Number: **WG-15253**

Llywodraeth Cymru
Welsh Government

www.cymru.gov.uk

Welsh Government

Consultation Document

2012 consultation on changes to the Building Regulations in Wales Part L (Conservation of fuel and power)

Section three - The Regulatory Impact Assessment

Date of issue: **31 July 2012**
Action required: Responses by **23 October 2012**

Overview

The Building Regulations and the associated statutory guidance set out in Approved Documents seek to ensure buildings meet certain standards for minimum health, safety, welfare, convenience and sustainability.

This document covers proposals for changes relating to Part L (Conservation of fuel and power).

This consultation is aimed primarily at firms, individuals and their representative bodies within construction and construction-related industries and the building control bodies that enable the building control system to operate. Specific elements may be of interest to members of the public.

How to respond

A response form is provided at Annex B of this document.

Consultees are invited to e-mail responses to:
enquiries.brconstruction@wales.gsi.gov.uk

Those who prefer to submit a paper copy of their response should send these to:

Building Regulations Consultation
Construction Unit
Environment and Sustainable Development Directorate
Welsh Government
Rhyd y Car Offices
Merthyr Tydfil
CF48 1UZ

Further information and related documents

Large print, Braille and alternate language versions of this document are available on request.

Contact Details

For further information:

Welsh Government
Rhyd y Car Offices
Merthyr Tydfil
CF48 1UZ
Telephone: 0300 062 8141
E-mail: enquiries.brconstruction@wales.gsi.gov.uk

Data Protection

How the views and information you give us will be used.

Any response you send us will be seen in full by Welsh Government staff dealing with the issues which this consultation is about. It may also be seen by other Welsh Government staff to help them plan future consultations.

The Welsh Government intends to publish a summary of the responses to this document. We may also publish responses in full. Normally, the name and address (or part of the address) of the person or organisation who sent the response are published with the response. This helps to show that the consultation was carried out properly. If you do not want your name or address published, please tell us this in writing when you send your response. We will then blank them out.

Names or addresses we blank out might still get published later, though we do not think this would happen very often. The Freedom of Information Act 2000 and the Environmental Information Regulations 2004 allow the public to ask to see information held by many public bodies, including the Welsh Government. This includes information which has not been published. However, the law also allows us to withhold information in some circumstances. If anyone asks to see information we have withheld, we will have to decide whether to release it or not. If someone has asked for their name and address not to be published, that is an important fact we would take into account. However, there might sometimes be important reasons why we would have to reveal someone's name and address, even though they have asked for them not to be published. We would get in touch with the person and ask their views before we finally decided to reveal the information.

Title: Proposed Changes to Part L (Conservation of fuel and power) of the Building Regulations 2012/13 in Wales	Regulatory Impact Assessment (IA)
	Date: July 2012 **Stage:** Consultation **Source of intervention:** Domestic **Type of measure:** Primary legislation/ Secondary Legislation / Other **Contact for enquiries**: Francois Samuel

Summary: Intervention and Options

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

The Welsh Government has a commitment to reduce carbon emissions by 3% per annum from 2011 and all sectors - including domestic and non-domestic buildings - are expected to contribute to the carbon savings. Amending Building Regulations is one option that can be considered in situations where the market would not deliver the carbon savings of its own accord, where other existing measures (regulatory or non-regulatory) would not achieve the objectives and where it is shown to be cost-effective. In this case, market failures include the cost of carbon not being fully reflected in energy prices, a lack of information on i) future energy prices and ii) a building's energy efficiency and limited incentives. Amending building regulations 'locks in' energy efficient design and low carbon technologies at the point of build.

What are the policy objectives and the intended effects?

The Welsh Government is committed to reducing the level of carbon emissions in Wales to support its overall climate change objectives – one of which is to reduce emissions by 3% per annum from 2011. The devolution of Building Regulations in 2011 has provided the Welsh Government with the scope to introduce a carbon standard for new domestic and non-domestic buildings that is most appropriate to Wales. The introduction of more stringent targets for carbon emissions from new and existing buildings is intended to complement the Welsh and UK Government's existing policies such as the *Arbed* programme and the Green Deal.

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

Option 1: Do Nothing – keep existing Planning for Sustainable Buildings policy (this forms the baseline for the analysis).

Option 2: Low case - new domestic buildings target of a 25% energy efficiency improvement on Part L 2010 Standards, new non-domestic buildings target of 11% improvement on 2010 standards and tighter standards for extensions, replacements and consequential improvements to existing buildings.

Option 3: High case - new domestic buildings target of a 40% energy efficiency improvement on Part L 2010 Standards, new non-domestic buildings target of 20% improvement on 2010 standards and tighter standards for extensions, replacements and consequential improvements to existing buildings. This is the preferred option.

Option 4: Hybrid case - new domestic buildings target of a 25% energy efficiency improvement on Part L 2010 Standards, new non-domestic buildings target of 20% improvement on 2010 standards and tighter standards for extensions, replacements and consequential improvements to existing buildings.

Will the policy be reviewed? It will be reviewed. **If applicable, set review date:** 2016

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:** **3.9 - 4.1**		**Non-traded:** **21.3 - 21.6**

Summary: Analysis & Evidence

Policy Option 2

Description: Low increase in standards for new domestic and non-domestic property, tighter standards for changes to domestic and non-domestic properties and consequential improvements for all properties.

FULL ECONOMIC ASSESSMENT

Price Base Year	PV Base Year	Time Period Years	Net Benefit (Present Value (PV)) (£m)		
			Low:	**High:**	**Best Estimate:**
2011	2011	70			**£2,761.9**

COSTS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Cost** (Present Value)
Low	Optional		Optional	**Optional**
High	Optional		Optional	**Optional**
Best Estimate	0		24.9	**£835.2**

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

Increased building costs: new domestic property £182.5m; existing domestic property £17.8m; consequential improvements to existing domestic property £18.6m; new non-domestic property £75.5m; existing non-domestic property £538m, consequential improvements to existing non-domestic property £2.9m. The initial capital costs will be borne by the developers (these costs may ultimately be passed to landowners) and building occupiers. Ongoing maintenance and replacement costs borne by building owner/tenant.

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

No account has been taken of the potential impact of higher capital costs on construction activity in Wales or the demand for extensions or improvements to existing property.

BENEFITS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Benefit** (Present Value)
Low	Optional		Optional	**Optional**
High	Optional		Optional	**Optional**
Best Estimate			166.1	**£3,597.1m**

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

Energy savings. New domestic property £62.6m; existing domestic property £9.1m; domestic consequential improvements £30.3m; new non-domestic property £52.2m; existing non-domestic property £2,216m; non-domestic consequential improvements £4.2m. Benefits accrue to the occupiers of the buildings. **Carbon savings**. New domestic property £24.3m; existing domestic property £9.3m; domestic consequential improvements £24.2m; new non-domestic property £33.3m; existing non-domestic property £1,123m; non-domestic consequential improvements £3.3m.

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

The analysis does not include an estimate of the potential health benefits from warmer homes or the potential air quality benefits.

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

Analysis assumes full compliance with the new regulations and that property occupiers maintain property fabric & services and replace worn-out PV components. Sensitivity analysis has been undertaken to assess the impact of adopting the Interdepartmental Analyst Groups high and low values for future energy prices and carbon values. Sensitivity testing has also been carried out on the assumed new domestic property build mix.

BUSINESS ASSESSMENT (Option 2)

Direct impact on business (Equivalent Annual) £m:				
Costs: 22.5	**Benefits:** 67.6	**Net:** 45.1		

Summary: Analysis & Evidence

Policy Option 3

Description: High increase in standards for new domestic and non-domestic property, tighter standards for changes to domestic and non-domestic properties and consequential improvements for all properties.

FULL ECONOMIC ASSESSMENT

Price Base Year	PV Base Year	Time Period Years	Net Benefit (Present Value (PV)) (£m)		
2011	2011	70	**Low:** Optional	**High:** Optional	**Best Estimate: £2,805.6m**

COSTS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Cost** (Present Value)
Low	Optional		Optional	**Optional**
High	Optional		Optional	**Optional**
Best Estimate	0		£27.3m	**£951.1m**

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

Increased building costs: new domestic property £231.1m; existing domestic property £17.8m; consequential improvements to existing domestic property £18.6m; new non-domestic property £142.7m; existing non-domestic property £538m, consequential improvements to existing non-domestic property £2.9m. The initial capital costs will be borne by the developers (these costs may ultimately be passed to landowners) and building occupiers. Ongoing maintenance and replacement costs borne by building owner/tenant.

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

No account has been taken of the potential impact of higher costs on the demand for new property or the demand for extensions or improvements to existing property.

BENEFITS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Benefit** (Present Value)
Low	Optional		Optional	**Optional**
High	Optional		Optional	**Optional**
Best Estimate			173.3	**£3,756.6m**

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

Energy savings. New domestic property £150.0m; existing domestic property £9.1m; domestic consequential improvements £30.3m; new non-domestic property £99.3m; existing non-domestic property £2,216m; non-domestic consequential improvements £4.2m. Benefits accrue to the occupiers of the buildings. **Carbon savings**. New domestic property £30.8m; existing domestic property £9.3m; domestic consequential improvements £24.2m; new non-domestic property £51.1m; existing non-domestic property £1,123m; non-domestic consequential improvements £3.3m.

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

The analysis does not include an estimate of the potential health benefits from warmer homes or the potential air quality benefits.

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

Analysis assumes full compliance with the new regulations and that property occupiers maintain property fabric & services and replace worn-out PV components. Sensitivity analysis has been undertaken to assess the impact of adopting the Interdepartmental Analyst Groups high and low values for future energy prices and carbon values. Sensitivity testing has also been carried out on the assumed new domestic property build mix.

BUSINESS ASSESSMENT (Option 3)

Direct impact on business (Equivalent Annual) £m:				
Costs: 25.8	**Benefits:** 68.8	**Net:** 43.1		

Summary: Analysis & Evidence — Policy Option 4

Description: Low increase in standards for new domestic property, a high increase in standards for new non-domestic property, tighter standards for changes to domestic and non-domestic properties and consequential improvements for all properties

FULL ECONOMIC ASSESSMENT

Price Base Year 2011	PV Base Year 2011	Time Period Years 70	Net Benefit (Present Value (PV)) (£m)		
			Low: Optional	**High:** Optional	**Best Estimate: £2,759.9**

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	Optional		Optional	**Optional**
High	Optional		Optional	**Optional**
Best Estimate	0		£26.0m	**£902.4m**

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

Increased building costs: new domestic property £182.5m; existing domestic property £17.8m; consequential improvements to existing domestic property £18.6m; new non-domestic property £142.7m; existing non-domestic property £538m, consequential improvements to existing non-domestic property £2.9m. The initial capital costs will be borne by the developers (these costs may ultimately be passed to landowners) and building occupiers. Ongoing maintenance and replacement costs borne by building owner/tenant.

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

No account has been taken of the potential impact of higher costs on the demand for new property or the demand for extensions or improvements to existing property.

BENEFITS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low	Optional		Optional	**Optional**
High	Optional		Optional	**Optional**
Best Estimate			169.3	**£3,662.3m**

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

Energy savings. New domestic property £62.6m; existing domestic property £9.1m; domestic consequential improvements £30.3m; new non-domestic property £99.3m; existing non-domestic property £2,216m; non-domestic consequential improvements £4.2m. Benefits accrue to the occupiers of the buildings. **Carbon savings**. New domestic property £24.3m; existing domestic property £9.3m; domestic consequential improvements £24.2m; new non-domestic property £51.1m; existing non-domestic property £1,123m; non-domestic consequential improvements £3.3m.

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

The analysis does not include an estimate of the potential health benefits from warmer homes or the potential air quality benefits.

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

Analysis assumes full compliance with the new regulations and that property occupiers maintain property fabric & services and replace worn-out PV components. Sensitivity analysis has been undertaken to assess the impact of adopting the Interdepartmental Analyst Groups high and low values for future energy prices and carbon values. Sensitivity testing has also been carried out on the assumed new domestic property build mix.

BUSINESS ASSESSMENT (Option 4)

Direct impact on business (Equivalent Annual) £m:				
Costs: 24.6	**Benefits:** 68.8	**Net:** 44.2		IN/OUT/Zero net cost

Contents

SECTION 1: BACKGROUND AND SCOPE

1. The Welsh Government is committed to reducing the level of carbon emissions in Wales to support its overall climate change objectives – one of which is to reduce Greenhouse Gas (GHG) emissions by 3% per annum from 2011. As part of this commitment there is a need to reduce the long-term demand for fossil fuel-based energy generation through improved energy efficiency and the development of renewable energy capacity.

2. Building Regulations provide one mechanism through which to reduce carbon emissions. They deal with **regulated** energy - heating, cooling, lighting and ventilation – which can contribute to the reduction of the carbon footprint of new developments through improved energy efficiency standards. However, Building Regulations do not cover **unregulated** energy use, such as household electrical appliances. The Zero Carbon Hub[1] estimates that at present, around two-thirds of carbon emissions from the average house built to 2006 standards comes from regulated energy use, with the remaining third attributed to unregulated energy use.

3. The devolution of Building Regulations in 2011 has provided the Welsh Government with the scope to introduce a carbon standard for new domestic and non-domestic buildings that is most appropriate to Wales. Welsh National Planning Policy currently requires that all new housing developments achieve a Code for Sustainable Homes Rating at Level 3. This is equivalent to a 31% improvement on Building Regulations Part L 2006 requirements. However, this standard is just one step on the proposed trajectory towards a 'zero carbon' approach, with the eventual objective being for all new residential buildings to reduce carbon emissions via a potential mix of on-site methods and off-setting 'allowable solutions'.

4. This Impact Assessment (IA) therefore covers the Part L 2013 proposals for the construction industry, in line with the 2011 'Programme for Government' commitment to 'work towards a 55% improvement in building standards over 2006 levels by 2013 as we move towards zero carbon buildings'.

5. The introduction of a more stringent target for carbon emissions is intended to complement the Welsh Government's existing policies such as the *Arbed* programme, which aims to make energy efficiency improvements to homes in economically deprived communities in Wales. The overarching objectives of the policy are aligned with the Welsh Government's climate change commitments. However, consideration must also be given to the burden on businesses of multiple regulation - particularly in the context of the economic downturn - along with other cumulative impacts arising as a result of this policy.

[1] Zero Carbon Hub: http://www.zerocarbonhub.org

SECTION 2: RATIONALE FOR GOVERNMENT INTERVENTION

6. As is noted above, the Welsh Government has a commitment to reduce carbon emissions by 3% per annum from 2011 and all sectors of the economy - including the construction sector - are expected to contribute to the carbon savings. Amending Building Regulations is one option that can be considered in situations where the market would not deliver the carbon savings of its own accord, other existing measures (regulatory or non-regulatory) would not achieve the objectives and where it is shown to be cost-effective.

7. There are a number of reasons why the market may not deliver cost-effective carbon savings of its own accord; these are termed 'market failures'. In this case, the market failures include:

   - Externalities – In the absence of comprehensive carbon pricing property builders and occupiers do not incur the full cost of their carbon emissions. This results in a higher level of carbon emissions than is socially optimal;

   - Imperfect Information – Information is required in order for a market to operate efficiently. A lack of adequate information about future energy prices and a property's energy efficiency may prevent better performing properties being properly valued by the market. In situations where there is little prospect of receiving a price premium when they come to sell the property, property builders or those undertaking extensions or refurbishments have little incentive to invest in more energy efficient materials and products;

   - A lack of capital, potentially long payback periods and general risk aversion may prevent homeowners and businesses from undertaking energy efficiency improvements to existing buildings even when these would be cost effective in the medium or long term.

8. Building Regulations are considered to be an appropriate mechanism for attempting to overcome these market failures. Low carbon technologies can be 'locked in' at the point of build (assuming that the owners/tenants choose to use and maintain the fabric standards and building services), avoiding the potentially higher cost of retrofitting at a later stage. However, since the majority of emissions from domestic dwellings are currently attributed to the existing stock, retrofitting existing dwellings is proposed as an additional method for contributing to the overall reduction in carbon emissions from domestic dwellings.

SECTION 3: OPTIONS

9. In addition to the 'Do Nothing' (baseline) option, three policy intervention options have been assessed. These can be summarised as follows:

   a. Low case – A 25% improvement in the energy efficiency of new domestic property compared to current Part L standards, an 11% improvement in the energy efficiency of new non-domestic property compared to 2010 standards, a tightening of standards for extensions to existing domestic and non-domestic property and the removal of the area threshold for consequential improvements.

   b. High case - A 40% improvement in the energy efficiency of new domestic property compared to current Part L standards, a 20% improvement in the energy efficiency of new non-domestic property compared to 2010 standards, a tightening of standards for extensions to existing domestic and non-domestic property and the removal of the area threshold for consequential improvements. This is the preferred option.

   c. Hybrid case – A 25% improvement in the energy efficiency of new domestic property compared to current Part L standards, a 20% improvement in the energy efficiency of new non-domestic property compared to 2010 standards, a tightening of standards for extensions to existing domestic and non-domestic property and the removal of the area threshold for consequential improvements.

Summary of the Options

10. The difference between the three options relates to the improvement in energy efficiency standards for new domestic and non-domestic property. The tightening of standards for extensions to existing domestic and services in non-domestic property and the requirements in relation to consequential improvements apply to each option.

11. The Net Present Value (NPV) for the preferred (High) option is £2,806m and indicates a slightly higher net benefit to society than the Low and Hybrid options (£2,762m and £2,760m respectively).

12. The positive and high NPV for each option masks some significant differences in the results for the individual elements of the proposals. The overwhelming majority of the energy and carbon savings in each option come from the proposed tightening of standards for the replacement of components in existing non-domestic property.

13. The NPV for both the 25% and 40% improvement in energy efficiency of new domestic property is negative (i.e. the proposals represent a net cost to UK society when compared to the baseline) with the additional capital

and maintenance costs exceeding the energy and carbon savings. The reason for this is that existing building regulations already impose relatively high energy efficiency standards and further improvements can not be achieved without incurring significant additional costs.

14. The NPV for a 40% improvement in the energy efficiency of new domestic property is higher (less negative) than that for a 25% improvement. The reason for this is that the cost-effectiveness of solar PV panels improves as more panels are added (assuming the availability of suitable roof space).

15. The other elements (extension to existing domestic property, new non-domestic property and consequential improvements to domestic and non-domestic property) all demonstrate a net benefit to UK society (i.e. a positive NPV), although the result is relatively marginal for the proposals on existing domestic property.

16. Table 1 presents a breakdown of the preferred option into the six individual elements for illustrative purposes.

17. The modelling does not include wider costs and benefits, for example improvements in air quality or potential health benefits.

18. Similarly, the modelling makes no assessment of the impact of the proposals on construction activity in Wales. There is a risk that the increased capital costs associated with these (and other) policies may make building projects in Wales less attractive from a financial perspective and may reduce the number of new building developments that take place. This is particularly true for those areas of Wales where building projects are at the margin of viability. This may have consequences for other Welsh Government policies such as those relating to increasing the supply of housing, the availability of affordable homes and regeneration.

Table 1. Present values of costs and benefits for the preferred option broken down into individual elements (NPV £m)

	New domestic property 40%	Existing Domestic property	Domestic consequential improvements	New non-domestic property 20%	Existing non-domestic property	Non-domestic consequential improvements	Total
Energy savings (£m)	150.0	9.1	30.3	99.3	2,216.0	4.2	2,509.0
Incremental costs (£m)	231.1	17.8	18.6	142.7	538.0	2.9	951.1
Sub-total (£m)	**-81.1**	**-8.7**	**11.7**	**-43.3**	**1,678.0**	**1.3**	**1,558.0**
Carbon savings - non-traded (£m)	22.0	9.3	24.2	44.0	988.0	3.2	1,090.7
Carbon savings - traded (£m)	8.9	0.0	0.0	7.0	135.0	0.1	151.0
Total carbon savings (£m)	**30.8**	**9.3**	**24.2**	**51.1**	**1,123.0**	**3.3**	**1,241.8**
Net benefit/cost excl. avoided renewables (£m)	**-50.2**	**0.7**	**35.9**	**7.7**	**2,801.0**	**4.6**	**2,799.7**
Avoided renewables (£m)	0.9	0.2	0.9	0.7	3.0	0.1	5.9
Net benefit/cost incl. avoided renewables (£m)	**-49.3**	**0.9**	**36.8**	**8.4**	**2,805.0**	**4.8**	**2,805.6**
volume of CO2 saved - traded (MtCO2(e))	0.2	-	-	0.2	3.7	0.001	4.1
volume of CO2 saved - non-traded (MtCO2(e))	0.4	0.2	0.5	0.9	19.5	0.1	21.6
Cost effectiveness (£/tCO2)							
- traded	241	-	-	-4	-722	-5,829	-639
- non-traded	164	41	-25	42	-93	-23	-79

Note: Numbers may not sum due to rounding

SECTION 4: ESTIMATION OF COSTS AND BENEFITS

21. To estimate the costs and benefits associated with the proposed policy options we have compared building costs, maintenance costs, energy use and CO_2 emissions for property built to the proposed 2013 building standards with a baseline based on the current (2010) standards.

22. Data on traded and non-traded carbon values, emission factors, the value of avoided renewables and fuel prices has been taken from the Department for Energy & Climate Change (DECC) guidance "Valuation of energy use and greenhouse gas emissions for appraisal and evaluation, October 2011". The modelling in this RIA uses the following emission factors for gas and electricity:

    - gas: 0.1832 kgCO_2/kWh
    - electricity: 0.3735 kg CO_2/kWh

23. Evidence suggests that a common response to an improvement in the energy efficiency of a home is for the home owner to heat the property to a higher temperature than was previously the case. This is known as a 'rebound effect' or 'comfort factor'. As a result of this rebound effect not all of the theoretical energy cost and carbon savings associated with energy efficiency measures are actually realised. In the modelling work, a 15% comfort factor has been assumed when looking at new and existing domestic property. The welfare gain derived from having a warmer home should be counted as a social benefit within the appraisal. However, only the resource and emission savings of the net reduction in energy should be valued (i.e. 85% of the theoretical benefit).

24. Energy savings are valued at the long-run variable cost of energy supply. Again, this is in line with DECC guidance. The supply cost reflects the long-term variable costs associated with energy supply but excludes costs (such as head office overheads) that will continue to be incurred at the same level in the long run regardless of changes in energy use. **The cost excludes carbon costs (which are valued separately), taxes and other charges.** In the future the expectation is that the value of carbon will be factored into energy prices (effectively internalising the cost of carbon in consumption decisions), however, for the purpose of this analysis (and in line with the DECC Guidance) energy and carbon savings are considered separately.

25. When valuing the rebound effect, the full retail price of energy/fuel is used since it is to be assumed that consumers are willing to pay at least the full retail price for the welfare gains achieved through higher energy/fuel consumption.

26. The analysis assumes that home-owners and businesses will not demand the use of higher specification fabrics, components and services in the absence of this change in regulations. In reality, the expectation is that

rising energy prices will encourage consumers/businesses to make more energy efficient decisions in the future. The analysis may therefore overestimate the impact of the change in regulations.

27. The appraisal period used in this impact assessment is 70 years (2013-82). This period has been adopted to capture the costs and benefits over the lifetime of new property built in the first 10 years of the appraisal period (new buildings are typically assumed to have a life of 60 years). The costs and benefits are presented in Present Value (PV) terms with a discount rate of 3.5% used for the first 30 years of the appraisal period and 3.0% for the remaining years. This is in line with the guidance in HM Treasury's Green Book.

28. The assessment of costs and benefits is broken down between the four property categories affected by the proposals, namely:

- New domestic property;
- Existing domestic property – including extensions and consequential improvements;
- New non-domestic property;
- Existing non-domestic property – including the replacement of components and consequential improvements.

Each of these categories will be considered in turn.

29. The analysis undertaken on each property category has generated estimates for each of the following variables over the appraisal period:

- Volume (GWh) and value (£m) of energy savings – split into electricity and gas savings;
- Volume (tCO2(e)) and value (£m) of carbon savings – split between traded and non-traded emissions;
- Incremental capital, maintenance and replacement costs (£m), and;
- Avoided renewables (£m);
- Cost effectiveness – the cost (benefit) per tonne of carbon abated (split between the traded and non-traded sectors)

New Domestic Property

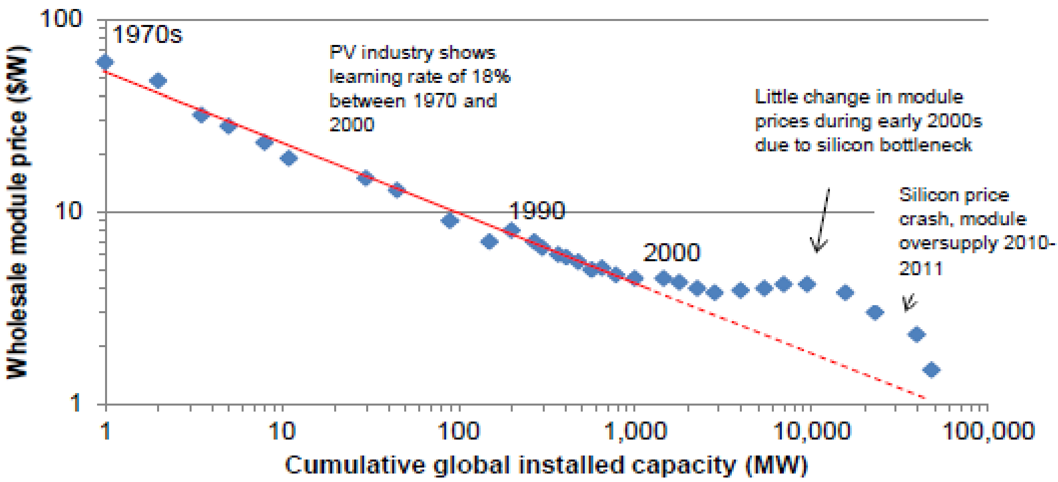
30. Two potential policy options have been modelled for improving the energy efficiency standards of new domestic property:

- a 25% improvement in energy efficiency and carbon emissions relative to the 2010 Part L building regulations. This is equivalent to a 44% reduction in carbon emissions relative to Part L 2006;
- a 40% improvement in energy efficiency and carbon emissions relative to the 2010 Part L building regulations. This is equivalent to a 55% reduction in carbon emissions relative to Part L 2006. This is the preferred option.

31. The modelling assumes that the improved energy efficiency standards will be achieved through a combination of improvements to the building fabric (i.e. walls, floor, roof and windows) and the use of on-site electricity generation. This is termed a 'recipe' approach. Where improvements to a buildings fabric alone failed to meet the target, developers are assumed to install photovoltaic panels (PV) up to the point at which the target is achieved.

32. PV is used as a proxy for on-site electricity generation because the technology can be applied to a wide variety of building types. The cost of solar PV systems has been declining steadily in recent decades, largely reflecting the change in the price of the principal component of PV modules – silicone (see figure 1).

Figure 1. Trends in Solar PV Module Price ($/W)



Source: Element Energy analysis

33. The introduction of the Feed-in-Tariff (FiT) scheme in 2010 has provided a further boost to the solar PV sector in the UK as increasing demand has resulted in an increase in the number of domestic PV installers operating in the UK. This increase in competition has contributed to further reductions in the price of installing a PV system in recent months.

34. The main cost of a PV system is the modules (or panels), however, installation costs (electrical work, labour and scaffolding etc.) also represent a significant component. Evidence commissioned by DECC[2] shows that an element of the installation cost is fixed and as such, that the cost per kW of capacity decreases as the size of the system increases. This suggests that the cost effectiveness of PV improves as the size of the system increases. However, this is only true up to a point for domestic solar PV systems as the size of the installation is constrained by the area of suitable roof space available.

[2] Solar PV Cost Update, Parsons Brinkerhoff, May 2012

35. The modelling makes an assumption of the most cost-effective way of meeting the proposed targets based on the currently available technology for individual homes and assumed learning rates. Developers would be able to make their own choice between the alternative fabric standards and technologies (i.e. recipes) to meet the required target. Certain types of development lend themselves towards a community energy solution. Sensitivity analysis will be undertaken for the final Impact Assessment to assess whether community energy systems are more cost-effective in some cases.

36. For the purpose of the analysis, the asset life of a typical dwelling is assumed to be 60 years. Although the life of a dwelling is generally presumed to be longer than this, the fact that the costs and benefits have to be discounted over time will make these values negligible after this timeframe and will therefore not have any substantial impact on the overall calculations.

37. The modelling assumes that home-owners will opt to maintain their property's fabric and building services and replace any PV components etc. to ensure that the energy efficiency and carbon improvements continue for the full life of the asset.

38. The first stage of the analysis involved estimating the number of new domestic properties that are expected to be built during the appraisal period, the expected split between property types (i.e. detached, apartments etc.) and the expected fuel mix.

39. Data from StatsWales[3] shows that the number of new domestic properties completed in Wales has been decreasing in recent years. Approximately 9,300 new domestic properties were completed in Wales in 2006-07 but by 2010-11 this figure had dropped to just over 5,500 properties. This downwards trend reflects the recent economic conditions and difficulties in the construction industry. The UK economy is expected to strengthen in the coming years with the Office for Budget Responsibility (OBR) forecasting GDP growth of 0.8%, 2.0%, 2.7% and 3.0% in 2012, 2013, 2014 and 2015 respectively. As the economy improves so activity in the house-building sector (and the construction industry in general) is expected to increase.

40. The forecast of the number of new domestic properties that will be completed in Wales is based upon average annual housing completions between 2008-09 and 2010-11 and uprated to reflect current projections for the increase in the number of households in Wales. Data on household projections is available from StatsWales. Table 2 presents a forecast of the annual number of new domestic property completions in Wales between 2014 and 2023.

[3] http://wales.gov.uk/topics/statistics/statswales/?lang=en

Table 2. Forecast new domestic property completions in Wales per annum

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
New Domestic Properties	6,480	6,550	6,620	6,690	6,760	6,820	6,890	6,950	7,020	7,080

41. The standard to which new domestic property has to be built is based upon when the building plans are submitted rather than when the building work actually commences or is completed. For this reason, not all new buildings completed in or after 2013 will be built to the 2013 standards. Table 3 presents the phasing assumptions that have been made about the numbers of new properties which will be built to the 2013 standards.

Table 3. Phase-in assumptions for the new regulations

	2014	2015	2016	2017-23
% of new property built to 2013 standards	40%	60%	90%	100%

42. In undertaking this analysis, an aggregate approach has been adopted whereby not all new domestic property will achieve a 25% or 40% improvement – some property types will need to achieve higher standards and some lower standards. However, the approach means that when improvements for each domestic property type are aggregated over the predicted build mix, a 25% or 40% overall percentage reduction is achieved.

43. In delivering this ‘aggregate’ approach, the greatest improvement will be required for detached dwellings and the least for apartment buildings. The difference arises from two sources:

- Different building types currently require different specifications to achieve compliance and apartment buildings are already delivering to a significantly higher specification than detached dwellings. Hence, in now delivering to the same specification, those already delivering to a more demanding specification will tend to require less improvement.
- The installation of PV has more impact on some buildings than others. In particular, the benefits from PV on, say, a four-storey apartment building will be less as the electricity production is shared by the many dwelling units in the apartment building.

44. The modelling work has been designed to estimate the costs and benefits associated with improved energy efficiency and reduced carbon emissions for detached, semi-detached/end terrace, mid-terrace houses and apartments. These property types are consistent with those used in the

UK analysis of Part L buildings regulations undertaken by the UK Zero Carbon Hub (UKZCH).

45. Table 4 presents the new domestic property mix used in the modelling work. The mix of dwelling types to be built (e.g. detached houses, apartments etc.) has also been estimated using historic actual completions. Industry feedback suggests that a lower proportion of apartments are likely to be built in the short to medium term, however, it was considered appropriate to use a two-year average of actual dwellings completed (all tenures) between 2009 and 2011 as the baseline figure for 2011-12. The numbers employed reflected 'best-fit' when compared with a number of other datasets stretching back to 2006 and were deemed more likely to be representative of construction over the duration of the policy.

Table 4. Assumed new domestic property mix

Domestic Property Type	Assumed Proportion in Property Mix
Detached	30%
Semi-detached & End terrace	38.5%
Mid-terrace	10.5%
Apartment	21%

46. Given the current issues surrounding the demand for and over-supply of apartments in the housing market in Wales, sensitivity analysis assuming 10% apartments (with remainder of development apportioned between the other 3 'dwelling types') has been undertaken. The results from this sensitivity testing are presented in paragraphs 63 and 64.

47. Due to the 'aggregate' approach to target setting, a lower proportion of apartments (which have smaller carbon reduction targets than detached homes due to a reduced potential to address heat loss) would mean that the emissions target for other property types could be lowered. However, if that were to occur then if the proportion of apartments in the build mix were to return to pre-recession levels then there would be a risk that the aggregate emissions target would be missed.

48. The overwhelming majority (almost 90%) of new domestic property is assumed to be connected to the gas grid. The modelling work has considered domestic property that is connected to the gas grid and also 'off-gas' property. Properties that are off the gas grid are primarily located in rural (north, mid and eastern) areas of Wales and the type of heating fuel used tends to be more carbon intensive compared to properties connected to the gas grid. Apartment blocks may also be 'off-gas' in cases where having a gas supply to each apartment is either not

economically viable or not preferable. For off-gas properties, a mix of different fuel types has been considered including, oil, LPG, air source heat pump (ASHP) and direct electric solutions.

49. A further feature of the recipe approach is that the improvement to the specification is similar for all fuel types. Otherwise, for properties that are off the gas grid and which use a more carbon intensive fuel (e.g. LPG or oil), the amount of PV required to meet the carbon reduction target could be impractical.

50. The recipes for each fuel type therefore include the same level of fabric and service efficiencies and the same amount of PV[4]. However, there is a difference in the required system efficiency for each fuel (which is appropriate for the heating system type). Hence the specification for property constructed off the gas grid (for example, with oil or LPG) would not be more demanding than property heated with gas.

51. By adopting this approach to different fuel types, there is no need for a separate fuel factor (as currently exists). The fuel factor is effectively integrated into the 'recipe' for the different fuels with the recipe associated with each fuel type resulting in a different carbon target. The recipes can be viewed as more equitable – each requiring a similar challenge in terms of building specifications and each requiring a similar level of energy efficiency.

52. For proportionality purposes, only those property and fuel type combinations that represent over 1% of the total build mix have been included in the modelling. To have included all property and fuel type combinations (i.e. those which represent less than 1% of the overall mix such as biomass) in the analysis would have required a disproportionate amount of work given their likely minimal impact on the modelling results.

53. The second stage of the analysis considered the impact of the proposals on capital costs and energy consumption. Based upon the build mix and fuel mix identified in the first stage of the analysis, AECOM were tasked with identifying appropriate solutions for meeting the 25% and 40% options and calculating the associated energy consumption/savings relative to the baseline. Davis Langdon provided the estimated additional capital cost of achieving the solutions as well as estimates of maintenance and replacement costs. Further details about these assumptions are included in Appendix 1.

54. In estimating the additional capital cost, an allowance has been made for 'learning rates' reflecting the expectation that unit costs for low/zero carbon technology and more energy efficient materials will fall as production volumes increase. The application of learning rates is supported by evidence relating to solar panels, the cost of which have

[4] The exception to this is homes heated with a biomass boiler which are assumed to require no PV.

declined following the introduction of Feed-in-Tariffs (FITs) and the consequent increase in demand/production.

55. Learning rates for Air Tightness, Thermal Bridging and windows have also been applied in the modelling work. Air tightness relates to the amount of 'air leakage' from a building, i.e. "the uncontrolled movement of air in to and out of a building which is not for the specific and planned purpose of exhausting stale air or bringing in fresh air"[5]. Air leakage is measured as the rate of leakage per m^2 of external envelope per hour. Further information about the learning rates is provided in Appendix 2.

56. In the final stage, AECOM and Davis Langdon's energy and capital cost estimates were combined with the property forecasts to generate overall estimates for energy cost savings, incremental capital costs and carbon savings for the period.

57. In addition to the energy savings, occupiers of homes with a solar PV system (or other renewable technology) installed would be eligible for payments under the Feed-in-Tariff (FiTS) scheme. However, these payments are excluded from the analysis because they are a transfer payment. This is in line with HM Treasury Green Book methodology.

58. The estimated costs and benefits for the 25% and 40% energy efficiency improvement targets are shown in table 5. The costs and benefits are relative to a baseline of 'Do Nothing' (compliance with current planning policy).

59. Both the 25% and 40% options show a negative net present value (NPV). This means that the additional costs associated with the proposals exceed the energy and carbon savings over the appraisal period. The NPV of the 40% option is lower (less negative) than that of the 25% option. The rationale for this finding is that there is a fixed cost associated with the installation of PV panels and so as more PV is added to a property (i.e. in order to achieve the higher target) so the cost-effectiveness of the technology improves. For this reason, the 40% improvement is the preferred option.

---

[5] http://www.greenspec.co.uk/refurb-airtightness.php

Table 5. Present values of costs and benefits: new domestic buildings (NPV £m)

	25%	40%
Energy savings (£m)	62.6	150.0
Incremental costs (£m)	182.5	231.1
Sub-total (£m)	**-119.9**	**-81.1**
Carbon savings - non-traded (£m)	22.0	22.0
Carbon savings - traded (£m)	2.3	8.9
Total carbon savings (£m)	**24.3**	**30.8**
Net benefit/cost excl. avoided renewables (£m)	**-95.6**	**-50.2**
Avoided renewables (£m)	0.6	0.9
Net benefit/cost incl. avoided renewables (£m)	**-95.0**	**-49.3**
volume of CO2 saved - traded (MtCO2(e))	0.1	0.2
volume of CO2 saved - non-traded (MtCO2(e))	0.4	0.4
Cost effectiveness (£/tCO2)		
- traded	1,511	241
- non-traded	267	164

60. The cost-effectiveness (CE) indicators demonstrate the net cost (benefit) per tonne of carbon abated. The CE indicators for both the traded and non-traded sectors are lower for the 40% option than the 25% option. However, neither option performs well when compared to standard cost comparators (£36 per tonne for the traded sector and £50 per tonne for the non-traded sector) or other carbon abatement policies (for example retro-fitting energy efficiency improvements (e.g. cavity wall or loft insulation) in existing domestic property).

Sensitivity Analysis

61. Sensitivity testing has been carried out on a number of the key assumptions used in the analysis. The effect of using higher and lower values of future energy prices and carbon values has been assessed using the range of values suggested in DECC's appraisal guidance. The impact of adopting the higher and lower energy prices and carbon values are presented in tables 6 and 7 respectively. In both cases, the NPV for both options remains negative.

Table 6. Present values of costs and benefits: new domestic buildings – high energy price and carbon value Sensitivity (NPV £m)

	25%	40%
Energy savings (£m)	70.6	163.6
Incremental costs (£m)	182.5	231.1
Sub-total (£m)	**-111.9**	**-67.5**
Carbon savings - non-traded (£m)	23.4	23.4
Carbon savings - traded (£m)	2.5	9.3
Total carbon savings (£m)	**25.8**	**32.7**
Net benefit/cost excl. avoided renewables (£m)	**-86.0**	**-34.8**
Avoided renewables (£m)	0.6	0.9
Net benefit/cost incl. avoided renewables (£m)	**-85.5**	**-33.9**
volume of CO2 saved - traded (MtCO2(e))	0.1	0.2
volume of CO2 saved - non-traded (MtCO2(e))	0.4	0.4
Cost effectiveness (£/tCO2)		
- traded	1,366	180
- non-traded	249	132

Table 7. Present values of costs and benefits: new domestic buildings – low energy price and carbon value Sensitivity (NPV £m)

	25%	40%
Energy savings (£m)	52.4	128.9
Incremental costs (£m)	182.5	231.1
Sub-total (£m)	**-130.1**	**-102.1**
Carbon savings - non-traded (£m)	21.2	21.2
Carbon savings - traded (£m)	2.2	8.5
Total carbon savings (£m)	**23.4**	**29.7**
Net benefit/cost excl. avoided renewables (£m)	**-106.6**	**-72.4**
Avoided renewables (£m)	0.6	0.9
Net benefit/cost incl. avoided renewables (£m)	**-106.0**	**-71.5**
volume of CO2 saved - traded (MtCO2(e))	0.1	0.2
volume of CO2 saved - non-traded (MtCO2(e))	0.4	0.4
Cost effectiveness (£/tCO2)		
- traded	1,679	329
- non-traded	290	213

62. The impact of changing the number of new domestic properties built each year can also be tested. In the modelling approach adopted any change in the number of new properties built (assuming no change in build mix) has a simple proportionate impact on the costs and benefits. For example, a 10% increase in the number of new properties built (with all other assumptions held constant) will increase costs and benefits by 10%. Similarly, a 20% reduction in the number of new properties built results in a 20% decrease in costs and benefits.

63. As is noted above, feedback from industry sources suggests that the build mix from recent years may not be a good indicator of the future build mix. In particular, it has been suggested that apartments/flats will represent a smaller proportion of the build mix going forward. In the sensitivity analysis an alternative build mix has been analysed, this assumes that apartments represent just 10% of the build mix.

Table 8. Alternative domestic property build mix

	Central assumption	Sensitivity assumption
Detached	30%	34%
End terrace/semi-detached	38.5%	42.5%
Mid-terrace	10.5%	13.5%
Apartment	21%	10%

64. Changing the build mix to assume a lower proportion of apartments increases energy and carbon savings but to a lesser extent than the increase in capital costs. Consequently, the net present value for both the 25% and 40% options decreases (becomes more negative) to £-98.8m and £-50.7m respectively.

65. The impact of altering the assumed learning rates for PV, windows, air-tightness and thermal bridging has also been assessed. Increasing learning rates (i.e. assuming that capital costs decline at a faster rate than identified above) reduces costs and improves the cost-effectiveness of the proposals, however, it would require a very significant reduction in learning rates (beyond any anticipated level) to reverse the result that the proposals generate a negative NPV.

Existing Domestic Property

66. For existing domestic property, the proposal is to raise energy efficiency standards for extensions from 2013. The revised regulations will relate to the fabric standards of walls, roofs and floors. Energy efficiency standards for windows and doors installed in extensions will remain at the level established under the 2010 regulations.

67. For other categories of works carried out on existing buildings (for example, the replacement of windows) it is proposed that performance standards will remain at the level set under the 2010 Building Regulations.

68. Table 9 compares the performance standards for walls, roofs and floors in extensions under the 2010 and proposed 2013 regulations.

Table 9. Performance standards in the 2010 regulations and the proposed 2013 regulations (u-value)

	2010	2013
Wall	0.28	0.21
Roof	0.20	0.15
Floor	0.25	0.18

69. The additional costs and energy savings associated with the move to the proposed standards (relative to the 2010 standards) were provided by Davis Langdon and AECOM. Further details about these assumptions are provided in Appendix 3. It has been assumed that there are approximately 11,000 extensions to domestic property in Wales each year.

70. The results of the analysis are shown in Table 10. The additional costs of the proposal exceed the estimated energy savings by approximately £8.7 million. However, when carbon savings and avoided renewables are included in the calculation the proposals generate a small, positive NPV of a little under £1million.

Table 10. Present values of costs and benefits: existing domestic buildings (NPV £m)

Energy savings (£m)	9.1
Incremental costs (£m)	17.8
Sub-total (£m)	**-8.7**
Carbon savings - non-traded (£m)	9.3
Carbon savings - traded (£m)	0.0
Total carbon savings (£m)	**9.3**
Net benefit/cost excl. avoided renewables (£m)	**0.7**
Avoided renewables (£m)	0.2
Net benefit/cost incl. avoided renewables (£m)	**0.9**
volume of CO2 saved - traded (MtCO2(e))	-
volume of CO2 saved - non-traded (MtCO2(e))	0.2
Cost effectiveness (£/tCO2)	
- traded	-
- non-traded	40.6

Sensitivity analysis

71. The results of this element of the proposals are relatively sensitive to changes to some key assumptions. As is shown by table 11, adopting DECC's recommendations for low energy prices and carbon values results in a negative NPV and an increase in the cost per tonne of CO_2 abated.

Table 11. Present values of costs and benefits: existing domestic buildings – low energy price and carbon value sensitivity (NPV £m)

Energy savings (£m)	5.8
Incremental costs (£m)	17.8
Sub-total (£m)	**-12.0**
Carbon savings - non-traded (£m)	8.9
Carbon savings - traded (£m)	0.0
Total carbon savings (£m)	8.9
Net benefit/cost excl. avoided renewables	**-3.1**
Avoided renewables (£m)	0.2
Net benefit/cost incl. avoided renewables (£m)	**-2.9**
volume of CO2 saved - traded (MtCO $_{2(e)}$)	0.0
volume of CO2 saved - non-traded (MtCO $_{2(e)}$	0.2
Cost effectiveness (£/tCO2)	
- traded	-
- non-traded	56.4

72. Adopting DECC's high energy prices and carbon values increases the positive NPV from the proposals.

Table 12. Present values of costs and benefits: existing domestic buildings – high energy price and carbon value sensitivity (NPV £m)

Energy savings (£m)	12.5
Incremental costs (£m)	17.8
Sub-total (£m)	**-5.3**
Carbon savings - non-traded (£m)	9.8
Carbon savings - traded (£m)	0.0
Total carbon savings (£m)	9.8
Net benefit/cost excl. avoided renewables	**4.5**
Avoided renewables (£m)	0.2
Net benefit/cost incl. avoided renewables (£m)	**4.8**
volume of CO2 saved - traded (MtCO $_{2(e)}$)	0.0
volume of CO2 saved - non-traded (MtCO $_{2(e)}$	0.2
Cost effectiveness (£/tCO2)	
- traded	-
- non-traded	24.2

73. Changing the assumed number of domestic extensions that are built in Wales each year has a proportionate impact on the results (i.e. a 10% increase (decrease) in the number of extension built will increase

(decrease) the energy savings, carbon savings and incremental costs by 10%).

74. The result is also relatively sensitive to changes in assumptions about the additional capital costs associated with the proposed higher standards. A relatively small (6%) increase in the additional capital costs would be sufficient for the costs of the proposals to exceed the benefits.

Consequential Improvements to Domestic Property

75. Under existing building regulations, property owners carrying out extensions or large refurbishment projects have to make improvements to the fabric of the rest of the building to improve its energy efficiency – these are termed **consequential improvements**. The rationale for introducing consequential improvements is that the triggering works will generally increase the energy use and carbon emissions in the building and therefore that upgrading the energy efficiency of the rest of the building will help to offset the increase in carbon emissions. The consequential improvements will also help to mitigate some of the increase in energy costs.

76. Currently, the requirement to make consequential improvements only applies to buildings over $1000m^2$, a threshold which excludes the vast majority of domestic property. The consultation includes a proposal to remove this area threshold. The result of this would be that all homeowners undertaking major works such as extensions or increases in habitable space (for example, a loft or garage conversion) would have to deliver energy efficiency improvements on the original building.

77. Optional finance for these consequential improvements may be available through the UK Government's Green Deal (due to launch in October 2012). This scheme will enable private sector firms to offer domestic and non-domestic consumers energy efficiency improvements to their property at no upfront cost and to recoup payments in installments through an additional charge on the customer's energy bill.

78. The intention is that the need to make consequential improvements will be limited to works which are already notifiable under the Building Regulations. This is intended to ensure that only works of a reasonably significant scale are included and avoids the need to identify relatively minor property improvements (such as decorating or the replacement of minor fittings). Similarly, it is intended that the consequential improvements will be in proportion to the scale and cost of the triggering work.

79. Where a building has already undergone energy efficiency improvements (for example, it already has cavity wall and loft insulation etc.) or if it is a relatively new building with a high energy performance, then there will be no requirement to make consequential improvements when undertaking any further work.

80. For modelling purposes, a small set of low-cost improvement measures has been assumed, the cost and energy saving associated with these improvement measures are summarised in Table 13. All of the identified measures are assumed to be economically feasible.

Table 13. Cost and energy savings for measures considered in domestic consequential improvements modelling

Measure	Asset life (years)	Capital cost per improvement (£)	Energy saving per improvement (kWh per annum)
Cavity wall insulation	42	500	2,673
Loft insulation	42	300	499
Hot water cylinder insulation	30	30	490

Source: Department of Energy & Climate Change

81. In the modelling, an estimate has been made of the number of homes that would have each of the measures shown in the table above installed each year as a result of this policy proposal. The estimate is based on the assumed number of 'trigger events' each year, the construction type of the existing housing stock and the existing take up of each measure (i.e. the proportion with cavity walls that already have cavity wall insulation).

82. Table 14 presents the costs and benefits of consequential improvements on domestic property in Wales. The energy savings associated with the proposal exceed the additional cost and when carbon savings are included the proposals show a net benefit of £35.9 million (NPV) over the lifetime of the measures.

83. The cost-effectiveness indicator for the non-traded sector is negative which indicates that there is a net social benefit for every tonne of carbon abated.

Table 14. Present values of costs and benefits: domestic consequential improvements (NPV £m)

Energy savings (£m)	30.3
Incremental costs (£m)	18.6
Sub-total (£m)	**11.7**
Carbon savings - non-traded (£m)	24.2
Carbon savings - traded (£m)	0.0
Total carbon savings (£m)	**24.2**
Net benefit/cost excl. avoided renewables (£m)	**35.9**
Avoided renewables (£m)	0.9
Net benefit/cost incl. avoided renewables (£m)	**36.8**
volume of CO2 saved - traded (MtCO2(e))	0.0
volume of CO2 saved - non-traded (MtCO2(e))	0.5
Cost effectiveness (£/tCO2)	
- traded	n/a
- non-traded	-25

84. Breaking the analysis down shows that each of the measures identified in Table 13 delivers a net benefit, however, the majority of the energy and carbon savings accrue from the installations of cavity wall insulation.

Sensitivity analysis

85. The result (that there is a positive NPV) is not sensitive to changes in assumptions about energy prices or the value of carbon. Tables 15 and 16 present the costs and benefits of extending the requirements for consequential improvements on domestic property using DECC's high and low energy prices and carbon values respectively.

Table 15. Present values of costs and benefits: domestic consequential improvements – high energy price and carbon value sensitivity (NPV £m)

Energy savings (£m)	41.2
Incremental costs (£m)	18.6
Sub-total (£m)	**22.6**
Carbon savings - non-traded (£m)	25.4
Carbon savings - traded (£m)	0.0
Total carbon savings (£m)	**25.4**
Net benefit/cost excl. avoided renewables (£m)	**48.0**
Avoided renewables (£m)	0.9
Net benefit/cost incl. avoided renewables (£m)	**48.9**
volume of CO2 saved - traded (MtCO2(e))	0.5
volume of CO2 saved - non-traded (MtCO2(e))	0.0
Cost effectiveness (£/tCO2)	
- traded	-47
- non-traded	0

Table 16. Present values of costs and benefits: domestic consequential improvements – low energy price and carbon value sensitivity (NPV £m)

Energy savings (£m)	19.0
Incremental costs (£m)	18.6
Sub-total (£m)	0.4
Carbon savings - non-traded (£m)	23.0
Carbon savings - traded (£m)	0.0
Total carbon savings (£m)	23.0
Net benefit/cost excl. avoided renewables (£m)	**23.3**
Avoided renewables (£m)	**0.9**
Net benefit/cost incl. avoided renewables (£m)	**24.3**
volume of CO2 saved - traded (MtCO2(e))	**0.5**
volume of CO2 saved - non-traded (MtCO2(e))	**0.0**
Cost effectiveness (£/tCO2)	
- traded	**-1**
- non-traded	**0**

New non domestic buildings

86. The main consultation proposal for non-domestic buildings is the adoption of two metrics; one for primary energy and another for carbon. This involves carrying out cost benefit analysis firstly of energy efficiency measures only and then energy efficiency measures in combination with low carbon energy supply measures.

87. Firstly the scope for reducing primary energy consumption in a range of new buildings was assessed. Cost curves for primary energy reduction were compiled using capital cost data from published sources and industry based estimates. The cost curves prioritise energy saving measures by lowest capital cost to achieve a unit saving in primary energy reflecting the approach that a developer would take in meeting a given primary energy reduction target. These cost curves can be found in Appendix 4.

88. 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 (NCM) 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 but with a fixed specification. Under the proposed new primary energy methodology the primary energy consumption from this notional building becomes the target (the Target Primary Energy Consumption, TPEC) by which the primary energy consumption from the actual building (Building Primary Energy Consumption, BPEC) is compared.

89. 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.

90. A number of permutations of notional building are therefore proposed for 2013. Table 17 and Table 18 summarise the packages of fabric and building services specifications 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 are then grouped as A1, A2, A3, B1, B2, B3, to determine the best mix of fabric and fixed services specifications.

Table 17. 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	0.10
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 18. 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) – i.e. 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

91. The aggregate reduction in primary energy from 2010 for each notional building, given the build mix is shown in the bottom row of Table 19. This shows that the most onerous specification (D3) achieves an overall aggregate saving of just over 16%. It is suggested therefore that 16% is about the **theoretical** limit of savings possible with improvements only to fabric and services in the notional building.

Table 19. Primary energy reductions by building type and specification

Package	A1	A2	A3	B1	B2	B3	C1	C2	C3	D1	D2	D3
Primary School	0.0%	7.6%	7.6%	0.5%	8.1%	8.1%	1.7%	9.2%	9.2%	3.1%	10.5%	10.5%
Office	0.0%	14.8%	19.4%	1.9%	16.5%	21.1%	4.5%	18.7%	23.2%	6.8%	20.6%	25.1%
Hotel	0.0%	5.3%	5.3%	0.9%	6.2%	6.2%	2.6%	7.7%	7.7%	4.3%	9.4%	9.4%
Warehouse	0.0%	5.7%	5.7%	4.2%	9.8%	9.8%	8.3%	13.9%	13.9%	14.9%	20.3%	20.3%
Community Hospital	0.0%	8.9%	8.9%	1.4%	10.3%	10.3%	4.9%	13.5%	13.5%	8.2%	16.6%	16.6%
Multi-Residential	0.0%	7.9%	7.9%	0.8%	8.7%	8.7%	3.7%	11.4%	11.4%	6.3%	13.9%	13.9%
Retail	0.0%	9.7%	11.7%	2.3%	11.8%	13.6%	3.4%	12.8%	14.5%	5.3%	14.6%	16.1%
Aggregate total	0.0%	8.3%	9.5%	2.4%	10.5%	11.6%	4.4%	12.5%	13.5%	7.5%	15.4%	16.3%

Source: AECOM

92. In practice some building types (warehouses in particular that make up a large part of the build mix) will technically find some of the measures in the higher fabric packages technically difficult to achieve. Under any primary energy target it will not be possible to incorporate renewable technologies to compensate for lower performing fabric and services standards. Therefore, given the need for flexibility (interchangeability of measures) it is suggested that the higher packages (C3 and above) will result in an overly inflexible policy.

93. Two primary energy targets over 2010 Building Regulations were therefore chosen; one lower target delivering in the region of a 5% reduction and one higher target delivering more than a 10% saving over 2010.

94. 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 is shown in Table 20. The table shows differentiation between top-lit (red) and side-lit buildings (as 2010) but also between predominantly cooled buildings (blue) and predominantly heated buildings (green). 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 TPEC for the particular building.

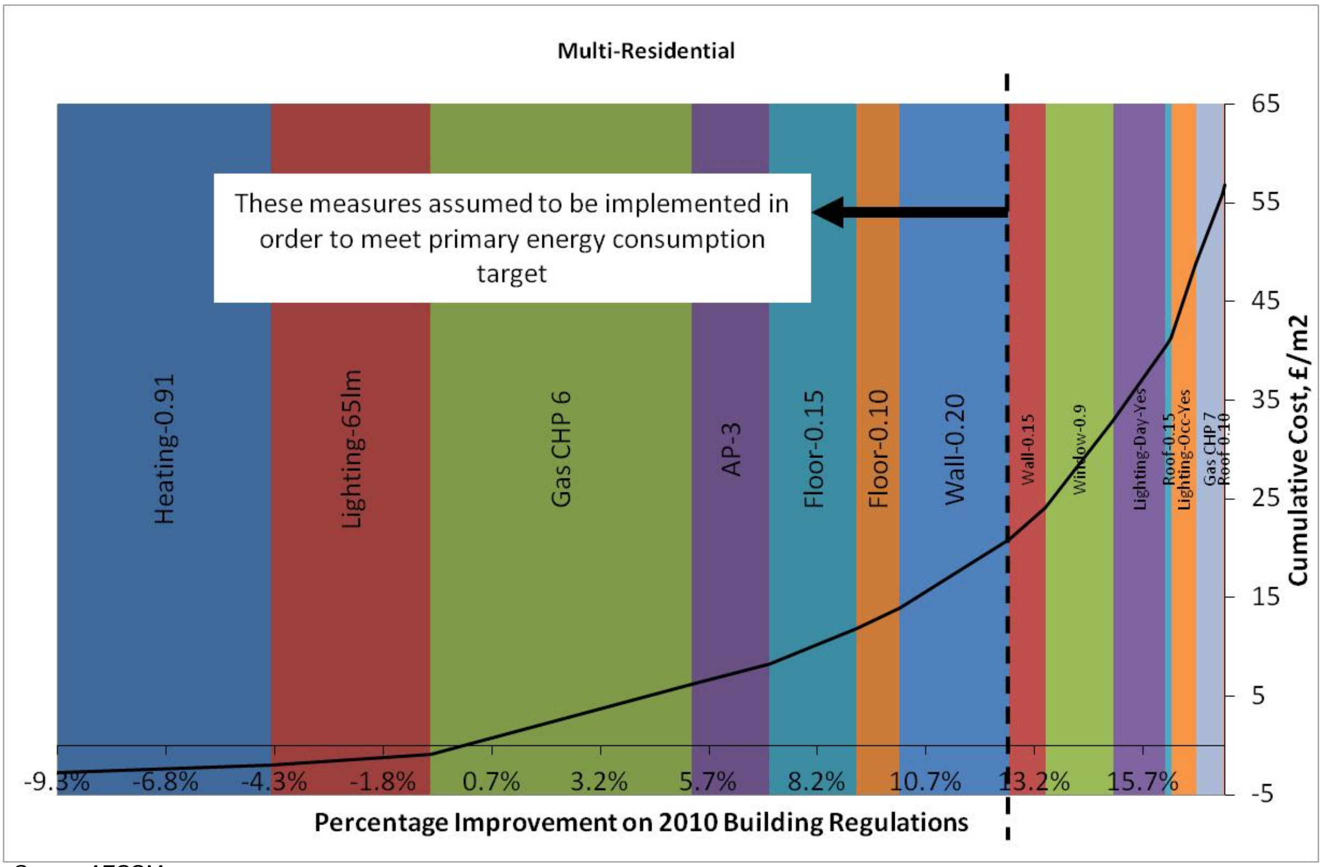
Table 20. Selected specifications for notional buildings

	Lower Package		Higher Package	
Target aggregate reduction	Notional Building	Resultant target reduction	Notional Building	Resultant target reduction
Primary School	B1	0.5%	B2	8.1%
Office	A2	14.8%	A3	19.4%
Hotel	B1	0.9%	B2	6.2%
Warehouse	A2	5.7%	A2	5.7%
Community Hospital	B1	1.4%	B2	10.3%
Multi-Residential	B1	0.8%	B2	8.7%
Retail	A2	9.7%	A3	11.7%
Aggregate Total		7%		10%

Source: AECOM

95. 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 energy efficiency measures that would be cost effectively employed in practice for each of the target reductions. Figure 2 shows the cost curve for the multi-residential building showing that a heating efficiency of 91%, lighting efficiency of 65 luminaire lumens per circuit watt, gas CHP, an air-permeability of 3 m3/m2/hour, floor U-value of 0.1 W/m2.K and Wall U-value of 0.2 W/m2.K would be a cost effective package of measures to meet the 11.4% target set by notional building C2 for the higher target.

Figure 2. Example of cost curve – multi-residential (modelled as a care home for the elderly



Source: AECOM

96. Next, the target percentages were converted to carbon for the purposes of the second TER metric. Then, as with homes, the TER was stretched by adding PV to the notional building with the PV acting as proxy for a contribution from renewable technologies. Four PV targets were assessed; 0%, 1%, 5% and 6% of floor area, assumed to be added to the roof of the building as monocrystalline PV.

97. These PV proxy areas when added to the notional building give an overall carbon target as shown in table 21 below.

Table 21. Overall target percentages as a result of PV being added to the lower and higher fabric and services packages

	% target set by adding PV to the notional building as proxy for renewables	
Energy Efficiency Package	Lower Package	Higher Package
% carbon reduction achieved by energy efficiency alone, i.e. no PV.	8%	11%
1% floor area added as PV	10%	13%
5% floor area added as PV	18%	20%
6% floor area added as PV	20%	22%

Source: AECOM

98. It is important to note that whilst the notional building features PV to stretch the target not all buildings would necessarily choose PV to achieve their given target. The choice will depend upon the relative cost effectiveness of PV against other demand-side measures.

99. The final cost curves in Appendix 4 then consist, firstly, of a range of energy efficiency measures to achieve the primary energy target (TPEC) followed by a number of renewable technologies where required to achieve the carbon target (TER).

100. In the final 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. Four of the eight target percentages above have been examined for this impact assessment with three taken forward as options for consultation.

101. 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. These build rates are shown in Table 22 and are assumed to apply for the 10 year policy period covered in the cost benefit analysis.

Table 22. Build rate assumptions

	Build rate assumed *per year* over period 2013 - 2022 (m^2)	Build mix
Primary School	32,431	6.7%
Office	33,404	6.9%
Hotel	28,384	5.9%
Warehouse	173,849	36.1%
Community Hospital	19,486	4.0%
Multi-Residential	15,349	3.2%
Retail	179,063	37.2%

102. Table 23 sets out the results of this modelling for these scenarios. All of the scenarios show a net financial cost (i.e. the incremental costs outweigh the associated energy savings). However, when carbon savings are taken into account all four policy options show a net benefit. Most of the savings come from reduction in consumption of gas. The options with a low target for renewable energy have a higher net benefit than those with the higher target for energy from renewable sources.

Table 23. Present values of costs and benefits: new non-domestic buildings (NPV £m)

	Lower Energy Efficiency Package		**Higher Energy Efficiency Package**	
	Low Target (10%)	High Target (20%)	Low Target (11%)	High Target (20%)
Energy savings (£m)	46.5	93.7	52.2	99.3
Incremental costs (£m)	61	134.9	75.5	142.7
Sub-total (£m)	**-14.4**	**-41.2**	**-23.3**	**-43.3**
Carbon savings - non-traded (£m)	24.7	39.7	29.9	44
Carbon savings - traded (£m)	3.2	6.8	3.4	7
Total carbon savings (£m)	27.8	46.5	33.3	51.1
Net benefit/cost excl. avoided renewables (£m)	**13.4**	**5.3**	**10**	**7.7**
Avoided renewables (£m)	0.4	0.7	0.4	0.7
Net benefit/cost incl. avoided renewables (£m)	**13.8**	**5.9**	**10.4**	**8.4**
volume of CO2 saved - traded (MtCO2(e))	0.1	0.2	0.1	0.2
volume of CO2 saved - non-traded (MtCO2(e))	0.5	0.8	0.6	0.9
Cost effectiveness (£/tCO2)				
- traded	-113	8	-67	-4
- non-traded	23	44	34	42

Source: Europe Economics

103. Three options are presented in the consultation document - a 10%, 11% and 20% improvement. The 20% option in the consultation is based on the Higher Energy Efficiency Package. This option was selected on the basis that it generates greater carbon savings and a higher NPV than a 20% improvement based on a Lower Energy Efficiency Package.

Sensitivity tests

104. Sensitivity tests have been carried out for higher and lower energy prices and carbon values using the DECC IAG ranges. With the higher energy prices and carbon values, the net benefits shown in Table 23 increase to around £40 million for the Low targets under both energy efficiency scenarios. The NPV for the high targets is approximately £50m and £56m for the low and high energy efficiency packages respectively.

Table 24. Present values of costs and benefits: new non-domestic buildings – high energy price and carbon value sensitivity (NPV £m)

	Lower Energy Efficiency Package		**Higher Energy Efficiency Package**	
	Low Target (10%)	High Target (20%)	Low Target (11%)	High Target (20%)
Energy savings (£m)	57.4	113.3	64.9	120.5
Incremental costs (£m)	61	135.3	75.5	143.1
Sub-total (£m)	**-3.6**	**-22.1**	**-10.6**	**-22.7**
Carbon savings - non-traded (£m)	37.9	61.1	45.9	67.6
Carbon savings - traded (£m)	4.6	9.9	5	10.3
Total carbon savings (£m)	42.5	70.9	50.9	77.9
Net benefit/cost excl. avoided renewables (£m)	**38.9**	**48.9**	**40.3**	**55.2**
Avoided renewables (£m)	0.4	0.7	0.4	0.7
Net benefit/cost incl. avoided renewables (£m)	**39.3**	**49.6**	**40.7**	**56**
volume of CO2 saved - traded (MtCO2(e))	0.1	0.2	0.1	0.2
volume of CO2 saved - non-traded (MtCO2(e))	0.5	0.8	0.6	0.9
Cost effectiveness (£/tCO2)				
- traded	-377	-209	-359	-231
- non-traded	-2	16	10	14

Source: Europe Economics

105. The results with lower energy prices and carbon values are given in Table 25 below. In each case the targets show a net cost under this sensitivity. For the Low targets, this net cost is approximately £13 million NPV for the lower energy efficiency package and £21 million NPV for the higher energy efficiency package. For the High targets, it is just over £40 million for both packages.

Table 25. Present values of costs and benefits: new non-domestic buildings - low energy price and carbon value sensitivity (NPV £m)

	Lower Energy Efficiency Package		Higher Energy Efficiency Package	
	Low Target (10%)	High Target (20%)	Low Target (11%)	High Target (20%)
Energy savings (£m)	34.1	69.8	38	73.8
Incremental costs (£m)	61	134.4	75.5	142.1
Sub-total (£m)	**-26.8**	**-64.6**	**-37.5**	**-68.2**
Carbon savings - non-traded (£m)	11.4	18.4	13.8	20.4
Carbon savings - traded (£m)	1.7	3.5	1.8	3.7
Total carbon savings (£m)	13.1	22	15.6	24.1
Net benefit/cost excl. avoided renewables (£m)	**-13.7**	**-42.6**	**-21.8**	**-44.1**
Avoided renewables (£m)	0.4	0.7	0.4	0.7
Net benefit/cost incl. avoided renewables (£m)	**-13.3**	**-42**	**-21.4**	**-43.4**
volume of CO2 saved - traded (MtCO2(e))	0.1	0.2	0.1	0.2
volume of CO2 saved - non-traded (MtCO2(e))	0.5	0.8	0.6	0.9
Cost effectiveness (£/tCO2)				
- traded	169	247	241	246
- non-traded	52	78	61	75

Source: Europe Economics

Existing Non-Domestic Property

106. The consultation proposes a tightening of the standards for replacement fixed services (boiler, air-conditioning and lighting) in existing non-domestic property.

107. The same seven building energy models used for the new-build non-domestic analyses were used for the analysis of existing non-domestic property. The buildings were thought to be typical of current Welsh construction in the following seven categories:

- Education
- Health
- Retail
- Industrial
- Offices
- Multi-residential
- Hotel

108. In order to make the buildings representative of existing stock, the energy-related parameters for fabric and services were adjusted to those presented as 'typical' in the National Calculation Methodology[6]. These values are roughly equivalent to those presented in Part L 1995 and are presented in Table 26 below.

[6] Appendix A, NCM Modelling Guide 2008

Table 26. Parameters used to achieve the 'typical building' according to Appendix A of the 2008 NCM Modelling Guide

NCM Modelling Guide 2008: Appendix A - Parameters for the typical building	
Parameter	***Typical Value***
Roof U value (W/m^2K)	0.5
Wall U value (W/m^2K)	0.45
Ground floor U value (W/m^2K)	0.45
Window U value (W/m^2K)	3.3
Air permeability ($m^3/(h.m^2)$ @ 50Pa)	15
Heating SCoP	0.55
Auxiliary energy (W/m^2)	1.23
Zonal extract SFP (W/ls^{-1})	1.1
Lighting in office & warehouse (W/m^2/100lux)	4.5
Lighting in other spaces (W/m^2/100lux)	6.2

109. The first stage for assessing the impact of tightening the existing building regulations was to change each of the fabric and service parameters identified above, firstly to those required in Part L 2010 (the current requirements for component replacement) and then to those proposed in the Non-Domestic Building Services Compliance Guide as part of the English Part L 2013 consultation. These parameters were changed one at a time, keeping all other parameters at the baseline values as defined in Table 26 above. The parameters that were changed and the values they were changed to are shown in Table 27 below.

Table 27. Parameters tested for each of the seven building models. The dates in the first column indicate whether the parameter is that found in Part L 2010 or proposed in the English Part L 2013 consultation

Building Type	Parameter Being Tested
Education	
2010	Boiler CoP 86%
2013	Boiler CoP 91%
2010	Lighting 55 lum/W (2.52 W/m^2/100lux)
2013	Lighting 60 lum/W (2.31 W/m^2/100lux)
Retail	
2010	Boiler CoP 86%
2013	Boiler CoP 91%
2010	Chiller SEER 2.5
2013	Chiller SEER 2.7
2010	Lighting 55 lum/W (3.49 W/m^2/100lux)
2013	Lighting 60 lum/W (3.20 W/m^2/100lux)
Warehouse	
2010	Multi-burner Eff_{th} = 86%; Eff_{rad} = 55%

2013	Multi-burner Eff_{th} = 86%; Eff_{rad} = 60%[7]
2010	Lighting 55 lum/W (2.13 W/m^2/100lux)
2013	Lighting 60 lum/W (1.95 W/m^2/100lux)
Office	
2010	Chiller SEER 2.5
2013	Chiller SEER 2.7
2010	Lighting 55 lum/W (2.47 W/m^2/100lux)
2013	Lighting 60 lum/W (2.26 W/m^2/100lux)
Hotel	
2010	Boiler CoP 86%
2013	Boiler CoP 91%
2010	Lighting 55 lum/W (2.75 W/m^2/100lux)
2013	Lighting 60 lum/W (2.52 W/m^2/100lux)
Healthcare	
2010	Boiler CoP 86%
2013	Boiler CoP 91%
2010	Lighting 55 lum/W (3.19 W/m^2/100lux)
2013	Lighting 60 lum/W (2.92 W/m^2/100lux)
Multiresidential	
2010	Boiler CoP 86%
2013	Boiler CoP 91%
2010	Lighting 55 lum/W (2.69 W/m^2/100lux)
2013	Lighting 60 lum/W (2.47 W/m^2/100lux)

110. Costs for the above energy efficiency improvements were supplied by Welsh Government cost consultants (AECOM-Davis Langdon), utilising their in house cost database, SPON's price books, information direct from manufacturer's and costs from Welsh construction projects where appropriate. The assumed costs are presented in Table 28.

[7] Energy savings were calculated on improvement of multi-burner Eff_{th} = 86%; Eff_{rad} = 55% to Eff_{th} = 86%; Eff_{rad} = 60% but costs based on boiler improvement of CoP 86% to CoP 91%

Table 28. Additional costs for fixed service improvements

Building type	Element	Cost (£)	m2	£/m2
Education	Boiler	613	2297	0.27
	Chiller		2297	0.00
	Lighting	1517	2297	0.66
Retail	Boiler	375	1210	0.31
	Chiller	567	1210	0.47
	Lighting	560	1210	0.46
Warehouse	Boiler	1186	5262	0.23
	Chiller		5262	0.00
	Lighting	437	5262	0.08
Office	Boiler		1120	0.00
	Chiller	524	1120	0.47
	Lighting	888	1120	0.79
Hotel	Boiler	639	2729	0.23
	Chiller		2729	0.00
	Lighting	826	2729	0.30
Healthcare	Boiler	555	2507	0.22
	Chiller		2507	0.00
	Lighting	1987	2507	0.79
Multiresidential	Boiler	403	1935	0.21
	Chiller		1935	0.00
	Lighting	670	1935	0.35

Source: AECOM

111. From these simulations, the energy consumption by fuel type before and after each parameter change was recorded. The decrease in energy consumption was therefore calculated as a result of each parameter change. This enabled the impact of changing each parameter listed in Table 27 to be approximated.

112. The energy savings made per m^2 in a building of a specific type was then multiplied by the total floor area of buildings of that particular sector (type) that exist in Wales: this was established via a dataset supplied by Building Research Establishment. This enabled an estimate of the total potential annual energy and cost savings that could be achieved in Wales by the particular sectors analysed (approximately two thirds of the m^2 of total Welsh existing non-domestic stock).

113. A building life (including replacement of assets) is assumed to be 60 years and the costs and benefits of the energy efficiency improvements are considered over this time period. Arguably this period is too long since not all buildings will have been newly built at the time when the improvements are installed. Within this 60 year period it is assumed that, with a 15 year lifetime, boilers and chillers will need to be replaced three times, and lighting, with a 20 year lifetime, will need to be replaced twice.

114. The results of this modelling approach are presented in Table 29 below.

Table 29. Present values of costs and benefits: Existing non-domestic buildings (NPV £m)

Energy savings (£m)	2,216
Incremental costs (£m)	538
Sub-total (£m)	**1,678**
Carbon savings - non-traded (£m)	988
Carbon savings - traded (£m)	135
Total carbon savings (£m)	**1,123**
Net benefit/cost excl. avoided renewables (£m)	**2,801**
Avoided renewables (£m)	3
Net benefit/cost incl. avoided renewables (£m)	**2,805**
volume of CO2 saved - traded (MtCO2(e))	4
volume of CO2 saved - non-traded (MtCO2(e))	20
Cost effectiveness (£/tCO2)	
- traded	- 722
- non-traded	- 93

Source: Europe Economics

115. The results show that the potential energy savings are significantly greater than the additional costs. When carbon savings and avoided renewables are added then the net benefit increases to £2,805m. The cost effectiveness indicators are negative indicating a net benefit to society for every tonne of carbon saved.

116. These estimates assume that all of the existing non-domestic buildings will last for a further 60 years. While this may be true for some existing non-domestic property, it is unlikely to be true for all. The figures are therefore likely to over-estimate the net benefit from tightening the requirements for replacement fixed services in existing non-domestic property.

Consequential improvements

117. For non-domestic buildings with a floor area greater than 1,000m^2, consequential improvements are required under current Part L if one of the following is carried out:

- An extension or increase in habitable area,
- The initial provision of fixed building services, or
- An increased capacity of fixed building services.

118. This impact assessment considers the policy proposals to remove the 1,000m^2 threshold and require all non-domestic property to undertake consequential improvements where an extension or new habitable space is added.

119. It is assumed that the majority of extensions to buildings below 1,000m^2 will be to domestic style constructions. 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.

120. As such, the model for estimating the impact of consequential improvements in domestic property has been adapted to reflect smaller non-domestic buildings.

121. For the purpose of this analysis we assume that these non-domestic buildings have the same pattern of existing energy efficiency measures installed (e.g. 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 150 m^2 compared with 95 m^2 for domestic buildings. Costs and energy savings per building have been increased pro rata from the domestic model to adjust for this larger building size.

122. In line with similar work recently undertaken in England, 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. This is used to estimate the number of extensions to buildings that might trigger consequential improvements, suggesting that there may be about 900 extensions a year. The energy and carbon savings have been evaluated over the assumed life of each improvement without allowing for any subsequent replacement.

123. As is the case for domestic property, occupiers will have the option to offset the up-front capital costs of the consequential improvements through the Green Deal.

124. Estimates of the costs and benefits of extending the consequential improvement requirement to all non-domestic buildings are shown in Table 30. The proposal shows a small net benefit of £4.6 million. As was the case with the domestic consequential improvements most of the benefits generated by the proposals relate to the installation of cavity wall insulation.

Table 30. Present values of costs and benefits: non-domestic consequential improvements (NPV £m)

Energy savings (£m)	4.2
Incremental costs (£m)	2.9
Sub-total (£m)	**1.3**
Carbon savings - non-traded (£m)	3.2
Carbon savings - traded (£m)	0.1
Total carbon savings (£m)	**3.3**
Net benefit/cost excl. avoided renewables (£m)	**4.6**
Avoided renewables (£m)	0.1
Net benefit/cost incl. avoided renewables (£m)	**4.8**
volume of CO2 saved - traded (MtCO2(e))	0.0
volume of CO2 saved - non-traded (MtCO2(e))	0.1
Cost effectiveness (£/tCO2)	
- traded	-5829
- non-traded	-23

Sensitivity analysis

125. As would be expected, adopting DECC's higher estimates for future energy prices and carbon values increases the NPV for non-domestic consequential improvements. The value of costs and benefits assuming the higher energy prices and carbon values are shown in Table 31.

Table 31. Present values of costs and benefits: non-domestic consequential improvements – high energy price and carbon value sensitivity (NPV £m)

Energy savings (£m)	5.7
Incremental costs (£m)	2.9
Sub-total (£m)	**2.8**
Carbon savings - non-traded (£m)	3.4
Carbon savings - traded (£m)	0.1
Total carbon savings (£m)	**3.5**
Net benefit/cost excl. avoided renewables (£m)	**6.3**
Avoided renewables (£m)	0.1
Net benefit/cost incl. avoided renewables (£m)	**6.4**
volume of CO2 saved - traded (MtCO2(e))	0.0
volume of CO2 saved - non-traded (MtCO2(e))	0.1
Cost effectiveness (£/tCO2)	
- traded	-7,924
- non-traded	-46

126. Adopting DECC's lower energy price assumptions means that the increased capital costs exceed the value of the energy savings, however, the value of carbon savings (even when given a lower value) remain sufficient to generate a positive NPV.

Table 32. Present values of costs and benefits: non-domestic consequential improvements – low energy price and carbon value sensitivity (NPV £m)

Energy savings (£m)	2.6
Incremental costs (£m)	2.9
Sub-total (£m)	**-0.2**
Carbon savings - non-traded (£m)	3.0
Carbon savings - traded (£m)	0.1
Total carbon savings (£m)	**3.1**
Net benefit/cost excl. avoided renewables (£m)	**2.9**
Avoided renewables (£m)	0.1
Net benefit/cost incl. avoided renewables (£m)	**3.0**
volume of CO2 saved - traded (MtCO2(e))	0.0
volume of CO2 saved - non-traded (MtCO2(e))	0.1
Cost effectiveness (£/tCO2)	
- traded	-3,620
- non-traded	2

SECTION 5: DISTRIBUTION OF COSTS AND BENEFITS

127. The costs and benefits identified for new buildings in the RIA will be incurred or will accrue to different groups. In the first instance, additional building costs are likely to be borne by the building developer, however in the longer term developers are likely to pass the higher costs to customers (owners/tenants) or back to landowners in the form of lower land values where possible.

128. The property occupier is expected to benefit from lower energy bills due to the increased energy efficiency of the property. In addition to lower energy bills, occupiers of a building with a PV system (for example) installed could also benefit from a payment through the Feed in Tariff (FiT) scheme. However, they will also be liable for the additional maintenance and replacement costs that will be incurred during the lifetime of the building. The extent to which developers will be able to pass the additional cost of the higher standard property to the eventual owner/occupier depends upon their recognition of and willingness to pay for future energy cost savings.

129. Tables 33 and 34 show the assumed additional capital costs for new domestic and non-domestic buildings respectively (compared to buildings compliant with current planning policy).

Table 33. Additional capital cost for new domestic property[8]

Property Type	Capital Cost (£)			Additional capital cost (£)		Additional capital cost as a % of baseline	
	Baseline	25%	40%	25%	40%	25%	40%
Detached	38,591	43,735	45,195	5,144	6,604	13%	17%
Semi-Detached	26,694	29,732	30,548	3,038	3,854	11%	14%
Mid-Terrace	24,329	26,287	27,103	1,957	2,773	8%	11%
Apartment	13,897	15,710	16,191	1,814	2,294	13%	17%

Source: Davis Langdon & Welsh Government calculations

Table 34. Percentage increase in capital costs for new non-domestic property[9]

	Lower Energy Efficiency Package	Higher Energy Efficiency Package	
	Low Target	Low Target	High Target
Target aggregate reduction	**10%**	**11%**	**20%**
Primary School	0.0%	0.2%	1.0%
Office	1.6%	3.2%	4.7%
Hotel	0.0%	0.1%	0.3%
Warehouse	2.1%	1.6%	4.6%
Community Hospital	0.2%	0.7%	0.8%
Multi-residential	0.1%	0.6%	1.6%
Retail	2.4%	2.7%	4.3%

Source: Europe Economics

130. Data from Davis Langdon (cost consultants) suggest that the proposals will add between 8% and 17% to the capital cost for the 'superstructure' of new domestic property. The additional costs are higher for detached properties and apartments than semi-detached and mid-terrace properties.

131. For new non-domestic property, the proposals increase capital costs by between 0% and 5%, again depending upon property type and which of the three 'short-listed' options is selected.

132. As with other sectors of the economy, the construction industry in Wales and the UK has struggled in recent years as a result of the global economic recession. The number of new dwellings started in Wales has been increasing since 2008-09, however, the figure of 5,818 new house starts in Wales in 2010-11 is still significantly below the pre-recession level of 10,135 in 2007-08[10]. Expectations are for a recovery in the UK construction sector, however, that recovery is expected to take a number of years.

133. Given the difficult economic conditions faced by the building industry, consideration has to be given to what impact these proposals (and in particular the additional costs) will have on construction activity in Wales.

[8] Costs relate to the property's 'superstructure' and assume that the property is connected to the gas grid.
[9] For the three options that are being presented for consultation.
[10] New house building in Wales, October to December 2011, Welsh Government Statistical Release http://wales.gov.uk/docs/statistics/2012/120321sdr462012en.pdf)

The additional costs, coupled with those associated with other Government policies (for example, the requirement to install sprinkler systems in new homes) will make building projects in Wales less attractive from a financial perspective and may reduce the number of new building developments that take place. This is particularly true for those areas of Wales where building projects are at the margin of viability.

134. Clearly, any reduction in the number of building projects that take place in Wales will have an impact on landowners. However, there is also a risk that the proposals will have a negative impact on a number of other Welsh Government objectives such as those relating to increasing the supply of housing, the availability of affordable homes and the regeneration of particular areas.

SECTION 6: SPECIFIC IMPACT TESTS

Economic and financial impacts

Competition

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

136. The proposed higher standards mean that building contractors will have to comply with more stringent energy efficiency and building emissions targets. As a result of this, capital costs are expected to increase. Some of this increase in costs is expected to be passed on to landowners (through reduced land values) and the eventual owners (through higher property prices). The increase in production costs is expected to affect all building contractors broadly equally and the proportion of the additional costs that cannot be passed on to landowners or the eventual purchasers is likely to represent a relatively small percentage of overall construction costs. Any potential competitive impacts on building contractors are therefore likely to be minimal.

137. The new standards may have an impact on manufacturers and suppliers to the construction industry by increasing the demand for higher specification materials and products. Suppliers of low cost or low quality products and materials may be adversely affected by the change in regulations. However, the change in regulations is also expected to provide opportunities for manufacturers and suppliers of low/zero carbon generation technologies and high energy efficiency products.

Small Medium Enterprises

138. The majority of businesses in the construction industry in Wales are classed as a small or medium sized enterprise (SME). Welsh

Government statistics (Size Analysis of Welsh Business, 2011) show approximately 38,900 construction businesses (including self-employed individuals) operating in Wales in 2011. Of these, 97.7% were micro-businesses (employing between 0 and 9 people), just under 1.8% were small businesses (10-49 employees) and 0.35% were medium size businesses (50-249 employees). The remaining 0.2% of businesses were classified as large (250+ employees).

139. Although the majority of business in the sector are classed as SMEs, a significant proportion of construction activity (in terms of the number of new properties built) is carried out by the larger companies. The Office of Fair Trading[11] reported that the top 10 home-builders were responsible for 44% of the domestic property built in 2006 and that the top 25 were responsible for 54% of the domestic property built in the UK.

140. Businesses affected by the proposals for 2013 will include small firms involved in the construction of new buildings and extensions, companies that manufacture building materials and installers of energy efficiency measures such as loft and cavity wall insulation.

141. There are a number of ways in which small firms may be disproportionately affected by the proposals when compared to larger firms.

i. 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).

ii. 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.

iii. There is an additional risk that the new requirements and the proposals to extend the consequential improvement requirements to properties below 1,000m^2 will dissuade some homeowners and businesses from carrying out small building projects and improvements. This could have a negative impact on small businesses. However, the availability of finance through the Green Deal to cover the capital cost of the energy efficiency improvements may reduce this risk.

[11] Office of Fair Trading, Home Building in the UK: A Market Study, September 2008.

iv. On the other hand, 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.

Social Impacts

Health & Well-being

142. There is a wealth of evidence available on the impact that housing quality has on health and general well-being (see for example Geddes et al 2011[12]). Research shows direct links between cold housing and cardio-vascular and respiratory problems and also winter mortality amongst the elderly. Links have also been made between housing standards and mental health and children/young people's well-being and opportunities.

143. It follows then that any policy aimed at raising the thermal and energy efficiency of both new and existing (when extended/renovated) property has the potential to improve health and well-being.

144. Some concerns have been raised about the potential impact that energy efficiency improvements may have on indoor air quality and the risk of overheating in homes. In particular, it has been suggested that tightening building envelopes reduces ventilation and risks the build-up of indoor pollutants. The UK Government has announced plans for a review of the evidence on the potential impact of improvements to building specification on indoor temperatures and air quality.

Equalities

145. 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.

[12] Geddes, I., Bloomer, E., Allen, J. and Goldblatt, P. The Health Impacts of Cold Homes and Fuel Poverty - Marmot Review Team , Department of Epidemiology & Public Health, University College London, May 2011.

146. These proposals have been assessed in an initial screening process which determined that the proposals will have a neutral impact in terms of race, gender, sexual orientation and religion.

147. The proposals could be considered to have a positive impact in terms of protecting people in vulnerable age groups and people with a disability or long-term illness. As is detailed in the 'Health and Well-being section, there is evidence of a link between cold housing and excess winter deaths – the majority of which occur amongst older age groups – and between cold housing and non fatal adverse health consequences which again affect older age groups in particular and to a lesser extent younger children and those with a long-term illness or disability[13].

Rural

148. The majority of the existing 'off-gas' domestic properties are located in rural areas where connecting homes to the gas grid is not economically viable or feasible. In these locations, builders have to choose an alternative fuel such as LPG, oil or electric heating. Each of these alternative heating fuels has a higher carbon intensity than gas. For new property that uses a heating fuel other than gas, current Part L regulations include a 'fuel factor' that increases the carbon target/Target Emission Rate (TER) to make it less demanding. Without this fuel factor, builders in off-gas locations would need to build to higher and more expensive fabric and/or services standards in order to meet the same emissions target as those homes connected to the gas network.

149. The 'recipe' approach that is being proposed for new domestic property has been designed to ensure that the elemental specification is similar for all fuel types. In other words, the current fuel factor will be integrated into the recipe approach.

150. As a result of the recipe approach, the requirement for new domestic property of each fuel type includes the same level of fabric and service efficiencies and the same amount of PV. The main difference is the required system efficiency for each fuel, which is appropriate for the heating system type. Hence the specification for property constructed off-gas with oil or LPG would not be more demanding than domestic property heated with gas.

151. The recipe associated with each fuel type results in a different carbon target. The recipes can therefore be viewed as more equitable – each requiring a similar challenge in terms of building specifications and each requiring a similar level of energy efficiency. New domestic property being built in off-gas locations (typically rural areas) should not therefore be disadvantaged by the proposals.

[13] Getting the measure of fuel poverty: Final Report of the Fuel Poverty Review, John Hills

Welsh Language

152. There are no significant links between the policy proposals and the Welsh language. The proposals are not expected to have a positive impact on the promotion, support or development of the Welsh language nor are they expected to have a negative impact on Welsh speaking communities or Welsh language services.

Environmental Impacts

Greenhouse Gas Emissions

153. The impact of the proposed policy changes on carbon emissions have been quantified and included in the impact assessment.

Wider Environmental Impacts

154. The policy is expected to result in a reduction in the demand for energy (compared to the 'Do Nothing' option). Given the current 'energy mix', this is expected to result in an improvement in air quality. No attempt has been made to monetise this benefit in the impact assessment.

155. The policy is not expected to have any impact on water quality or quantity, biodiversity, waste management, noise pollution or the appearance of the landscape.

Sustainable Development

156. As has been mentioned previously in this assessment, the proposals present a potential conflict between environmental objectives and economic and social objectives.

157. The proposals are aimed at reducing Greenhouse Gas (GHG) emissions from new and existing buildings. However, the evidence suggests that this will lead to an increase in costs for developers and/or the owners of existing buildings. Given the current state of the economy, there are concerns that this increase in costs risks a reduction in construction activity in Wales and could dissuade the owners of existing buildings from extending/improving their property in the near term. If this were to occur then it may have a negative impact on the Welsh Government's policies for regeneration and the supply of affordable homes.

Appendix 1: Assumptions for New Domestic Property

Assumed Fabric specifications for new domestic property

All "medium" thermal mass parameter	Baseline "2010 PPW Compliant" Detached	Baseline "2010 PPW Compliant" Semi detached house	Baseline "2010 PPW Compliant" Mid terrace house	Baseline "2010 PPW Compliant" Apartment	25% 2010 Notional All dwelling types	40% 2010 IA Notional All dwelling types
Ext. Walls (W/m²K)	0.18	0.20	0.18	0.18	0.15	0.15
Party Walls (W/m²K)	n/a	0	0	0	0	0
Semi exposed walls, inc adjustment (W/m²K)	n/a	n/a	n/a	0.17	0.14	0.14
Floor (W/m²K)	0.17	0.13	0.13	0.15	0.15	0.13
Roof (W/m²K)	0.13	0.13	0.11	0.13	0.11	0.11
Windows (W/m²K) whole window u-value	1.4 (double glazed)	1.2 (double glazed)	1.2 (double glazed)	1.6 (double glazed)	1.4 (double glazed)	1.2 (double glazed)
Doors (W/m²K)	1.2	1	1	1.2	1	1
Airtightness (m³/hr/m²)	4.50	4.57	4.67	5.77	6.0	4.5
Thermal bridging y-value (W/m²K)	Half way ACD-ECD	ECD	ECD plus	Half way ACD-ECD	ACD	ECDplus
Ventilation type	Natural (with extract fans)	Natural (with extract fans)	Natural (with extract fans)	Natural (with extract fans)	Natural (with extract fans)	Natural (with extract fans)
Low energy lighting	100%	100%	100%	100%	100%	100%

Assumed annual energy consumption per property and fuel type

DETACHED

Floor area 117.92 m^2

Aggregate Target			25%	40%
Heat generation		Gas boiler	Gas boiler	Gas boiler
Specification		2010 PPW Compliant	2013 Notional	2013 Notional
Energy consumed / kWh/yr	Space heating	5599	4667	4667
	Domestic hot water	2634	2645	2645
	Fans and pumps	175	175	175
	Lighting	447	447	447
	PV generation	0	410	1160

MID TERRACE

Floor area 76.32 m^2

Aggregate Target			25%	40%
Heat generation		Gas boiler	Gas boiler	Gas boiler
Specification		2010 PPW Compliant	2013 Notional	2013 Notional
Energy consumed / kWh/yr	Space heating	2326	2249	2249
	Domestic hot water	2398	2399	2399
	Fans and pumps	175	175	175
	Lighting	351	351	351
	PV generation	0	265	751

SEMI-DETACHED

Floor area 76.32 m^2

Aggregate Target			25%	40%
Heat generation		Gas boiler	Gas boiler	Gas boiler
Specification		2010 PPW Compliant	2013 Notional	2013 Notional
Energy consumed / kWh/yr	Space heating	3065	2616	2616
	Domestic hot water	2383	2392	2392
	Fans and pumps	175	175	175
	Lighting	342	342	342
	PV generation	0	265	751

Aggregate Target			25%	40%
Heat generation		Oil boiler	Oil boiler	Oil boiler
Specification		2010 PPW Compliant	2013 Notional	2013 Notional
Fuel Factor allowance		Full fuel factor	No fuel factor	No fuel factor
Energy consumed / kWh/yr	Space heating	3873	2615	2615
	Domestic hot water	2301	2322	2322
	Fans and pumps	230	230	230
	Lighting	342	342	342
	PV generation	798	265	751

Aggregate Target			25%	40%
Heat generation		LPG boiler	LPG boiler	LPG boiler
Specification		2010 PPW Compliant	2013 Notional	2013 Notional
Fuel Factor allowance		Full fuel factor	No fuel factor	No fuel factor
Energy consumed / kWh/yr	Space heating	4409	2716	2716
	Domestic hot water	2337	2362	2362
	Fans and pumps	175	175	175
	Lighting	342	342	342
	PV generation	798	265	751

Aggregate Target			25%	40%
Heat generation		ASHP default	ASHP (COP 3.2)	ASHP (COP 3.2)
Specification		2010 PPW Compliant	2013 Notional	2013 Notional
Fuel Factor allowance		Full fuel factor	No fuel factor	No fuel factor
Energy consumed / kWh/yr	Space heating	2470	1029	1029
	Domestic hot water	1413	1105	1105
	Fans and pumps	130	130	130
	Lighting	342	342	342
	PV generation	0	265	751

4-STOREY APARTMENT (32 UNITS)

Floor area 1746.72 m^2

Aggregate Target			25%	40%
Heat generation		Gas boiler	Gas boiler	Gas boiler
Specification		2010 PPW Compliant	2013 Notional	2013 Notional
Energy consumed / kWh/yr	Space heating	64941	46883	46883
	Domestic hot water	63730	64181	64181
	Fans and pumps	5600	5600	5600
	Lighting	8060	8060	8060
	PV generation	6381	3363	9529

Aggregate Target			25%	40%
Heat generation		Direct Electric	ASHP (COP 3.2)	ASHP (COP 3.2)
Specification		2010 PPW Compliant	2013 Notional	2013 Notional
Fuel Factor allowance		Full fuel factor	No fuel factor	No fuel factor
Energy consumed / kWh/yr	Space heating	44675	16697	16697
	Domestic hot water	45786	31363	31363
	Fans and pumps	0	4160	4160
	Lighting	8060	6485	6485
	PV generation	4594	3363	9529

Appendix 2: Learning Rates

Assumed learning rates for solar PV

	Solar PV
2011	1.00
2012	0.91
2013	0.85
2014	0.79
2015	0.74
2016	0.69
2017	0.65
2018	0.62
2019	0.59
2020	0.56
2021	0.54
2022	0.51
2023	0.49

Source: AECOM, Jan 2012

Assumed learning rates for air permeability, thermal bridging and windows

DESIGN AIR PERMEABILITY	DESIGN AIR PERMEABILITY									
Year	0	1	2	3	4	5	6	7	8	9
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Airtightness >5	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Airtightness <=5 and >3	100%	84%	68%	52%	36%	20%	20%	20%	20%	20%
Airtightness <=3 and >1	100%	90%	80%	69%	59%	49%	49%	49%	49%	49%
Airtightness <=1	100%	95%	90%	85%	80%	75%	71%	68%	65%	62%

	THERMAL BRIDGING									
Year	0	1	2	3	4	5	6	7	8	9
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TB=ACD	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
TB = Halfway ACD-ECD	100%	84%	68%	52%	36%	20%	20%	20%	20%	20%
TB = ECD	100%	96%	92%	88%	84%	80%	80%	80%	80%	80%
TB=ECD plus	100%	93%	87%	80%	73%	67%	67%	67%	67%	67%

Normalised U value	WINDOWS									
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1.6	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
1.4	100%	99.2%	98.4%	97.6%	96.8%	96.0%	95.2%	94.4%	93.6%	92.8%

Source: AECOM

Appendix 3: Assumptions for Existing Domestic Property

Energy consumption for different standards for walls, roofs and floors

Extension		External Wall				
Specification		**ADL1A 2010**	**0.25 W/m^{2}K**	**0.21 W/m^{2}K**	**0.18 W/m^{2}K**	**0.15 W/m^{2}K**
Energy consumed / kWh/yr	Space heating	20881.04	20835.63	20778.048	20729.52	20683.98
	Domestic hot water	3416.61	3416.7	3416.804	3416.9	3416.99
	Fans and pumps	214	214	214	214	214
	Lighting	788.78	788.78	788.78	788.78	788.78

Extension		Roof			
Specification		**ADL1A 2010**	**0.15 W/m^{2}K**	**0.13 W/m^{2}K**	**0.11 W/m^{2}K**
Energy consumed / kWh/yr	Space heating	20881.04	20847.79	20825.61	20803.43
	Domestic hot water	3416.61	3416.67	3416.72	3416.76
	Fans and pumps	214	214	214	214
	Lighting	788.78	788.78	788.78	788.78

Extension		Ground Floor			
Specification		**ADL1A 2010**	**0.18 W/m^{2}K**	**0.15 W/m^{2}K**	**0.13 W/m^{2}K**
Energy consumed / kWh/yr	Space heating	20881.04	20836.7	20803.43	20781.23
	Domestic hot water	3416.61	3416.69	3416.76	3416.8
	Fans and pumps	214	214	214	214
	Lighting	788.78	788.78	788.78	788.78

Additional capital cost and energy costs for different standards for walls, roofs and floors.

Extension		External Wall				
Specification		**ADL1A 2010**	**0.25 W/m^{2}K**	**0.21 W/m^{2}K**	**0.18 W/m^{2}K**	**0.15 W/m^{2}K**
CAPEX extra over baseline		£ -	£ 39.38	£ 99.61	£ 107.56	£ 250.60
Energy cost / £/yr	Space heating	£ 787.22	£ 785.50	£ 783.33	£ 781.50	£ 779.79
	Domestic hot water	£ 128.81	£ 128.81	£ 128.81	£ 128.82	£ 128.82
	Fans and pumps	£ 29.04	£ 29.04	£ 29.04	£ 29.04	£ 29.04
	Lighting	£ 107.04	£ 107.04	£ 107.04	£ 107.04	£ 107.04

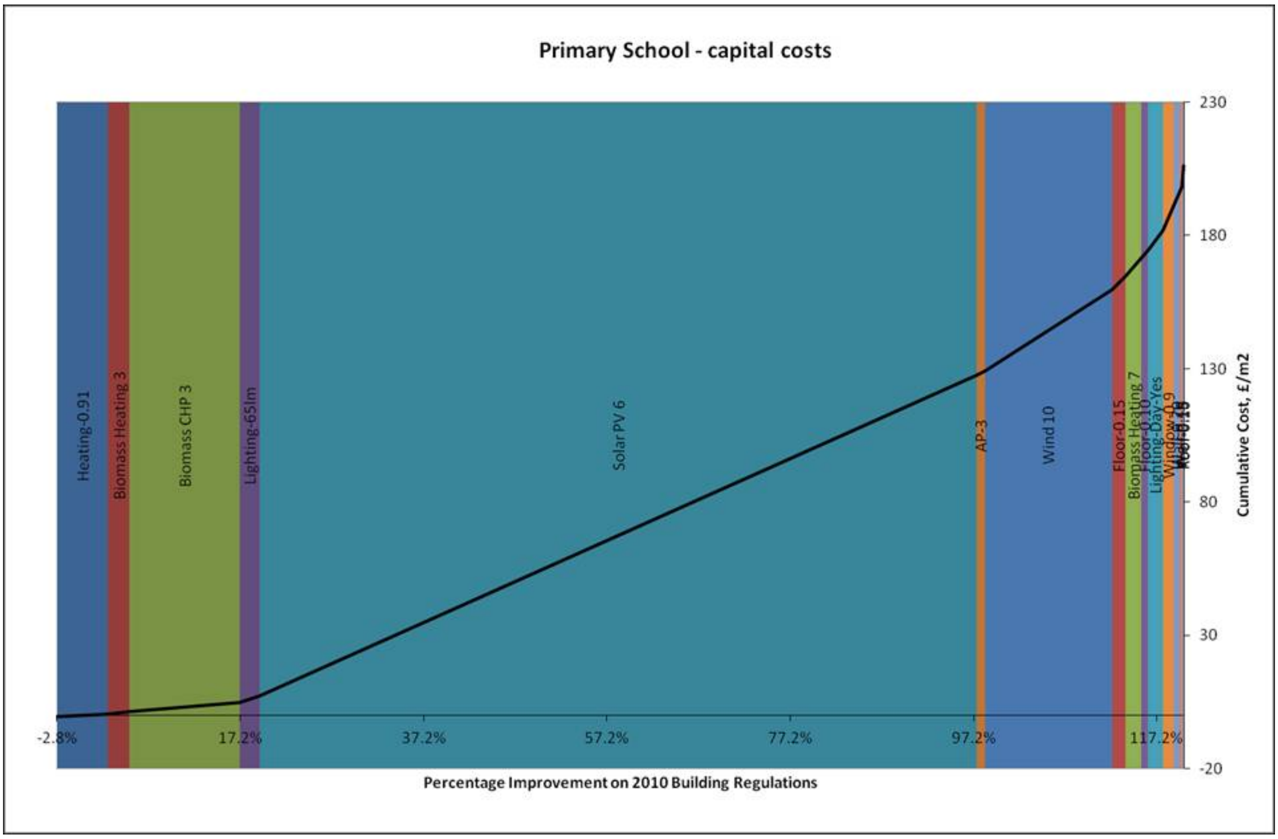
Extension		Roof			
Specification		**ADL1A 2010**	**0.15 W/m^{2}K**	**0.13 W/m^{2}K**	**0.11 W/m^{2}K**
CAPEX extra over baseline		£ -	£ 21.01	£ 36.48	£ 75.08
Energy cost / £/yr	Space heating	£ 787.22	£ 785.96	£ 785.13	£ 784.29
	Domestic hot water	£ 128.81	£ 128.81	£ 128.81	£ 128.81
	Fans and pumps	£ 29.04	£ 29.04	£ 29.04	£ 29.04
	Lighting	£ 107.04	£ 107.04	£ 107.04	£ 107.04

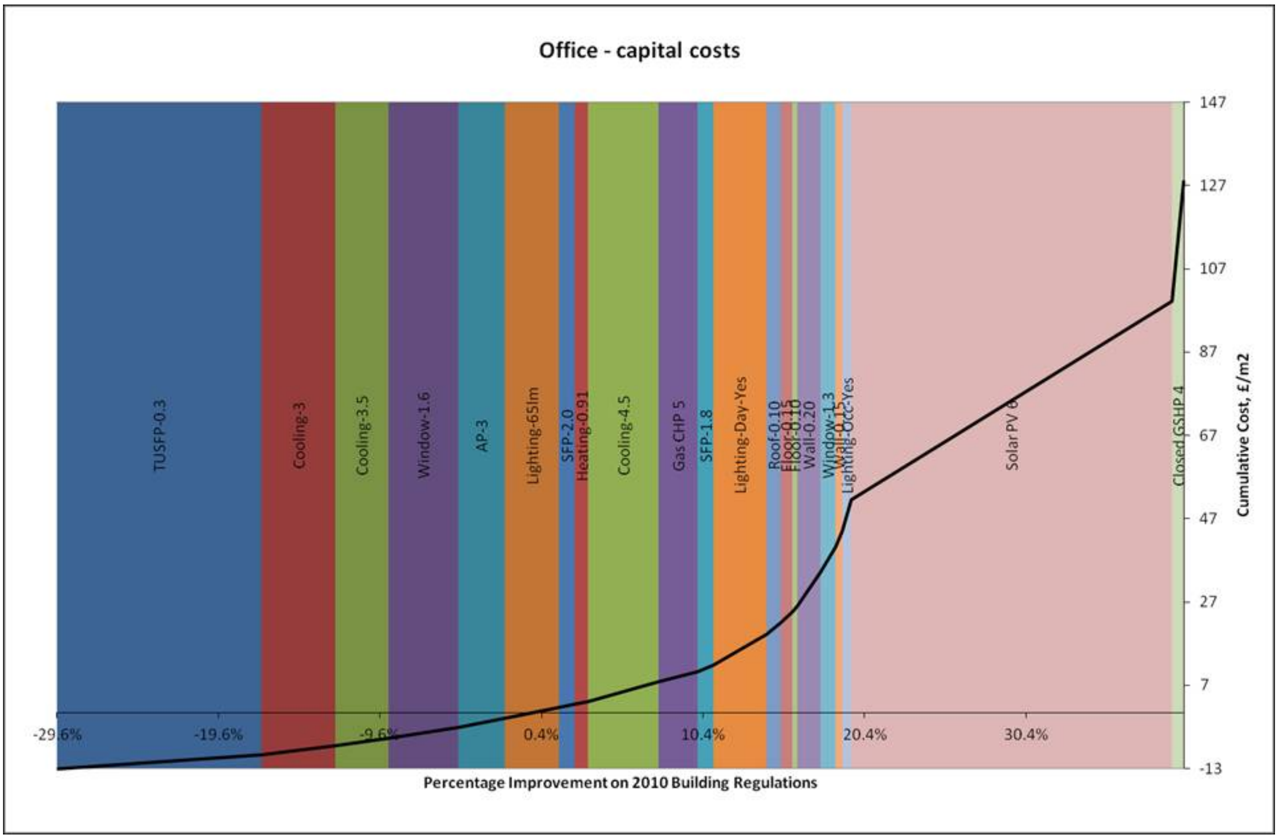
Extension		Ground Floor			
Specification		**ADL1A 2010**	**0.18 W/m^{2}K**	**0.15 W/m^{2}K**	**0.13 W/m^{2}K**
CAPEX extra over baseline		£ -	£ 87.95	£ 141.34	£ 167.21
Energy cost / £/yr	Space heating	£ 787.22	£ 785.54	£ 784.29	£ 783.45
	Domestic hot water	£ 128.81	£ 128.81	£ 128.81	£ 128.81
	Fans and pumps	£ 29.04	£ 29.04	£ 29.04	£ 29.04
	Lighting	£ 107.04	£ 107.04	£ 107.04	£ 107.04

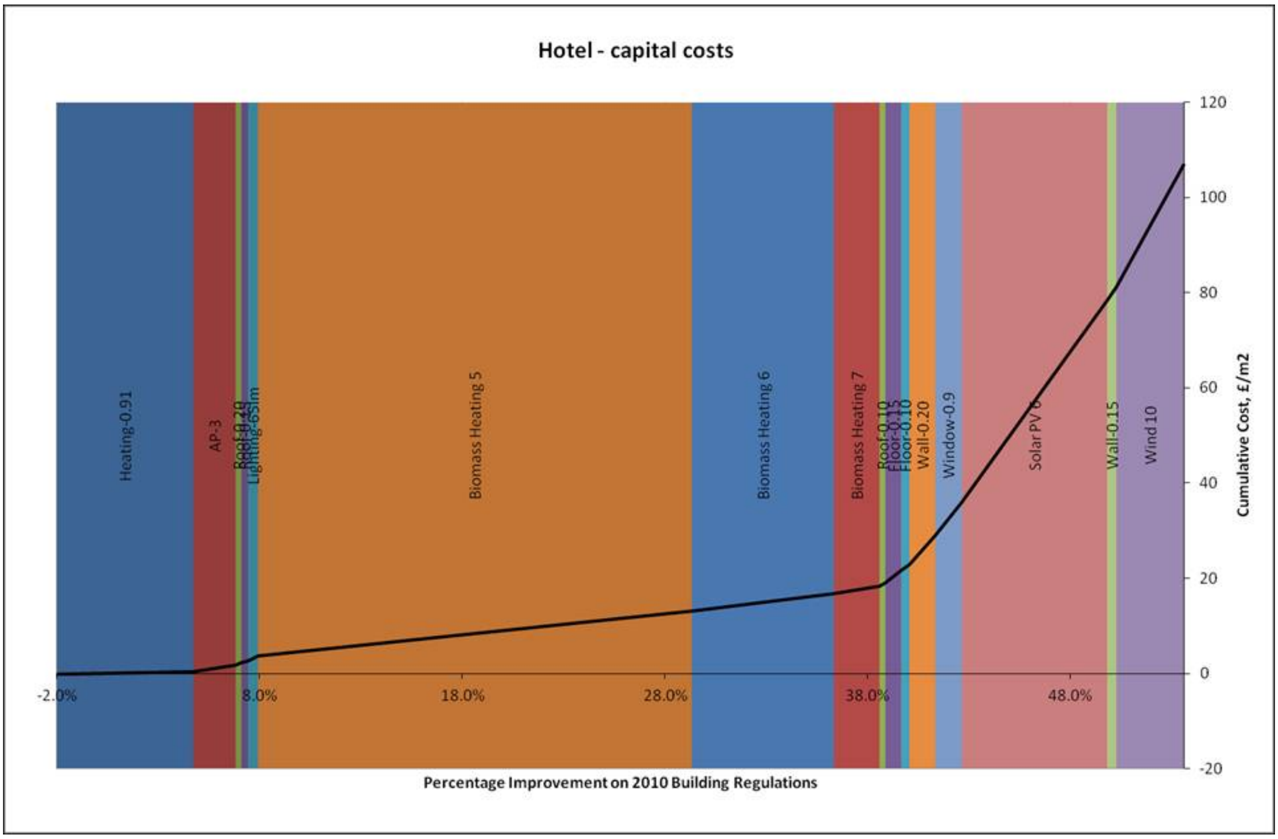
Appendix 4: Cost Curves for New Non-Domestic Property

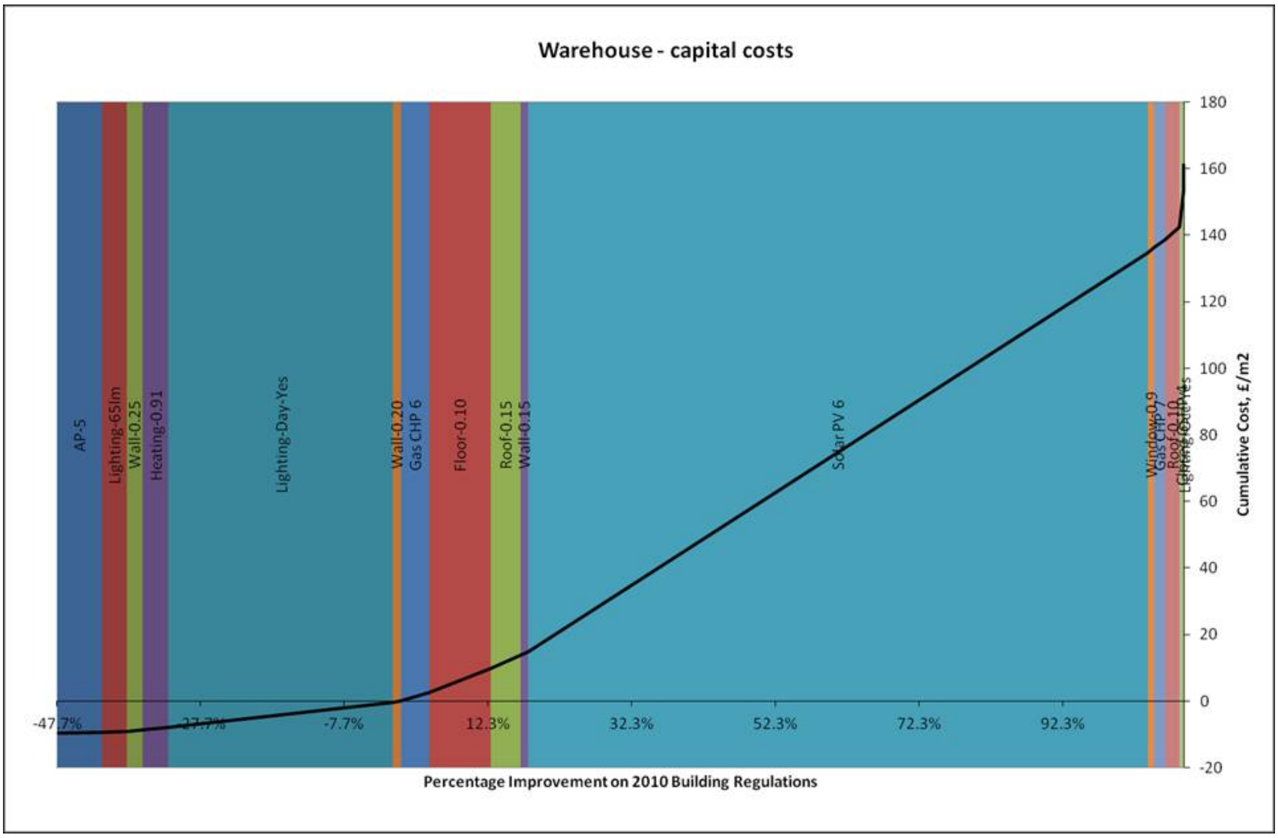
The cost curves in this Appendix represent the higher energy efficiency package. Cost curves for the lower energy efficiency package are available if required.

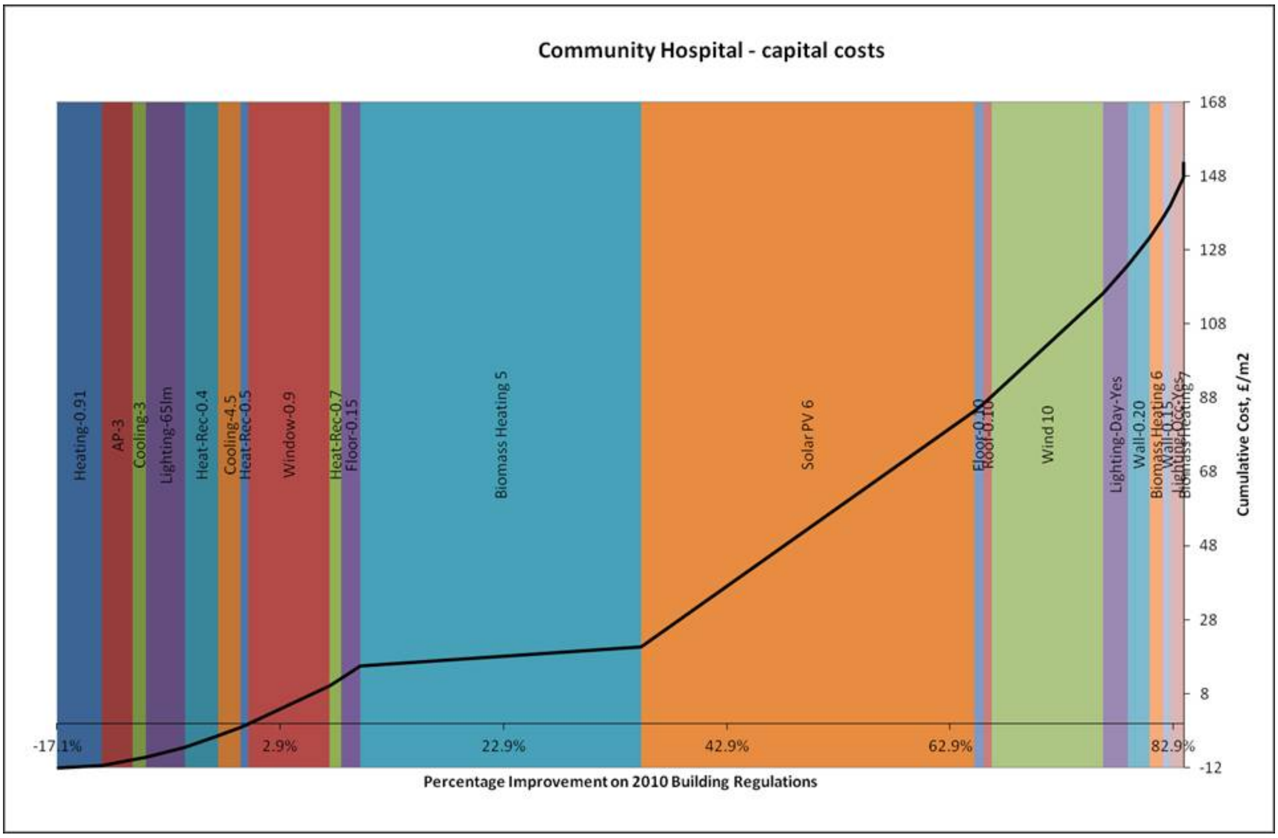
Lifecycle costs curves for the higher and lower energy efficiency packages are also available.

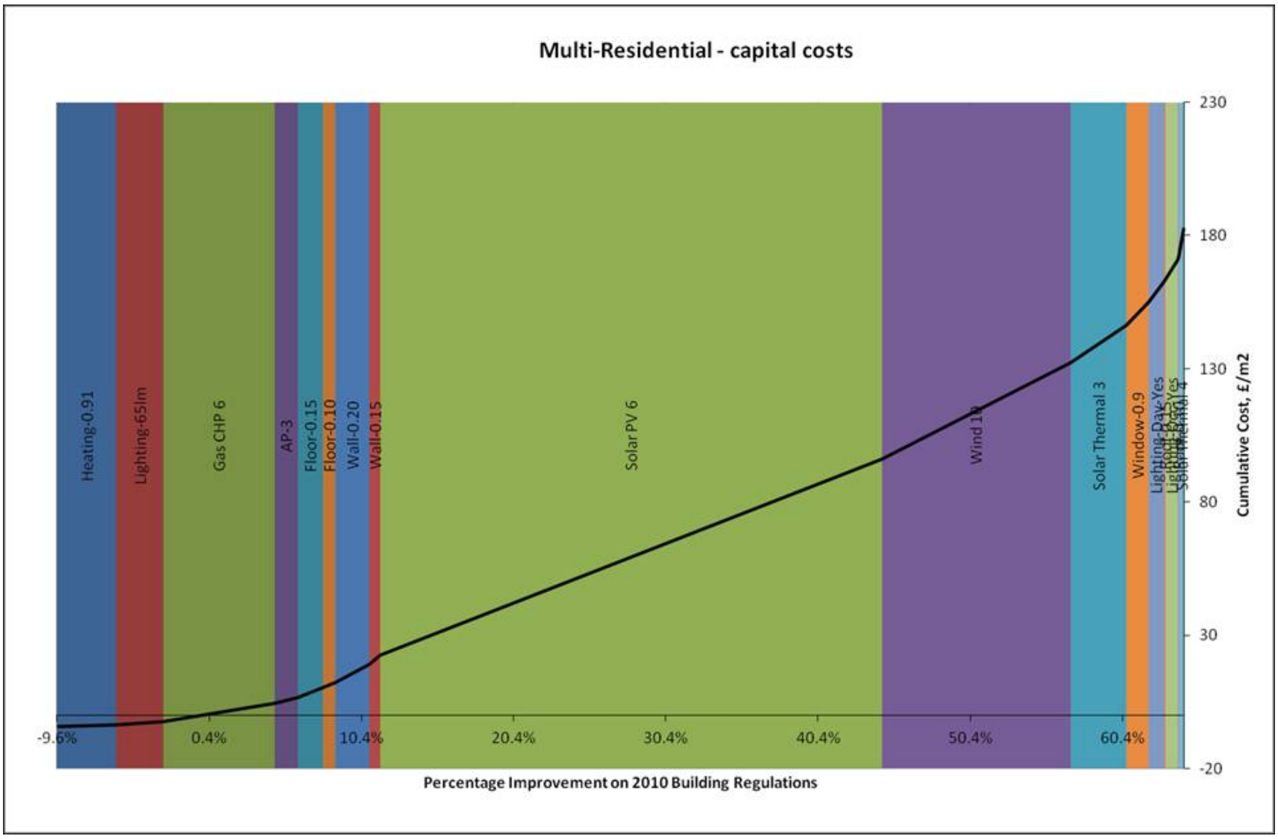


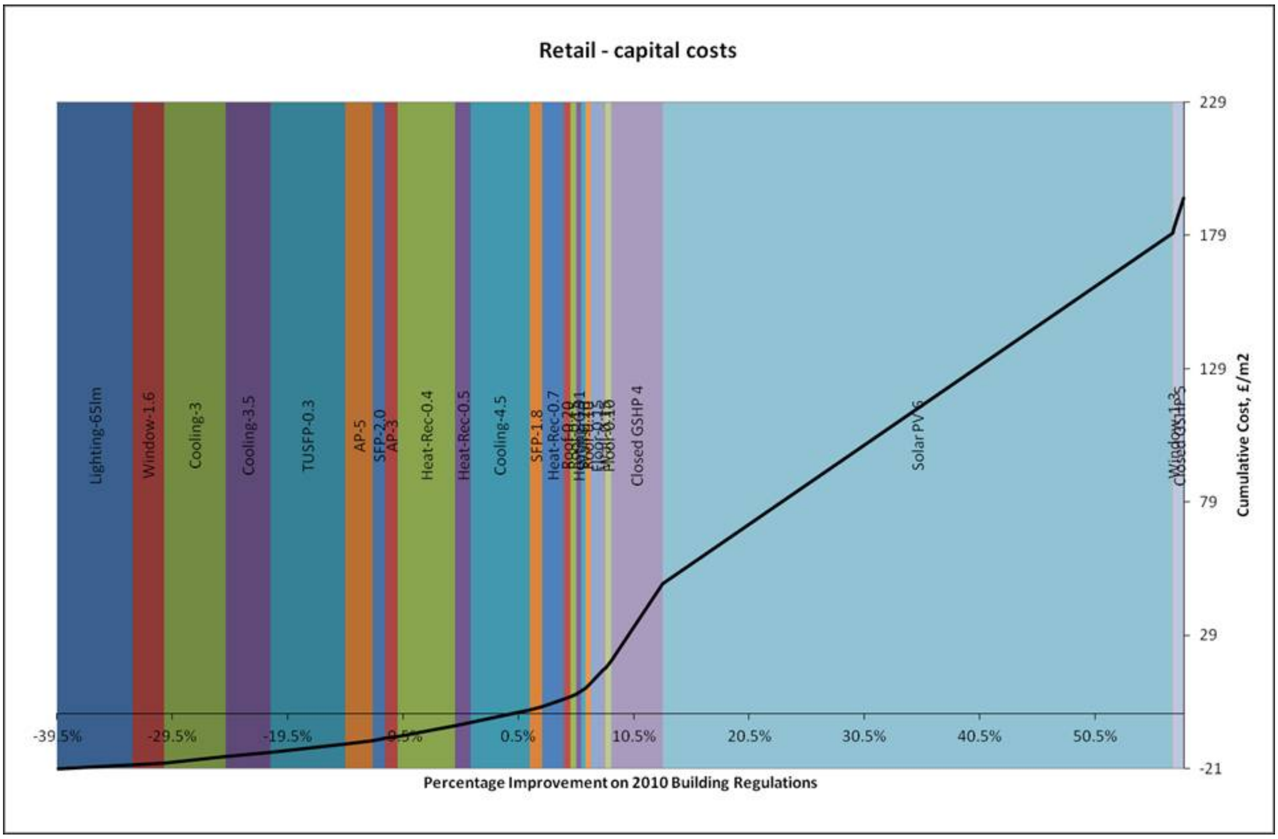

Office - capital costs
TUSFP-0.3
Cooling-3
Cooling-3.5
Window-1.6
AP-3
Lighting-65lm
SFP-2.0
Heating-0.91
Cooling-4.5
Gas CHP 5
SFP-1.8
Lighting-Day-Yes
Roof-0.10
Floor-0.15
Floor-0.10
Wall-0.20
Window-1.3
Wall-0.15
Lighting-Occ-Yes
Solar PV 6
Closed GSHP 4
147
127
107
87
67
47
27
7
-13
-29.6%
-19.6%
-9.6%
0.4%
10.4%
20.4%
30.4%
Percentage Improvement on 2010 Building Regulations
Cumulative Cost, £/m2


Hotel - capital costs
Heating-0.91
AP-3
Roof-0.20
Lighting-65lm
Biomass Heating 5
Biomass Heating 6
Biomass Heating 7
Roof-0.10
Floor-0.15
Floor-0.10
Wall-0.20
Window-0.9
Solar PV 6
Wall-0.15
Wind 10
120
100
80
60
40
20
0
-20
-2.0%
8.0%
18.0%
28.0%
38.0%
48.0%
Percentage Improvement on 2010 Building Regulations
Cumulative Cost, £/m2


Warehouse - capital costs
AP-5
Lighting-65lm
Wall-0.25
Heating-0.91
Lighting-Day-Yes
Wall-0.20
Gas CHP 6
Floor-0.10
Roof-0.15
Wall-0.15
Solar PV 6
Window-0.9
Percentage Improvement on 2010 Building Regulations
Cumulative Cost, £/m2


Community Hospital - capital costs
Heating-0.91
AP-3
Cooling-3
Lighting-65lm
Heat-Rec-0.4
Cooling-4.5
Heat-Rec-0.5
Window-0.9
Heat-Rec-0.7
Floor-0.15
Biomass Heating 5
Solar PV 6
Floor-0.10
Roof-0.10
Wind 10
Lighting-Day-Yes
Wall-0.20
Biomass Heating 6
Wall-0.15
Biomass Heating 7
Percentage Improvement on 2010 Building Regulations
Cumulative Cost, £/m2


Multi-Residential - capital costs
Heating-0.91
Lighting-65lm
Gas CHP 6
AP-3
Floor-0.15
Floor-0.10
Wall-0.20
Wall-0.15
Solar PV 6
Solar Thermal 3
Window-0.9
Percentage Improvement on 2010 Building Regulations
Cumulative Cost, £/m2
-9.6%
0.4%
10.4%
20.4%
30.4%
40.4%
50.4%
60.4%
230
180
130
80
30
-20


Retail - capital costs
Lighting-65lm
Window-1.6
Cooling-3
Cooling-3.5
TUSFP-0.3
AP-5
SFP-2.0
AP-3
Heat-Rec-0.4
Heat-Rec-0.5
Cooling-4.5
SFP-1.8
Heat-Rec-0.7
Closed GSHP 4
Percentage Improvement on 2010 Building Regulations
Cumulative Cost, £/m2
-39.5%
-29.5%
-19.5%
0.5%
10.5%
20.5%
30.5%
40.5%
50.5%
229
179
129
79
29
-21