electricity	(£1,050)	(£275)
Air Source Heat Pump	£5,788	£6,043
LPG	£960	
Oil	£2,160	

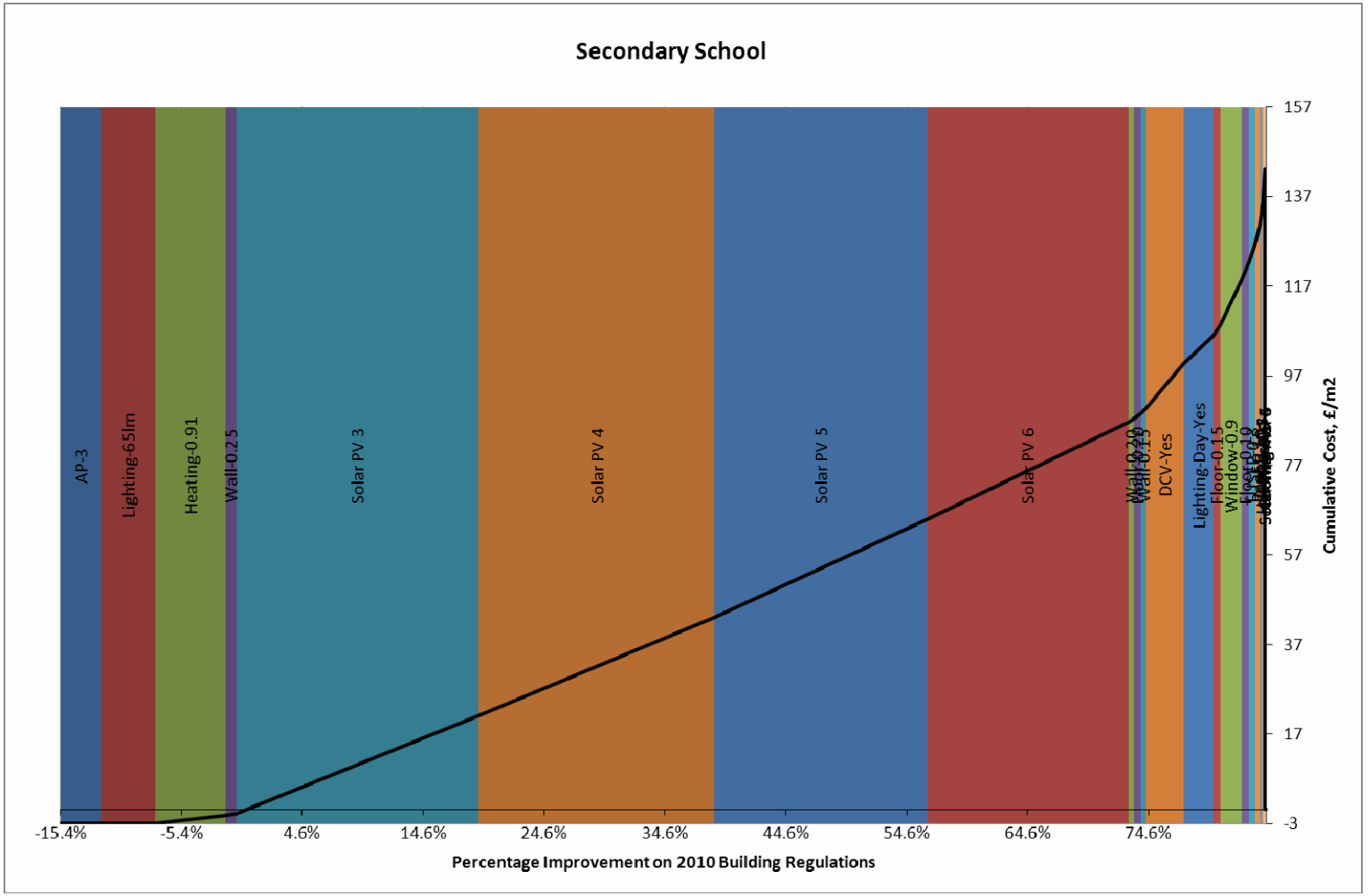
Domestic MVHR costs

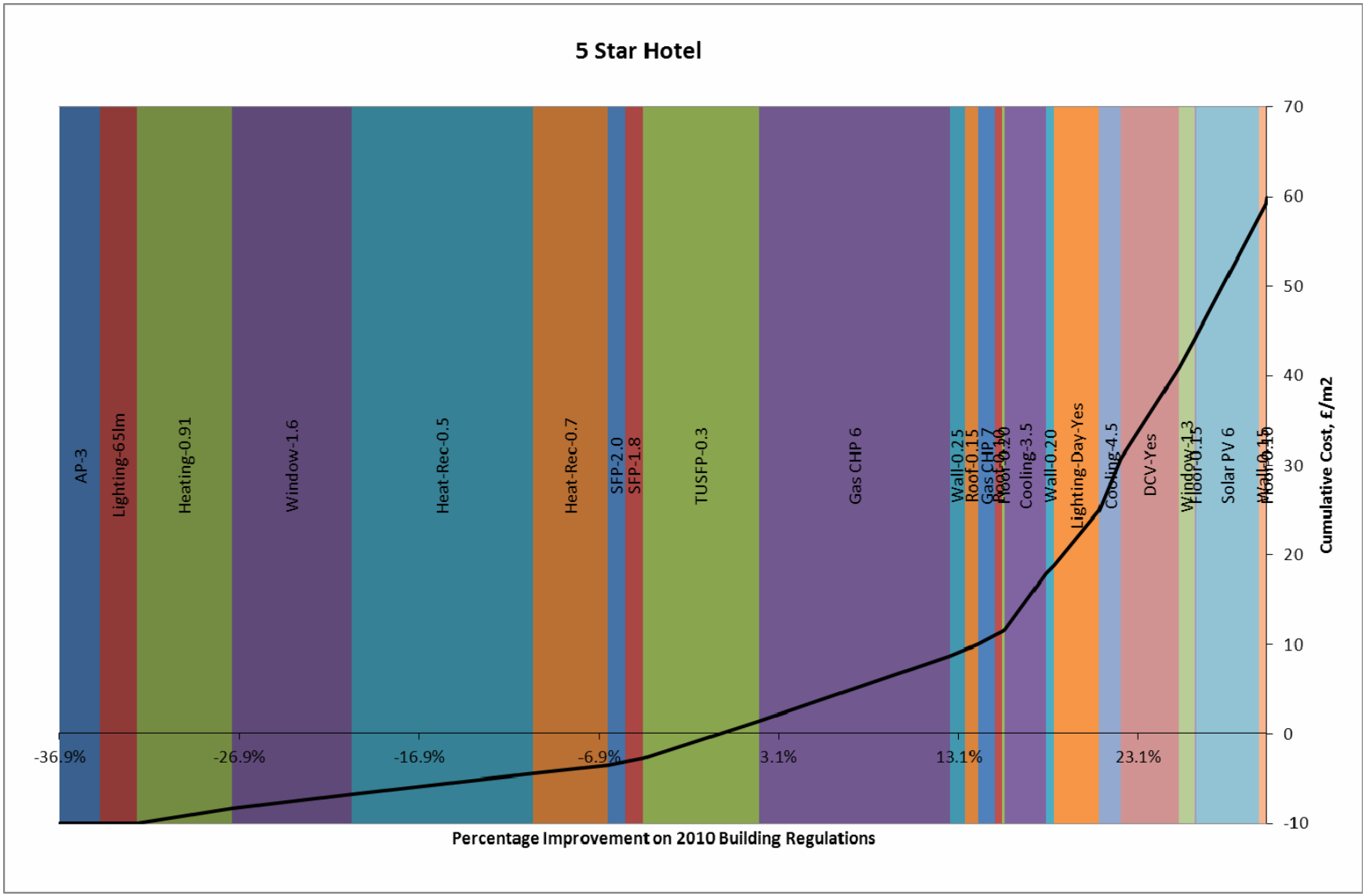
Initial costs	
Fixed	Apartment: £1090 Mid/End terraced: £1640 Detached: £1810
Maintenance costs	
Clean filter (annual)	£75
Clean MVHR (every four years)	£150
Replace MVHR unit (20 years)	£800

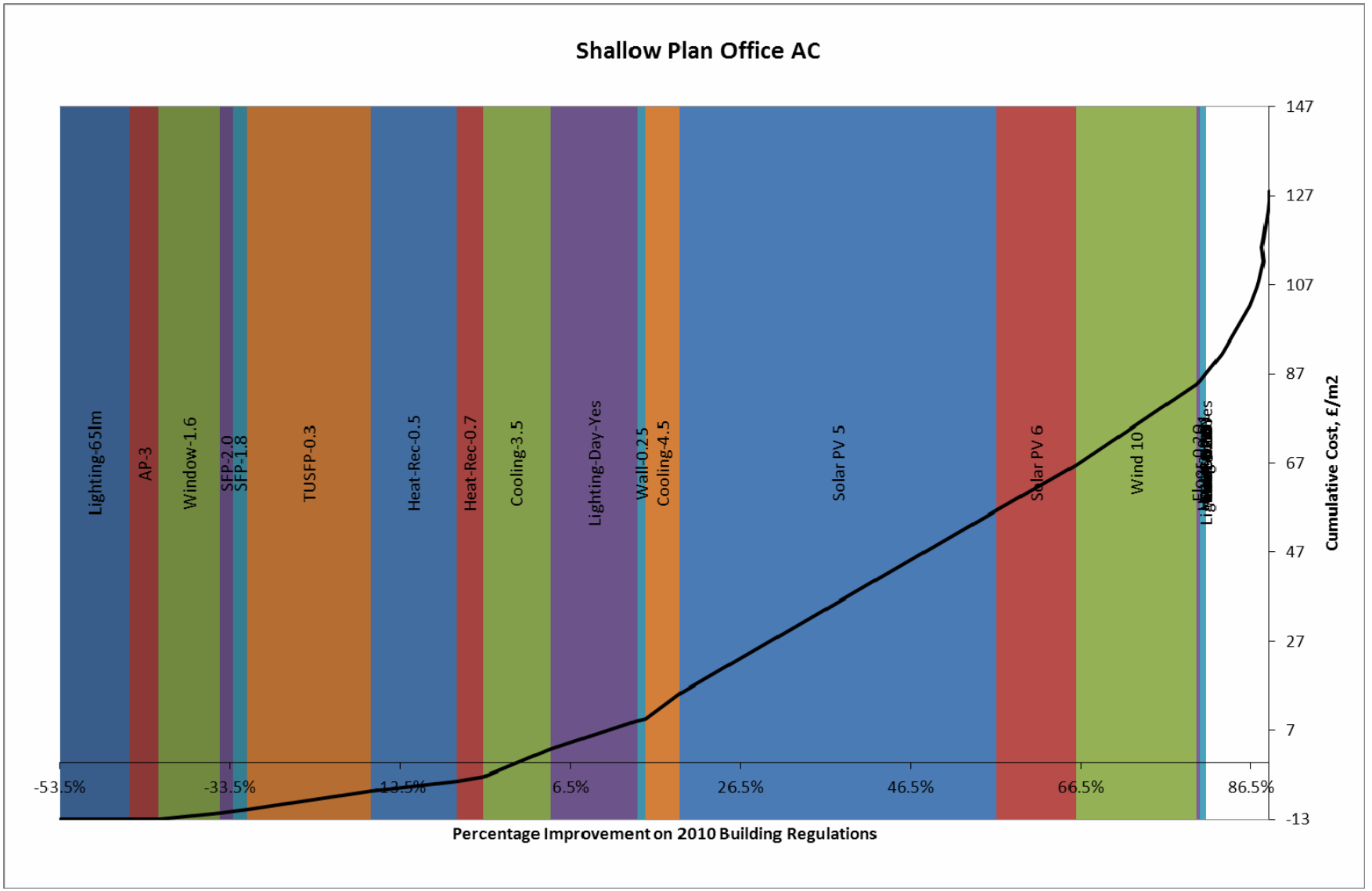
Domestic PV costs

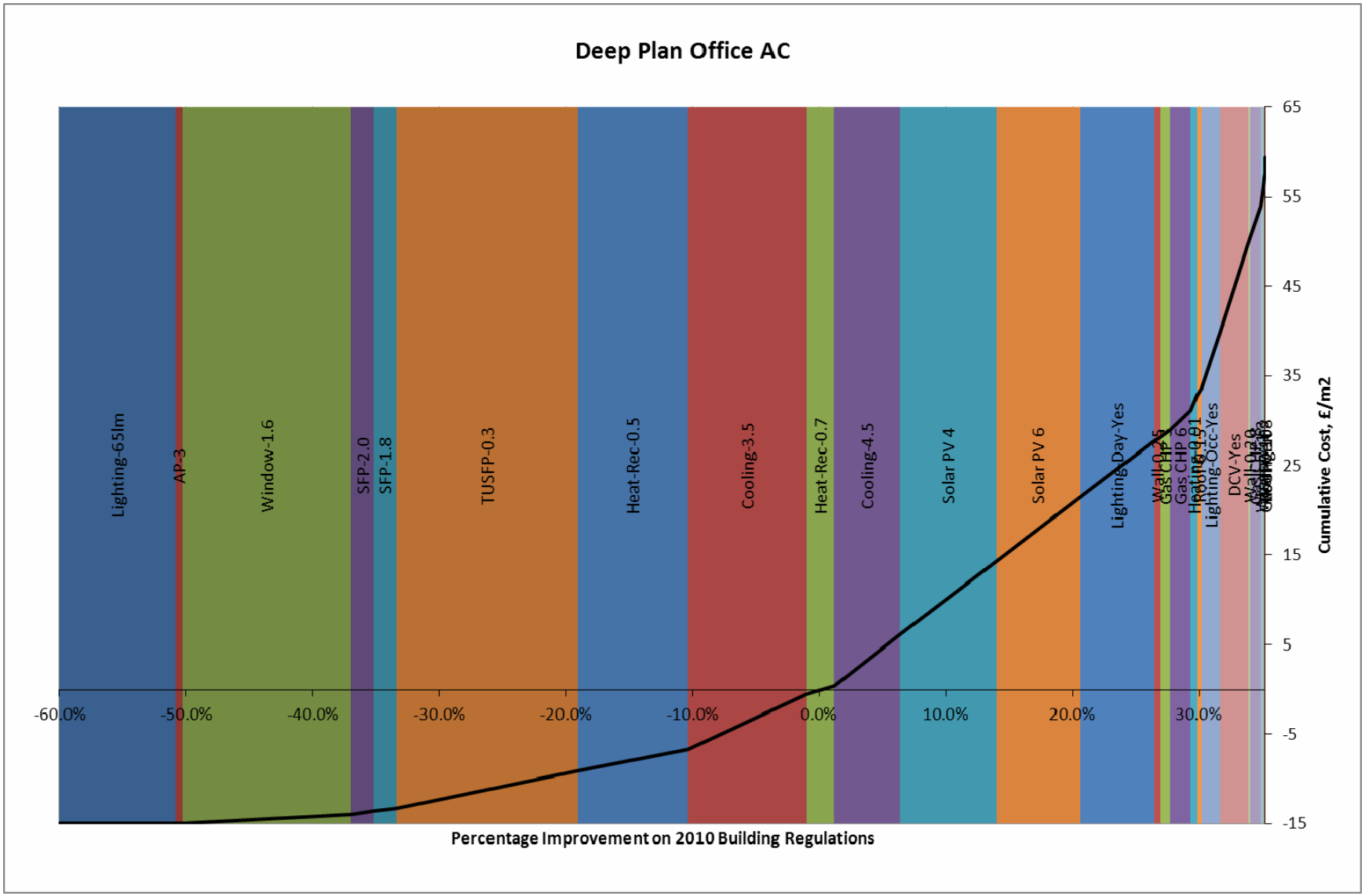
Initial costs	
Fixed	£900
Variable	£3728 (per kWp)
Maintenance costs	
PV electrical testing (every 5 years)	£75
Inverter replacement (every 12 years)	£1000
Panel replacement (every 30 years)	Same as initial costs

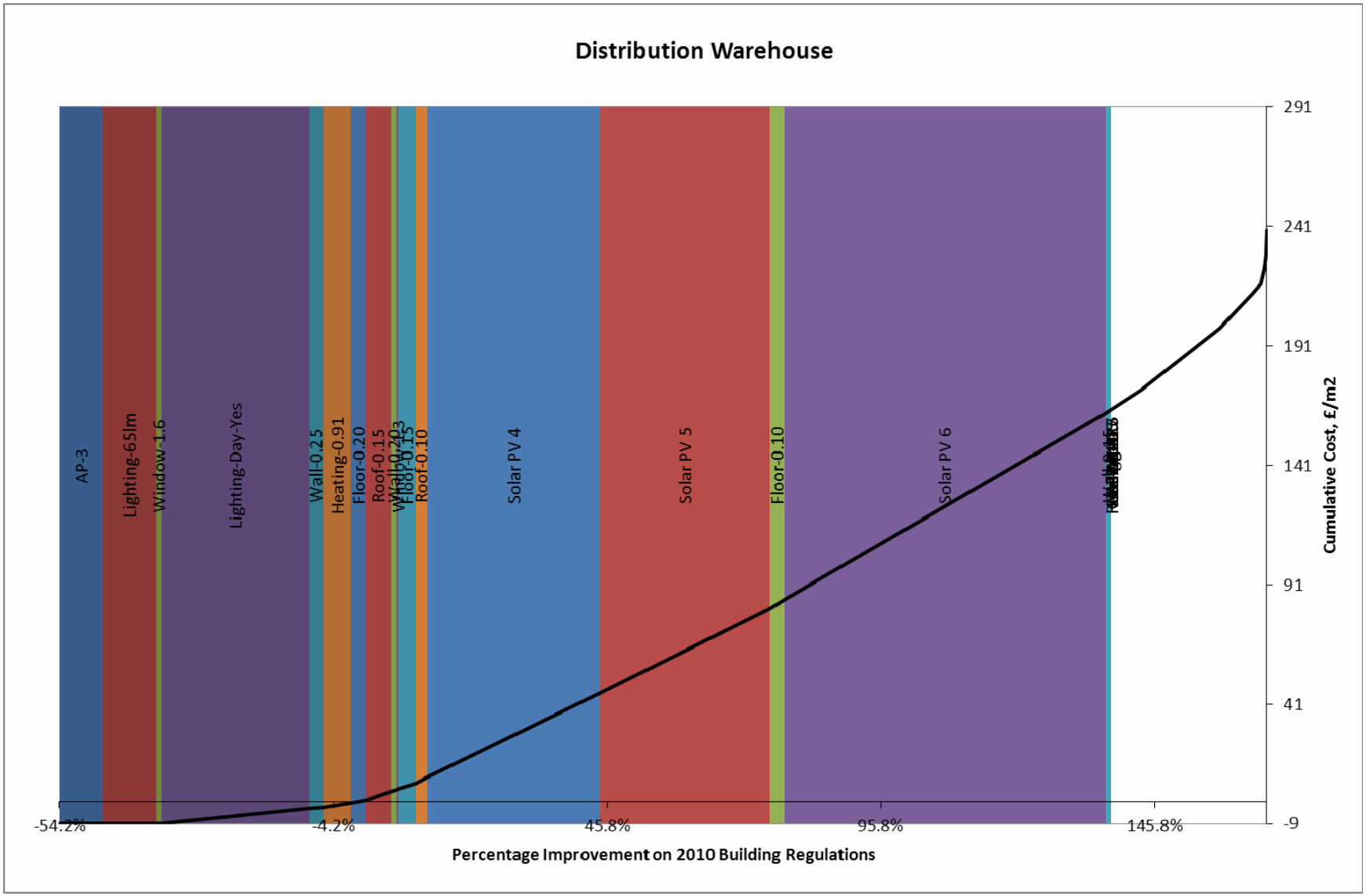
Cost curves for non-domestic buildings




5 Star Hotel
AP-3
Lighting-65lm
Heating-0.91
Window-1.6
Heat-Rec-0.5
Heat-Rec-0.7
SFP-2.0
SFP-1.8
TUSFP-0.3
Gas CHP 6
Wall-0.25
Roof-0.15
Gas CHP 7
Roof-0.10
Cooling-3.5
Wall-0.20
Lighting-Day-Yes
Cooling-4.5
DCV-Yes
Window-1.3
Floor-0.15
Solar PV 6
Wall-0.15
Roof-0.15
70
60
50
40
30
20
10
0
-10
Cumulative Cost, £/m2
-36.9%
-26.9%
-16.9%
-6.9%
3.1%
13.1%
23.1%
Percentage Improvement on 2010 Building Regulations


Shallow Plan Office AC
Lighting-65lm
AP-3
Window-1.6
SFP-2.0
SFP-1.8
TUSFP-0.3
Heat-Rec-0.5
Heat-Rec-0.7
Cooling-3.5
Lighting-Day-Yes
Wall-0.25
Cooling-4.5
Solar PV 5
Solar PV 6
Wind 10
-53.5%
-33.5%
-13.5%
6.5%
26.5%
46.5%
66.5%
86.5%
147
127
107
87
67
47
27
7
-13
Cumulative Cost, £/m2
Percentage Improvement on 2010 Building Regulations


Deep Plan Office AC
Lighting-65lm
AP-3
Window-1.6
SFP-2.0
SFP-1.8
TUSFP-0.3
Heat-Rec-0.5
Cooling-3.5
Heat-Rec-0.7
Cooling-4.5
Solar PV 4
Solar PV 6
Lighting-Day-Yes
Wall-0.25
Gas CHP 6
Heating-0.91
Lighting-Occ-Yes
DCV-Yes
-60.0%
-50.0%
-40.0%
-30.0%
-20.0%
-10.0%
0.0%
10.0%
20.0%
30.0%
65
55
45
35
25
15
5
-5
-15
Cumulative Cost, £/m2
Percentage Improvement on 2010 Building Regulations


Distribution Warehouse
AP-3
Lighting-65lm
Window-1.6
Lighting-Day-Yes
Wall-0.25
Heating-0.91
Floor-0.20
Roof-0.15
Roof-0.10
Solar PV 4
Solar PV 5
Floor-0.10
Solar PV 6
291
241
191
141
91
41
-9
Cumulative Cost, £/m2
-54.2%
-4.2%
45.8%
95.8%
145.8%
Percentage Improvement on 2010 Building Regulations


Retail Warehouse
Lighting-65lm
AP-3
Lighting-Day-Yes
SFP-2.0
SFP-1.8
Heat-Rec-0.5
TUSFP-0.3
Heat-Rec-0.7
Cooling-3.5
Wall-0.25
Cooling-4.5
Solar PV 5
Solar PV 6
Roof-0.15
Wall-0.10
Wind 10
-87.2%
-67.2%
-47.2%
-27.2%
-7.2%
12.8%
32.8%
52.8%
72.8%
92.8%
226
176
126
76
26
-24
Cumulative Cost, £/m2
Percentage Improvement on 2010 Building Regulations

APPENDIX 2: SENSITIVITY ANALYSIS

Carbon and energy prices

Table A2. 1: Present values of costs and benefits: new homes (NPV £m) – low carbon values and energy prices

Aggregate approach – FEES plus efficient services target

	Interim FEE + PV	Full FEES
Energy savings (£m)	391	290
Incremental costs (£m)	(1,643)	(1,079)
PAS (£m)	(113)	(113)
Sub-total (£m)	**(1,365)**	**(902)**
Carbon savings - non-traded (£m)	31	145
Carbon savings - traded (£m)	28	10
Total carbon savings (£m)	59	155
Net benefit/cost excl. avoided renewables (£m)	**(1,306)**	**(747)**
Avoided renewables (£m)	3	5
Net benefit/cost incl. avoided renewables (£m)	**(1,303)**	**(742)**
Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	1.34	6.29
Amount of CO2 saved - traded ($MtCO_2(e)$)	1.76	0.62
Cost effectiveness – non-traded (£/tCO_2)	997	142
Cost effectiveness – traded (£/tCO_2)	758	1,227

Source: Europe Economics

Aggregate approach – Halfway point target

	Interim FEE+PV	Full FEES + PV	Fabric only
Energy savings (£m)	1,304	1,201	772
Incremental costs (£m)	(3,269)	(3,409)	(5,760)
PAS (£m)	(113)	(113)	(113)
Sub-total (£m)	**(2,079)**	**(2,322)**	**(5,101)**
Carbon savings - non-traded (£m)	31	145	626
Carbon savings - traded (£m)	98	80	5
Total carbon savings (£m)	129	225	631
Net benefit/cost excl. avoided renewables (£m)	**(1,949)**	**(2,096)**	**(4,470)**
Avoided renewables (£m)	9	11	21
Net benefit/cost incl. avoided renewables (£m)	**(1,941)**	**(2,085)**	**(4,450)**
Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	*1.34*	*6.29*	*27.11*
Amount of CO_2 saved - traded ($MtCO_2(e)$)	*6.27*	*5.12*	*0.30*
Cost effectiveness – non-traded (£/tCO_2)	*1476*	*357*	*188*
Cost effectiveness – traded (£/tCO_2)	*327*	*425*	*15104*

Source: Europe Economics

Table A2. 2: Present values of costs and benefits: new homes (NPV £m) – high carbon values and energy prices

Aggregate approach — FEES plus efficient services target

	Interim FEE + PV	Full FEES
Energy savings (£m)	896	697
Incremental costs (£m)	(1,643)	(1,079)
PAS (£m)	(113)	(113)
Sub-total (£m)	**(860)**	**(496)**
Carbon savings - non-traded (£m)	99	462
Carbon savings - traded (£m)	83	29
Total carbon savings (£m)	182	491
Net benefit/cost excl. avoided renewables (£m)	**(678)**	**(5)**
Avoided renewables (£m)	3	5
Net benefit/cost incl. avoided renewables (£m)	**(675)**	**1**
Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	1.34	6.29
Amount of CO_2 saved - traded ($MtCO_2(e)$)	1.76	0.62
Cost effectiveness – non-traded (£/tCO_2)	579	74
Cost effectiveness – traded (£/tCO_2)	432	54

Source: Europe Economics

Aggregate approach – Halfway point target

	Interim FEE+PV	Full FEES + PV	Fabric only
Energy savings (£m)	2,966	2,764	1,919
Incremental costs (£m)	(3,269)	(3,409)	(5,760)
PAS (£m)	(113)	(113)	(113)
Sub-total (£m)	**(416)**	**(759)**	**(3,955)**
Carbon savings - non-traded (£m)	99	462	1,992
Carbon savings - traded (£m)	296	241	14
Total carbon savings (£m)	394	703	2,006
Net benefit/cost excl. avoided renewables (£m)	**(22)**	**(55)**	**(1,949)**
Avoided renewables (£m)	9	11	21
Net benefit/cost incl. avoided renewables (£m)	**(13)**	**(44)**	**(1,928)**
Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	*1.34*	*6.29*	*27.11*
Amount of CO_2 saved - traded ($MtCO_2(e)$)	*6.27*	*5.12*	*0.30*
Cost effectiveness – non-traded (£/tCO_2)	*90*	*82*	*145*
Cost effectiveness – traded (£/tCO_2)	*51*	*58*	*6624*

Source: Europe Economics

Table A2. 3: Present values of costs and benefits: new non-domestic buildings (NPV £m) – low carbon values and energy prices

	8%	11%	14%	20%
Energy savings (£m)	426	485	568	838
Incremental costs (£m)	(781)	(898)	(1,095)	(1,811)
Sub-total (£m)	(355)	(414)	(527)	(973)
Carbon savings - non-traded (£m)	15	28	69	69
Carbon savings - traded (£m)	38	43	46	70
Total carbon savings (£m)	53	71	115	139
Net benefit/cost (£m)	(302)	(343)	(412)	(834)
volume of CO_2 saved - non-traded ($MtCO_{2(e)}$)	0.7	1.2	3.1	3.1
volume of CO2 saved - traded ($MtCO_{2(e)}$)	2.4	2.8	3.0	4.5
cost effectiveness - non-traded (£/tCO_2)	478	304	157	295
cost effectiveness - traded (£/tCO_2)	141	140	154	202

Source: Europe Economics

Table A2. 4: Present values of costs and benefits: new non-domestic buildings (NPV £m) – high carbon values and energy prices

	8%	11%	14%	20%
Energy savings (£m)	992	1,130	1,341	1,965
Incremental costs (£m)	(781)	(898)	(1,095)	(1,811)
Sub-total (£m)	211	232	245	155
Carbon savings - non-traded (£m)	53	96	230	231
Carbon savings - traded (£m)	113	128	139	210
Total carbon savings (£m)	166	224	369	441
Net benefit/cost (£m)	377	455	614	596
volume of CO_2 saved - non-traded ($MtCO_{2(e)}$)	0.7	1.2	3.1	3.1
volume of CO2 saved - traded ($MtCO_{2(e)}$)	2.4	2.8	3.0	4.5
cost effectiveness - non-traded (£/tCO_2)	(488)	(294)	(125)	(119)
cost effectiveness - traded (£/tCO_2)	(109)	(119)	(160)	(86)

Source: Europe Economics

Fuel factor sensitivities

Table A2. 5: Present values of costs and benefits: new homes (NPV £m) – no fuel factor

Aggregate approach – FEES plus efficient services target

	Interim FEE + PV	Full FEES
Energy savings (£m)	1,329	1,135
Incremental costs (£m)	(2,173)	(1,827)
PAS (£m)	(113)	(113)
Sub-total (£m)	**(957)**	**(806)**
Carbon savings - non-traded (£m)	65	304
Carbon savings - traded (£m)	103	67
Total carbon savings (£m)	168	370
Net benefit/cost excl. avoided renewables (£m)	**(789)**	**(435)**
Avoided renewables (£m)	5	7
Net benefit/cost incl. avoided renewables (£m)	**(784)**	**(428)**
Present value net cost to business (£m)	(1,411)	(1,330)
Annual equivalent net cost to business (£m)	(164)	(154)
Amount of CO_2 saved - non-traded ($MtCO_2(e)$)	1.34	6.29
Amount of CO_2 saved - traded ($MtCO_2(e)$)	3.24	2.10
Cost effectiveness – non-traded (£/tCO_2)	636	118
Cost effectiveness – traded (£/tCO2)	275	240

Source: Europe Economics

Non-domestic consequential improvements

Energy demand sensitivities

Table A2. 6: Consequential improvements – non-domestic buildings under 1000m^2 (25% less energy demand)

	Total energy savings (£m)	Total capital cost (£m)	Net benefit exc carbon (£m)	Traded carbon savings (£m)	Non-traded carbon savings (£m)	Net benefit inc carbon, (£m)	Avoided renewables (£m)	Total net benefit (£m)	Amount of energy savings (GWh)	Amount of carbon savings ($MtCO_{2(e)}$)
Loft insulation (to 300mm if < 150mm)										
Currently with none	2	0	2	0	2	4	0.1	4	197	0.0
Currently with 50mm or less	1	0	0	0	0	1	0.0	1	45	0.0
Currently with 75mm	0	0	0	0	0	0	0.0	0	3	0.0
Currently with 100mm	2	(3)	0	0	2	2	0.1	2	215	0.0
Cavity wall insulation										
Pre-76 cavity insulation	9	(1)	8	0	7	15	0.2	15	807	0.1
Post -76 cavity insulation	5	(1)	4	0	4	8	0.1	8	433	0.1
Hot water cylinder insulation to >75mm										
Currently with no insulation	1	0	1	0	0	1	0.0	1	58	0.0
Currently with 25mm insulation	0	0	0	0	0	0	0.0	0	8	0.0
Currently with 50mm insulation	0	0	0	0	0	0	0.0	0	8	0.0
Draughtproofing	0	0	0	0	0	0	0.0	0	13	0.0
Low energy lighting	0	(1)	(1)	0	0	(1)	0.0	(1)	5	0.0
Total	21	(8)	15	0	16	30	0.6	31	1,787	0.3

Note: Soft measures are loft insulation, cavity wall insulation, hot water cylinder insulation, draught proofing and low energy lighting

Source: Europe Economics

Table A2. 7: Consequential improvements – non-domestic buildings under 1000m^2 (25% more energy demand)

	Total energy savings (£m)	Total capital cost (£m)	Net benefit exc carbon (£m)	Traded carbon savings (£m)	Non-traded carbon savings (£m)	Net benefit inc carbon, (£m)	Avoided renewables (£m)	Total net benefit (£m)	Amount of energy savings (GWh)	Amount of carbon savings ($MtCO_{2(e)}$)
Loft insulation (to 300mm if < 150mm)										
Currently with none	4	(1)	3	0	3	6	0.1	6	328	0.1
Currently with 50mm or less	1	0	1	0	1	1	0.0	1	74	0.0
Currently with 75mm	0	0	0	0	0	0	0.0	0	6	0.0
Currently with 100mm	4	(4)	0	0	3	3	0.1	3	358	0.1
Cavity wall insulation										
Pre-76 cavity insulation	15	(2)	13	0	12	25	0.4	25	1,345	0.2
Post -76 cavity insulation	8	(2)	6	0	6	13	0.2	13	722	0.1
Hot water cylinder insulation to >75mm										
Currently with no insulation	1	0	1	0	1	2	0.0	2	97	0.0
Currently with 25mm insulation	0	0	0	0	0	0	0.0	0	14	0.0
Currently with 50mm insulation	0	0	0	0	0	0	0.0	0	13	0.0
Draughtproofing	0	0	0	0	0	0	0.0	0	22	0.0
Low energy lighting	1	(2)	(1)	0	0	(1)	0.0	(1)	8	0.0
Total	35	(13)	25	0	26	51	1.0	52	2,978	0.6

Note: Soft measures are loft insulation, cavity wall insulation, hot water cylinder insulation, draught proofing and low energy lighting

APPENDIX 3: LEARNING RATES

Table A3.1: Learning rates applied to the new build domestic and non-domestic cost benefit analysis

	Gas CHP	Solar Thermal	Solar PV	ASHP[1] (technology)	ASHP[1] (install)	MVHR[2] (install)
2014	80%	93%	71%	94%	85%	96%
2015	78%	91%	66%	93%	84%	96%
2016	76%	89%	62%	91%	83%	95%
2017	75%	87%	59%	90%	82%	95%
2018	73%	86%	56%	88%	82%	94%
2019	72%	85%	53%	87%	81%	94%
2020	70%	84%	50%	86%	81%	93%
2021	69%	84%	48%	84%	81%	93%
2022	68%	83%	46%	83%	80%	92%
2023	67%	82%	44%	82%	80%	92%

Sources: Cyril Sweett, Renewable Energy Association

[1] This data was used for the domestic calculations only. The technology learning rates were applied to the capital cost of the system and the install learning rates were applied to the installation costs. Learning rates were only applied to additional components of the system introduced by replacing a gas boiler system by an air source heat pump eg the cost of the air source heat pump was subject to learning but not that of including the hot water cylinder.

[2] This data was used for the domestic calculations only. Given the wider use of MVHR internationally, it was assumed that the key learning rate benefit was from the increased installations in the UK.

Table A3.2 Learning rates applied to the new build domestic analysis[1]

	Airtightness and thermal bridging[2]	Windows[3]
2010	100%	100%
2011	80%	86%
2012	60%	71%
2013	40%	57%
2014	20%	43%
2015	0%	29%
2016	0%	14%
2017	0%	0%
2018	0%	0%
2019	0%	0%
2020	0%	0%
2021	0%	0%
2022	0%	0%
2023	0%	0%

Sources: Cyril Sweett, Zero Carbon Hub, AECOM

[1] Data from 2014 to 2023 only has been used in the analysis. Earlier data is shown to better understand the assumptions chosen.

[2] The learning rates are for improvements in airtightness and thermal bridging. Higher standards are assumed for an airtightness of 5.1 or better or thermal bridging of y= 0.06 or better. These rates are 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 eg it is assumed that, for example, design changes (for thermal bridging) and enhanced training and supervision (for airtightness) would be subject to learning but the need for additional materials or testing would not.

[3] This is the differential cost of building to a u-value of 1.2 rather than 1.4.