COST ANALYSIS: MEETING THE ZERO CARBON STANDARD

February 2014

In partnership with

sweett

ZERO CARBON HUB

The Zero Carbon Hub was established in 2008 to support the delivery of Zero Carbon homes from 2016. It is a public / private partnership drawing support from both the Government and the Industry and reports directly to the 2016 Taskforce.

To find out more, or if you would like to contribute to the work of the Zero Carbon Hub, please contact: info@zerocarbonhub.org.

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The Zero Carbon Hub commissioned Sweett Group to provide an update on the estimated costs of building homes to the proposed Zero Carbon Standard.

Sweett Group is a global business with expertise in property and infrastructure professional services. Their services include cost management, programme and project management, strategic advisory and specialist consultancy services.

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FOREWORD

A long-standing goal of the Zero Carbon Hub is to work with experts across the house building sector to recommend energy and carbon standards for Zero Carbon new homes which are both stretching and cost-effective.

For obvious reasons, understanding the costs associated with building Zero Carbon homes has been, and remains, a critical issue for stakeholders. It therefore continues to be a core part of the Hub's programme of work.

The analysis contained in this report, produced for the Hub by Sweett Group, provides an updated assessment of these costs. It reflects, for example, the significant reductions in installed solar PV costs seen in recent years.

What the new analysis shows is that, in many of the scenarios considered, the cost of building to the proposed Zero Carbon Standard has roughly halved since we last published cost estimates in 2011.[1] Furthermore, our projections suggest that costs may continue to fall between 2014 and 2020.

1. Carbon Compliance – Setting an appropriate limit for Zero Carbon new homes, findings and recommendations, February 2011. Annex D – Cost summary table for zero carbon homes. Note that estimated cost reductions since 2011 include changes in the cost of materials and labour and the impact of changes to the definition of a Zero Carbon home, including the exclusion of CO_2 emissions from unregulated energy use.

Park Central, Birmingham
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Acknowledgements

The Zero Carbon Hub and Sweett Group are thankful to the many organisations who provided information for use in this report.

At today's prices, the typical additional cost of building a semi-detached house[1] to the Zero Carbon Standard could be less than £5000.

It is impossible to estimate with absolute precision what the costs could be for every type of house in every scenario. But what we can see clearly is a trend of significant cost reductions over time. In the seven years since the zero carbon policy was first announced by the Government we have seen costs fall by tens of thousands of pounds.

However, even though costs are falling, we must also recognise that the house building industry is in a fragile period of recovery. Industry will need to continue to innovate and to evolve in order to keep prices as low as possible. The final Zero Carbon Standard implemented by the Government in 2016 must be both stretching and capable of being delivered in a cost-effective manner.

Building the high quality, highly efficient, low carbon homes of the future comes at a cost. Accepting this, one of the Hub's next tasks on the journey to zero carbon must be to support industry in demonstrating the value of such homes to their customers.[2]

ROB PANNELL
Managing Director, Zero Carbon Hub
January 2014

1. A semi-detached house is assumed to be 76m².

2. For example, the NHBC Foundation and the Zero Carbon Hub have produced a new infographic which demonstrates the significant fuel bill cost savings consumers can expect in new build homes compared to Victorian properties.

KEY FINDINGS

The Zero Carbon Hub previously commissioned Sweett Group to assess the costs[1] of building housing to the Zero Carbon Standard in 2010, as part of the development of recommendations for the level at which on-site carbon savings should be set.[2]

Both the costs of the required materials and technologies and the detail of the compliance standard have evolved in the intervening period.[3]

This report provides an updated snapshot of the costs associated with meeting the current proposals for the minimum Fabric Energy Efficiency Standard (FEES), Carbon Compliance and Allowable Solutions for Zero Carbon detached, semi-detached and mid-terraced housing, and for low-rise apartment blocks. The report includes a review of the construction costs for each house type and incorporates current proposals for Allowable Solutions.[4]

1. In this report references to 'costs' means the 'additional cost' associated with building to the Zero Carbon Standard compared to 2010 or 2013 Building Regulations standards.

2. Zero Carbon Hub, Carbon Compliance: setting an appropriate limit for zero carbon new homes – findings and recommendations, February 2011.

3. For example, it is now no longer necessary to address carbon emissions associated with unregulated energy use (e.g. cooking and appliances) to meet the Zero Carbon Standard.

4. The Allowable Solutions cost assumptions in this report are based on the maximum 'capped' price for the Central scenario taken from DCLG's Allowable Solutions Consultation (Aug 2013). In practice it may be possible to secure Allowable Solutions at lower cost.

Key findings

- Our analysis shows a continuing reduction in the cost of meeting the Zero Carbon Standard for homes, with particular reductions seen in the cost estimates for the solar PV, air tightness and thermal bridging components.
- The following cost allowances are considered to be reasonable for achieving the proposed Zero Carbon Standard:[1]
  - Detached homes = **~£6,700-7,500**
  - Semi-detached and mid-terraced properties = **~£3,700-4,700**
  - Apartments (low-rise) = **~£2,200-2,400**
- It is likely that the relative costs of meeting the Standard for each house type will reduce further between 2014 and 2016 and continue to fall through to 2020.[2] For a detached house this might mean additional costs[3] in 2020 of ~£5,700-6,300 per home, and for semi-detached and mid-terraced homes costs could be around £2,900-3,600 per home. For low-rise apartments costs could be between £1,900-2,000 per home.

The findings highlighted above emphasise the assumed lowest capital cost options for meeting the proposed Zero Carbon Standard, which involves the use of solar PV as a significant carbon reduction technology.

Alternative compliance routes that place greater emphasis on improved thermal performance and require less solar PV (or the use of an alternative carbon saving technology) are possible and for comparison are estimated to be more expensive than a 'FEES, efficient gas boiler, PV and Allowable Solutions' based approach (i.e. Scenario 1)[4]. The cost premium associated with 'Advanced' (close to PassivHaus) energy efficiency scenarios is likely to reduce in the future, however it is unlikely that it will outstrip the cost reductions projected for solar PV and therefore it is assumed to continue to be a more expensive option in terms of capital costs.[5]

1. Estimated additional costs of building to the proposed Zero Carbon Standard compared to Part L1A 2013.

2. Absolute costs may increase as a result of construction inflation; however it is projected that the likely percentage increase in costs associated with the Zero Carbon Standard will be lower in 2016 and 2020 than in 2013.

3. In 2013 prices, compared to Part L1A 2013.

4. Cost estimates for scenarios 2 to 8 are the costs associated with building above the Part L1A 2010 standard. The Hub intends to provide additional estimates against the 2013 standard in due course.

5. It is difficult to be definitive about future costs of different technologies, however it is assumed that there is likely to be greater scope for efficiency improvements and associated cost reductions with PV technologies than in insulation or window products where raw material costs are a more significant cost driver.

Centenary Quay, Woolston
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Table 1 below shows the central cost estimates for each element of the Zero Carbon Standard definition for each of the four house types analysed. The estimates are for 'Scenario 1': achieving the Standard through FEES, a highly efficient gas boiler, use of solar PV, and Allowable Solutions.[1]

Table 1.

Cost above Part L1A **2013** for achieving the Zero Carbon Standard for different house types via the assumed lowest cost route to compliance (Scenario 1 FEES + Efficient gas boiler + PV + AS)

ELEMENT	DETACHED HOUSE	SEMI-DETACHED HOUSE	MID-TERRACED HOUSE	LOW-RISE APARTMENT
PER HOME				
FEES	£1,728	£61	-£76	-£32
Heating and LZC technology	£3,270	£2,824	£2,477	£978
Carbon Compliance	£4,998	£2,885	£2,401	£947
Allowable Solutions	£2,118	£1,504	£1,508	£1,375
Total (central)	**£7,116**	**£4,389**	**£3,910**	**£2,322**
Range	**£6,700 - £7,500**	**£4,100 - £4,700**	**£3,700 - £4,200**	**£2,200 - £2,400**
PER M^2 [2]				
FEES	£15	£1	-£1	£0
Heating and LZC technology	£28	£37	£32	£18
Carbon Compliance	£42	£38	£31	£18
Allowable Solutions	£18	£20	£20	£25
Total (central)	**£60**	**£58**	**£51**	**£43**
Range	**£57 - £64**	**£54 - £62**	**£48 - £55**	**£42 - £44**

1. See page 20 for a list of all eight scenarios considered.

2. Due to rounding, the M^2 costs do not multiply exactly to generate the estimated cost per house type.

INTRODUCTION

The Zero Carbon Hub previously commissioned Sweett Group to assess the costs[1] of building housing to the Zero Carbon Standard in 2010, as part of the development of recommendations for the level at which on-site carbon savings should be set.[2]

Both the costs of the required materials and technologies and the detail of the compliance standard have evolved in the intervening period.[3]

This report provides an updated snapshot of the estimated costs associated with meeting the current proposals for the minimum Fabric Energy Efficiency Standard (FEES), Carbon Compliance and Allowable Solutions for Zero Carbon detached, semi-detached and mid-terraced housing and for low-rise apartment blocks. For a summary of the Zero Carbon definition see Figure 1.

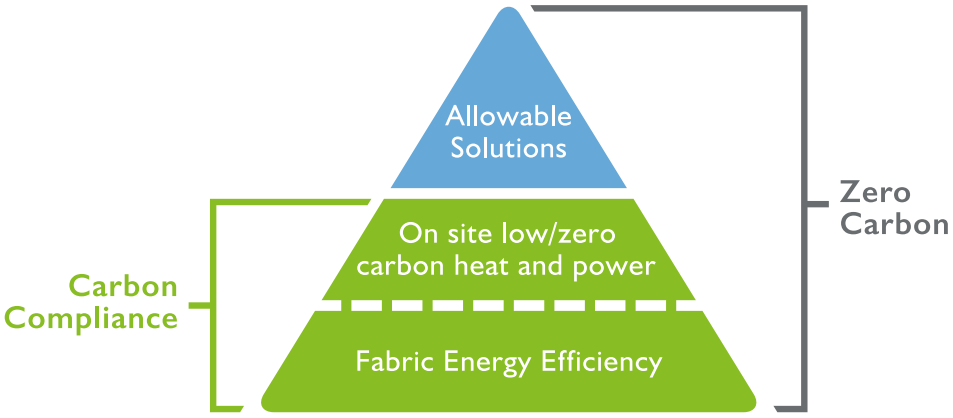
1. In this report references to 'costs' means the 'additional cost' associated with building to the Zero Carbon Standard compared to 2010 or 2013 Building Regulations standards.

2. Zero Carbon Hub, Carbon Compliance: setting an appropriate limit for zero carbon new homes – findings and recommendations, February 2011 (see Appendix E).

3. For example, it is now no longer necessary to address carbon emissions associated with unregulated energy use (e.g. cooking and appliances) to meet the zero carbon standard.

The analysis uses the same model house types, energy analysis methodology and low carbon technology options used in the previous study. However, it includes updated cost information and slightly different technical solutions for achieving the required energy efficiency standards, and so, although the analysis is broadly comparable with that previously provided, direct 'pound for pound' comparisons should not be made.[1]

Figure 1. **The three parts of the Government's stepped policy approach to Zero Carbon Homes**



Summary of the key elements of the review

The Zero Carbon Hub's previous cost study in 2011 has been used as the starting point for this analysis. It has been updated to include:

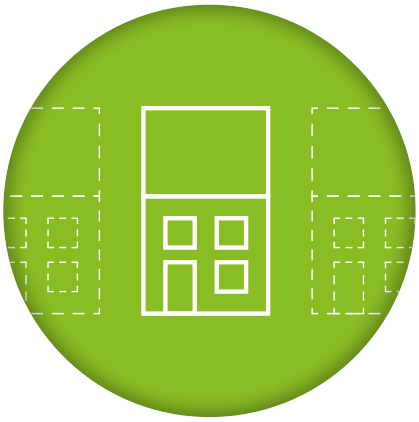
- New analysis on additional costs associated with building to the Zero Carbon Standard in comparison to the requirements of Part L1A 2013, as well as 2010. Much of the analysis is based on a comparison with the current regulations (Part L1A 2010) as, at the time of commissioning the analysis, Part L1A 2013 had not been published. Costs above Part L1A 2013 are shown for the assumed lowest cost solution only (Scenario 1);
- A revised approach to calculating the costs associated with FEES so that the cost base and specifications are consistent with assumptions used to inform the development of Building Regulations Part L1A 2013 and the accompanying Impact Assessment;
- Updated costs to 2013 prices (Quarter 2), including adjusting overall pricing assumptions and reviewing and updating of price information for the following key technologies (see Appendix B for further detail):
  - Air Source Heat Pumps (ASHPs)
  - Photovoltaic (PV) arrays
  - Solar hot water (SHW) systems

1. The study uses different assumptions about the baseline costs of meeting Part L1A 2010 standards for which very limited information from practical experience was available at the time of the previous study.

- A review and refinement of assumptions around thermal bridging and air tightness solutions and associated costs (building on work undertaken by Zero Carbon Hub, AECOM and Richards Partington Architects);[1]
- Updated assumptions on future cost trends through to 2020.

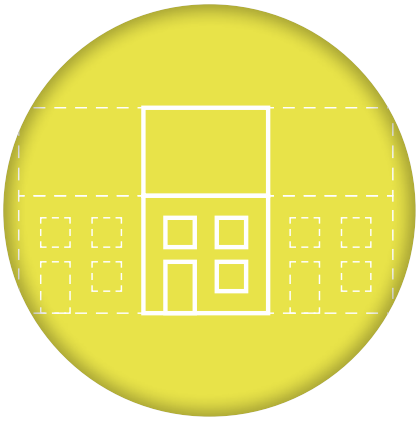
Modelled house types

Four benchmark properties have been used consistently within the Hub's work to help assess the costs and practicality of building to the Zero Carbon Standard. These comprise:

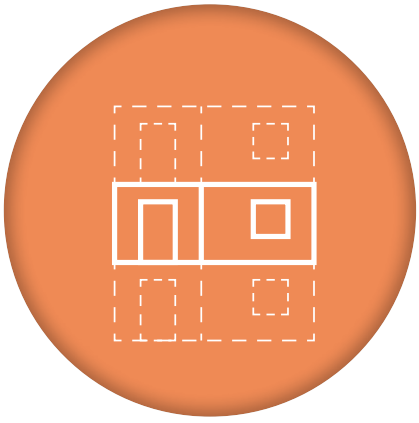


Detached houses
118 m²

End terrace / semi-detached houses
76 m²



Mid terrace houses
76 m²



Apartments (low-rise)[2]
Average floor area 56.5 m²

1. The revised approach incorporates fresh assumptions about the nature of the work required to achieve higher performance standards and whether accounting for these costs separately to the base materials costs results in double counting. The review also identified that air-tightness standards of around 5m3/m²/hr are being achieved routinely for well managed sites without additional costs being incurred.

2. Apartments were modelled on the basis of an equal number of one-bed (43 m²) and two-bed (66 m²) units per floor.

Scope and basis of the analysis

The costs presented in this report are indicative and are based on analysis of four representative house types. The costs of a range of fabric and technologies options were determined for each house type and house specifications developed to meet Part L1A 2010, 2013 and the proposed Zero Carbon Standard. The costs of achieving the Zero Carbon standard are based on the cumulative costs of meeting the FEES or 'Advanced Practice' energy efficiency requirements, together with a heating and/or low or Zero Carbon energy source sufficient to achieve Carbon Compliance and an allowance for Allowable Solutions to address the remainder of regulated carbon emissions.

The actual costs experienced by developers will be influenced by a wide range of other factors including:

- **Location** – construction prices are typically higher in London and the South-East of England;
- **Inflation and wider economic conditions** – the presented costs are for Q2 2013. The costs experienced in the future will be influenced by a great many economic factors operating at local, national and global scales;
- **Design and size** – the required specifications and associated costs for each house type will vary with the design (e.g. presence of integral garages) and the size of the property;
- **Developer size and supply chain** – due to their buying power and defined supply chain, larger developers can typically achieve lower material costs than smaller builders.

The estimated costs include the following elements:

- Materials and labour;
- Allowances for preliminaries (~12%), overheads and profit (~4%) and contingency (~5%);
- Any associated works (e.g. extending scaffold hire);
- Impacts on other development costs (e.g. increased foundation costs, and removal of combi-boilers and installation of conventional condensing boilers and dual coil hot water cylinders to support SHW systems).

The cost estimates presented in this report are considered representative of typical medium and large developers who are assumed to have established supply chain management processes. The analysis assumes a traditional construction method (e.g. brick and block) and a standard market housing specification. These costs may be of interest to, but are not necessarily reflective of, the costs likely to be incurred by self builders or developers of very large or high specification homes.

ACHIEVING THE ZERO CARBON STANDARD

To meet the Zero Carbon Hub's Zero Carbon Standard,[1] each home needs to meet minimum standards for fabric performance (FEES), on-site carbon abatement (Carbon Compliance) and then achieve zero carbon emissions from regulated energy use[2] which is expected to be achieved via the use of Allowable Solutions.

1. The final Standard will be determined by the Government for implementation in 2016.

2. Emissions of 0 kg CO_2 per m^2 as modelled in SAP.

The proposed performance standards are shown in Table 2.

Table 2.
Elements of the Zero Carbon Standard for homes

HOUSE TYPE	FABRIC ENERGY EFFICIENCY STANDARD (FEES)	CARBON COMPLIANCE STANDARD[1]	OVERALL ZERO CARBON STANDARD
Detached	46 kWh/m^2/year	10kg CO_2/m^2/year	0kg CO_2/m^2/year
Semi-detached	46 kWh/m^2/year	11kg CO_2/m^2/year	0kg CO_2/m^2/year
Mid-terraced	39 kWh/m^2/year	11kg CO_2/m^2/year	0kg CO_2/m^2/year
Apartments (low-rise)	39 kWh/m^2/year	14 kg CO_2/m^2/year	0kg CO_2/m^2/year

In this analysis, options for exceeding either the FEES or Carbon Compliance standards were considered either by a) investing in a higher standard of energy efficiency termed 'Advanced energy efficiency' or b) making greater use of low or zero carbon (LZC) sources of heating or energy generation on-site. Exceeding the FEES results in potentially less need for investment in LZCs whilst exceeding the Carbon Compliance standard would result in a reduced need to purchase or undertake Allowable Solutions.

Fabric Energy efficiency (FEES)

Achieving the minimum standard for fabric energy efficiency is a key first stage in meeting the Zero Carbon Standard. The fabric energy efficiency of a home is determined by the annual space heating and cooling demand in kWh per m^2, assessed using the Standard Assessment Procedure (SAP).[2]

In this study two levels of energy efficiency were considered, the minimum requirement (i.e. a specification that is 'FEES compliant' and an 'Advanced' practice standard that incorporates higher performing elements.[3] The advanced practice standard exceeds the minimum requirement for the FEES, but is still considered as a potential option because the additional reduction in energy demand will help to reduce the home's on-site CO_2 emissions and therefore contribute to the achievement of Carbon Compliance.

1. Calculated using 2016 CO_2 emission factors.

2. Including the specific requirements of SAP Section 11.

3. See Appendix A for details of the specifications used for each Standard.

On-site Low and Zero carbon heating or energy generation options

Beyond complying with a minimum level of fabric energy efficiency, the Zero Carbon Standard requires a specific level of on-site CO_2 emissions to be achieved. This is termed 'Carbon Compliance' and is again calculated using SAP.[1] Even very energy efficient homes will require some form of heating system, for space heating and hot water, and will use electricity for lighting and other building services (e.g. pumps and fans).

Generally speaking, the more energy efficient a home is, the lower its carbon emissions because less energy has to be supplied to the home to maintain the required internal conditions. However, the Dwelling CO_2 Emission Rate (i.e. the kg CO_2 per m^2 per year as calculated in SAP) is determined by a combination of the energy requirement, the efficiency by which this energy is supplied and the type of fuel used to provide the energy (e.g. grid electricity, gas, solar, wind, biomass).

A wide range of technical solutions exist for providing heat and power to homes, including efficient gas boilers, photovoltaic panels, solar hot water systems, biomass heating, air and ground source heat pumps, micro Combined Heat and Power units and larger shared or community scale solutions. Rather than re-assess each option in detail, this study focuses on those technologies that were shown to be most widely applicable and to represent the lower cost options in the 2011 analysis,[2] namely highly efficient gas boilers, PV panels, solar hot water systems and air source heat pumps.

A solar hot water system can be used in combination with either the gas boiler or ASHP option, however when used in scenarios with apartment blocks it was assumed that a **centralised system with a communal boiler and thermal store would be required**.

PV can be used in combination with any other technology, however in line with the previous 2011 analysis, it was assumed that for most properties the area that could potentially be used for PV would be no more than 40% of the ground floor area of the dwelling.[3]

1. In conceptual terms Carbon Compliance is equivalent to the Target Emissions Rate (TER), but set at a more demanding level than current standards.

2. Other options might be applicable for specific projects, for example for particularly large homes or for larger, higher density, developments where shared systems might be suitable.

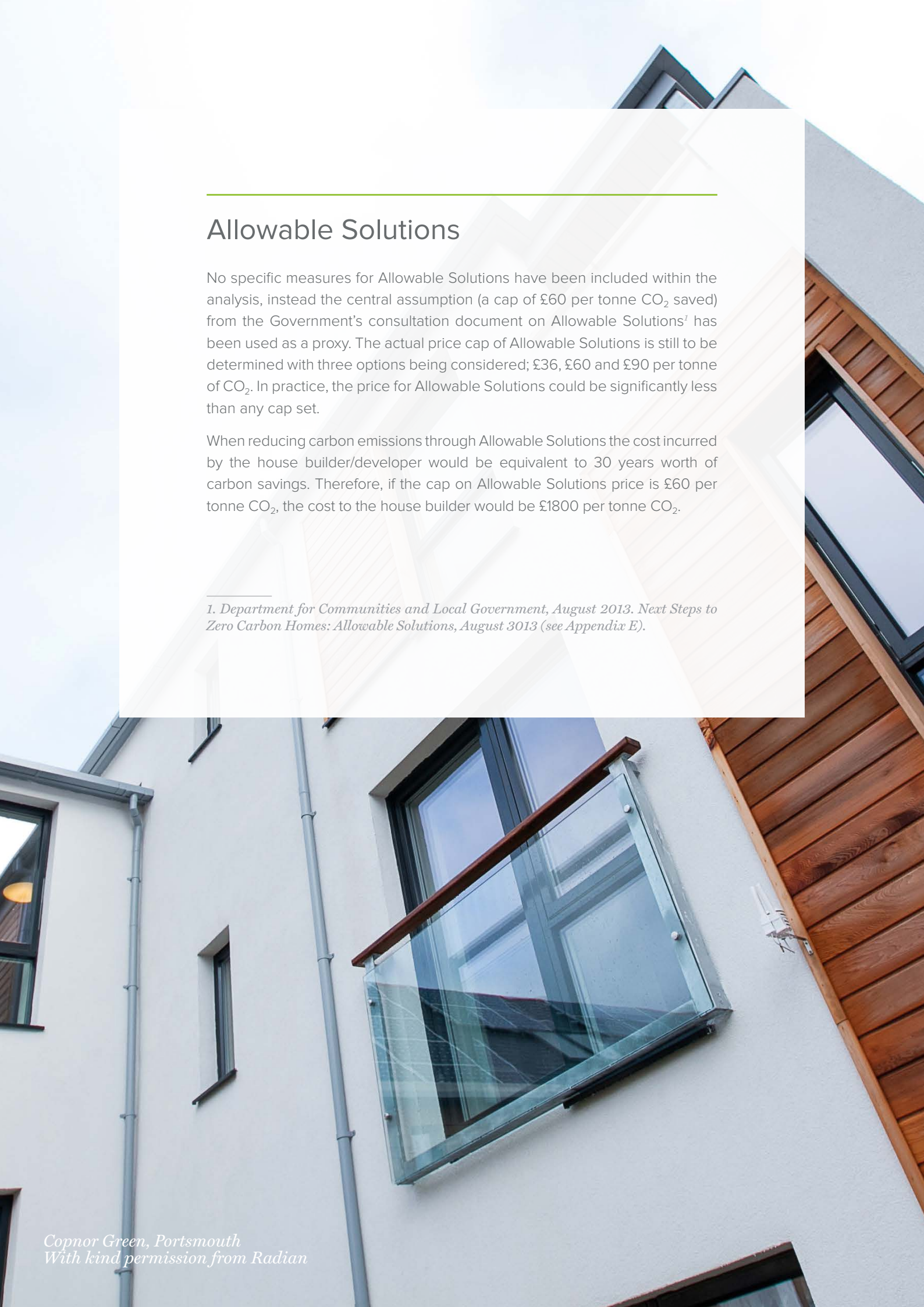
3. This threshold was selected on the basis that greater use of PV might necessitate design, master-planning or other changes to a development.

Allowable Solutions

No specific measures for Allowable Solutions have been included within the analysis, instead the central assumption (a cap of £60 per tonne CO_2 saved) from the Government's consultation document on Allowable Solutions[1] has been used as a proxy. The actual price cap of Allowable Solutions is still to be determined with three options being considered; £36, £60 and £90 per tonne of CO_2. In practice, the price for Allowable Solutions could be significantly less than any cap set.

When reducing carbon emissions through Allowable Solutions the cost incurred by the house builder/developer would be equivalent to 30 years worth of carbon savings. Therefore, if the cap on Allowable Solutions price is £60 per tonne CO_2, the cost to the house builder would be £1800 per tonne CO_2.

1. Department for Communities and Local Government, August 2013. Next Steps to Zero Carbon Homes: Allowable Solutions, August 3013 (see Appendix E).



Copnor Green, Portsmouth
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COST ANALYSIS

Estimated additional costs of building homes to the Zero Carbon Standard.

Summary of key changes

With a few notable exceptions, the relative costs of most of the materials and technologies required to achieve FEES and Carbon Compliance have changed relatively little since these were last assessed in 2011[1]. Key exceptions include:

- **PV** – costs have continued to decline with organisations identifying costs as low as £1,400-1,600 per kWp for installations of around 2-3kWp, although there is still variability in the costs experienced. These figures are in marked contrast to the typical figures experienced by the industry in late 2010 which were between £3,800-4,000 per kWp (albeit even then some developers were able to install PV less expensively);[2]
- **ASHPs** – with costs per unit declining by around 10% since 2011;
- **Thermal bridging** – increased understanding of the approaches and costs of achieving lower Psi values for thermal bridges has resulted in a significant reduction in the associated cost estimates (by circa £700 per home for a detached house).

1. The underlying costs of materials continue to fluctuate and the current increase in demand compared to previous years has had the impact of increasing material costs for some products. This situation is broadly applicable to house building costs in general and is not specifically linked to the materials or technologies necessary for zero carbon homes. All costs have been 're-based' to Q2 2013 prices.

2. See Appendix B for PV cost assumptions used in this report.

Of the changes outlined, the cost of PV is the most significant in impacting the overall costs of meeting the Zero Carbon Standard.

It is important to note that due to changes in the Zero Carbon Standard since the 2011 study, the proportion of the overall cost attributable to Carbon Compliance is now larger. This is mainly because of changes in the definition: that it excludes unregulated energy use and associated emissions.[3] As a result, the amount of Allowable Solutions required to achieve the Zero Carbon Standard has reduced significantly. Changes in the expected cost of Allowable Solutions have also impacted the associated costs.

Updated cost estimates

In line with the 2011 analysis, we assume that the most cost-effective means of achieving the Zero Carbon Standard is still the combination of FEES, a highly efficient gas boiler, PV and Allowable Solutions.

Estimates of the additional costs of meeting the Zero Carbon Standard over Part L1A 2010 are in the range of £8,500-9,500 for a detached house and £4,100-5,100 for semi-detached and mid-terraced houses. For apartments, costs are lower at £2,300-£2,500.

Estimates against the new Part L1A 2013 suggest that the additional costs of meeting the Zero Carbon Standard are typically lower, reflecting the higher energy efficiency baseline. Costs are in the range of £6,700-7,500 for detached houses and £3,700-4,700 for semi-detached and mid-terraced houses. The cost estimates for apartments is unchanged because the impacts of Part L 2013 above the 2010 standard are small (typically only a marginal improvement in air tightness).

Costs per m^2 internal floor area are markedly lower for low-rise apartments reflecting a) the reduced need for additional investment in building fabric and b) the reduced costs associated with PV because of the relatively larger size of the arrays on apartment blocks in comparison to houses. Costs per m^2 are higher for detached properties because of the greater extent of external envelop per m^2 internal area. The higher surface area to volume ratio results in the need for higher performance standards, e.g. an external wall U-value of 0.15 W/m^2K, and in the requirement to apply these to a proportionally greater area.

The additional costs in comparison to Part L1A 2010 are shown in Table 3 and Figure 2 and the additional costs in comparison to Part L1A 2013 are shown in Table 4 and Figure 3.

3. As announced in the 2011 Budget.

Table 3.

Cost above Part L1A **2010** for achieving the Zero Carbon Standard for different house types via the assumed lowest cost route to compliance (Scenario 1 FEES + Efficient gas boiler + PV + AS)

ELEMENT	DETACHED HOUSE	SEMI-DETACHED HOUSE	MID-TERRACED HOUSE	LOW-RISE APARTMENT
PER HOME				
FEES	£3,632	£439	£374	£0
Heating and LZC technology	£3,270	£2,824	£2,477	£978
Carbon Compliance	£6,902	£3,263	£2,851	£978
Allowable Solutions	£2,118	£1,504	£1,508	£1,375
Total (central)	**£9,020**	**£4,767**	**£4,360**	**£2,353**
Range	**£8,500 - £9,500**	**£4,500 - £5,100**	**£4,100 - £4,600**	**£2,300 - £2,500**
PER M^2				
FEES	£31	£6	£5	£0
Heating and LZC technology	£28	£37	£32	£18
Carbon Compliance	£59	£43	£37	£18
Allowable Solutions	£18	£20	£20	£25
Total (central)	**£76**	**£62**	**£57**	**£43**
Range	**£72 - £81**	**£59 - £67**	**£54 - £60**	**£42 - £46**

Figure 2.

Cost above Part L1A **2010** for achieving the Zero Carbon Standard for different house types via lowest cost route (Scenario 1 FEES + Efficient gas boiler + PV + AS)

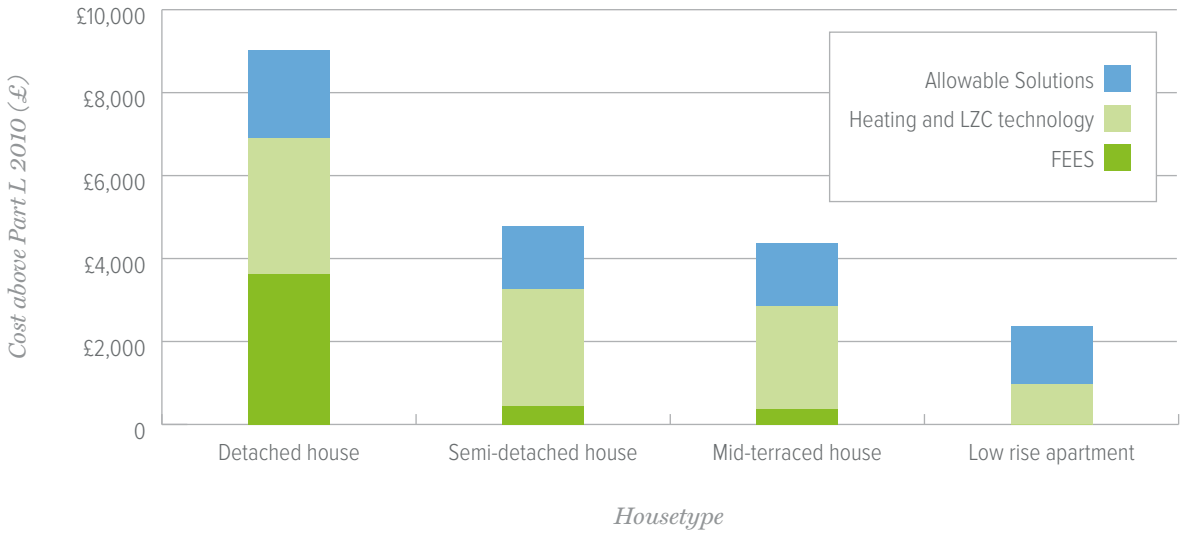

Table 4.

Cost above Part L1A **2013** for achieving the Zero Carbon Standard for different house types via lowest cost route (Scenario 1 FEES + Efficient gas boiler + PV + AS)

ELEMENT	DETACHED HOUSE	SEMI-DETACHED HOUSE	MID-TERRACED HOUSE	LOW-RISE APARTMENT
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FEES	£1,728	£61	-£76	-£32
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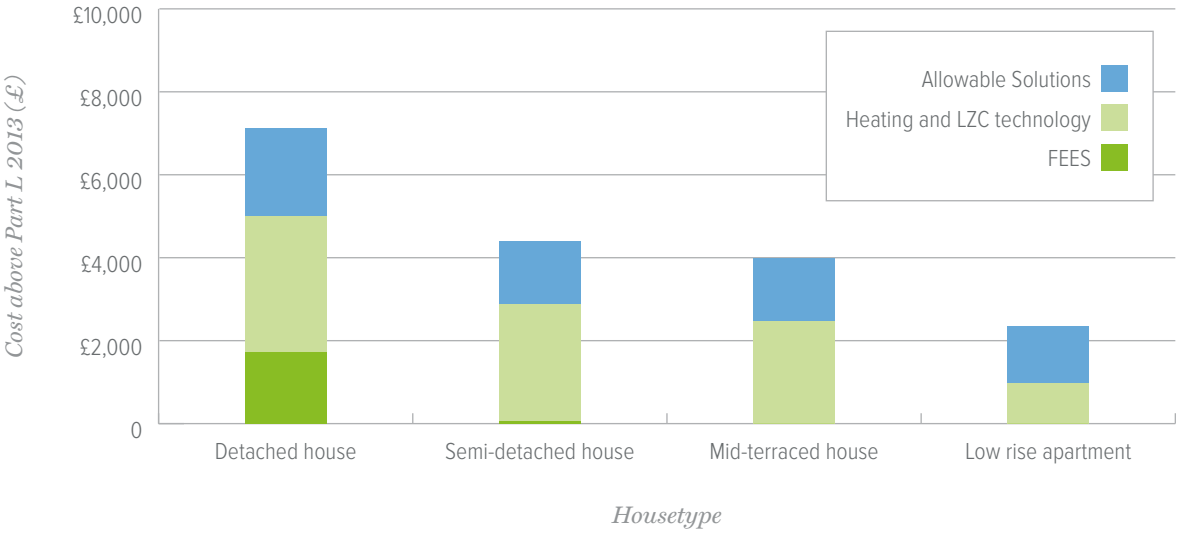
Total (central)	**£60**	**£58**	**£51**	**£43**
Range	**£57 - £64**	**£54 - £62**	**£48 - £55**	**£42 - £44**

This analysis shows that compliance costs are still heavily influenced by PV; the potential impact of future changes in PV and other costs is explored further in Section 4.

Figure 3.

Cost above Part L1A **2013** for achieving the Zero Carbon Standard for different house types via lowest cost route (Scenario 1 FEES + Efficient gas boiler + PV + AS)



COSTS FOR DIFFERENT COMPLIANCE STRATEGIES

Eight different compliance scenarios have been considered, comprising two levels of fabric energy efficiency (FEES and 'advanced' practice), together with four combinations of different heating technologies and PV. [1]

The fabric specifications used in the analysis are described in Appendix A.

1. All cost estimates in this Chapter are the costs associated with meeting the Zero Carbon Standard above Part L1A 2010.

Modelled Carbon Compliance scenarios

The following combinations of energy efficiency standard, heating technology, PV and Allowable Solutions were modelled to assess the differing costs of meeting the Zero Carbon Standard for homes via different compliance routes.

KEY

- FEES — Fabric Energy Efficiency Standard
- ASHP — Air Source Heat Pump
- PV — Solar Photovoltaics
- SHW — Solar Hot Water
- AS — Allowable Solutions

Scenario 1	FEES + Efficient gas boiler + PV + AS
Scenario 2	FEES + Efficient gas boiler + SHW + PV + AS
Scenario 3	FEES + ASHP + PV + AS
Scenario 4	FEES + ASHP + SHW + PV + AS
Scenario 5	Advanced energy efficiency + Efficient gas boiler + PV + AS
Scenario 6	Advanced energy efficiency + Efficient gas boiler + SHW + PV + AS
Scenario 7	Advanced energy efficiency + ASHP + PV + AS
Scenario 8	Advanced energy efficiency + ASHP + SHW + PV + AS

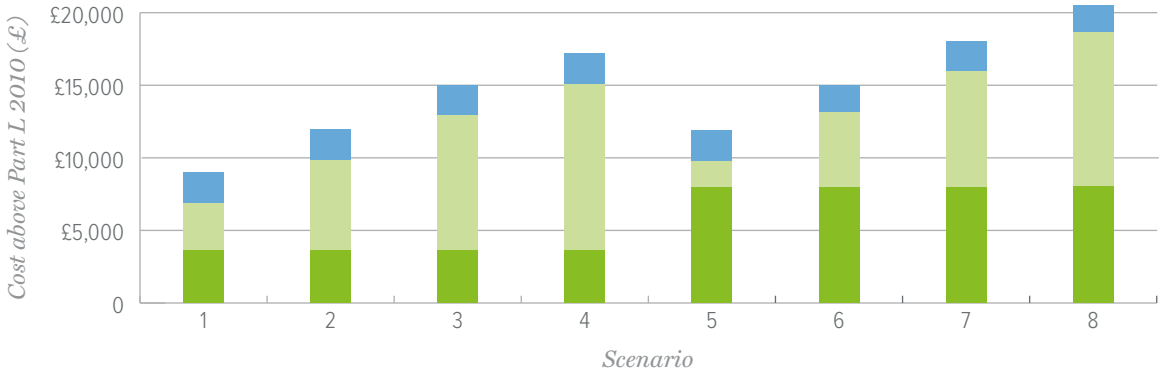
Each scenario uses the central assumption for Allowable Solutions of a cap of £60 per tonne CO_2 saved (for 30 years, which equates to a maximum capital cost of £1.80 per kg CO_2 saved). In all instances the assumption is that the cost of buying Allowable Solutions will be significantly lower than LZC options, and so it is assumed that developers will not install more LZCs (i.e. PV in Scenario 1) than is necessary to achieve the Carbon Compliance standard. The exception to this is where the combination of technologies used would result in very little PV being required to achieve the Carbon Compliance standard (e.g. for Scenario 5 - Advanced energy efficiency, with highly efficient gas boiler, PV and Allowable Solutions). In these instances a minimum of 0.5 kWp of PV has been added as this reflects a reasonable minimum installation size. In these instances the quantity of Allowable Solutions required, and the associated is reduced to reflect that the LZC's selected exceed the requirements of the carbon Compliance standard.

Figure 4 shows the costs associated with achieving the Zero Carbon Standard for each house type against the Part L1A 2010 standard, using the range of compliance strategies. For a more detailed breakdown of the costs, see Appendix C.

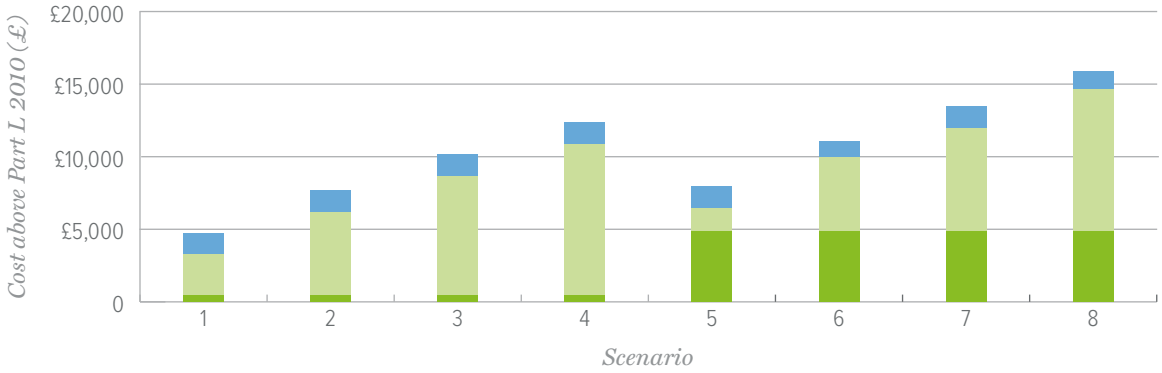
Figure 4.

Additional costs for Zero Carbon homes above **2010** Part L1A

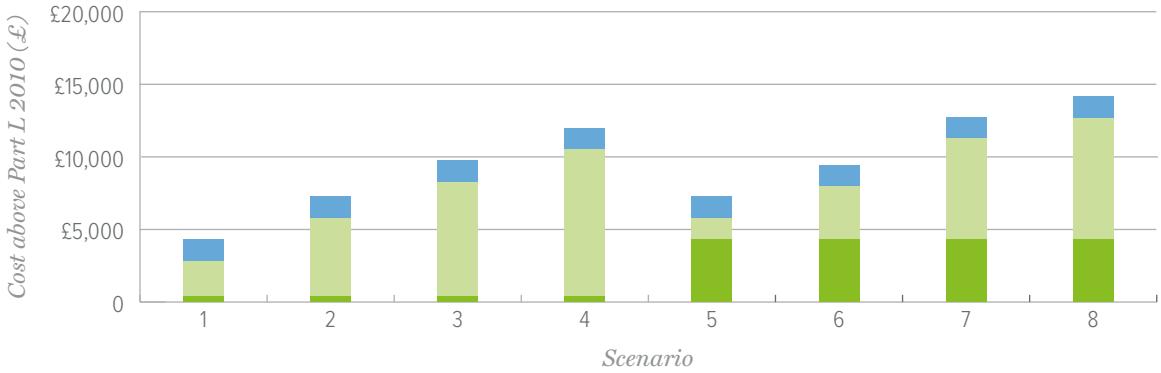
DETACHED HOUSE



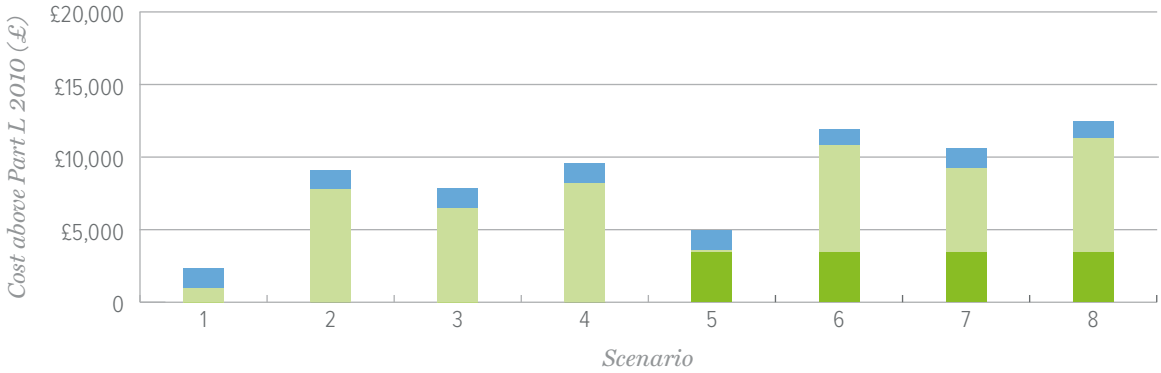
SEMI-DETACHED



MID-TERRACED



LOW-RISE APARTMENT



ESTIMATE OF FUTURE COSTS

The estimated costs of meeting the Zero Carbon Standard for homes have reduced consistently since first estimated in 2006/7 (when costs were as high as £15,000-40,000 per home, depending on the house type and compliance strategy).

This is in part due to changes in the definition itself, for example, the introduction of Allowable Solutions and the exclusion of any requirement to address carbon emissions from unregulated energy uses. However, a significant influence on the lower cost estimates is the continuing reductions in the cost of key technologies. The most high profile and significant example is the cost of PV, however other technologies such as ASHPs and higher performance glazing have also reduced in cost, albeit less dramatically.

To estimate how costs may change between 2014 and 2020, future trends in the prices of key technologies have been derived. For many technologies (e.g. insulation in roofs and external walls) no significant change in capital cost is forecast because they are already assumed to be mature technologies.[1] In other instances, such as the development of design standards and undertaking calculations for improved thermal bridging, it would be expected that the sector would be able to move to adopt these standards as everyday practice with the associated costs diminishing relatively rapidly as economies of scale take effect.

The percentage cost reductions projected for each element of the model through to 2020 are shown in Appendix D, together with the associated estimates of the resulting costs of achieving the Zero Carbon Standard in future years.[2] The results from this analysis are shown graphically in Figure 5.

The inherent uncertainties associated with any cost projection exercise means that these cost estimates should be treated with caution. However, it is possible to make the following broad conclusions:

- Costs are likely to continue to decline, with the costs of meeting the Zero Carbon Standard (using a Scenario 1 compliance strategy) in 2020 falling to £5,700-6,300 for a detached house, £2,900-3,600 for semi-detached or mid-terraced houses and £1,900-2,000 for apartments (all in comparison to Part L1A 2013);
- Reductions in cost are largely driven by further changes in the cost of PV and through lower costs for achieving higher standards of air tightness and tackling thermal bridging;
- Reductions in cost are more marked for house types with a higher initial cost of compliance, whilst for apartments the reductions are limited because Allowable Solutions comprise a significant portion of the additional projected costs and any change in these costs is not included in the analysis.

A full breakdown of the projected costs in each year for each house type for Scenario 1 can be found at Appendix D.

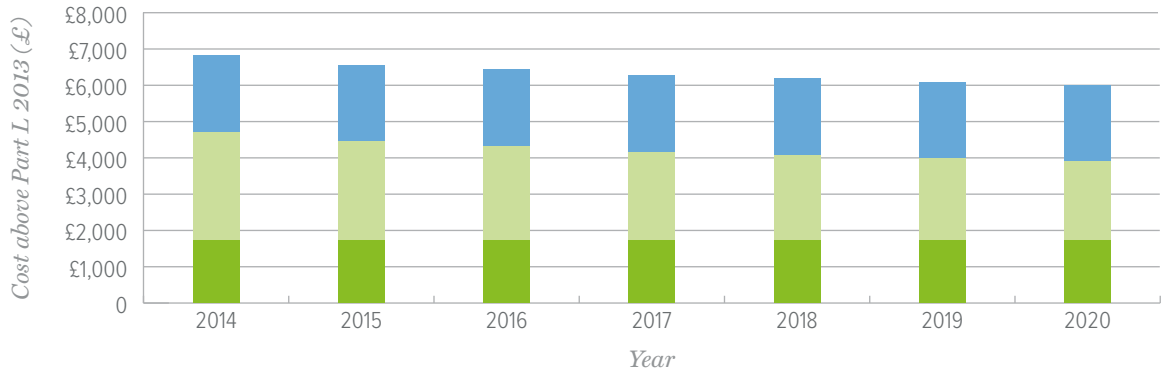
1. All forecasted costs are presented in 2013 prices and therefore exclude inflation.

2. All cost estimates are above Part L1A 2013, and based on central price assumptions.

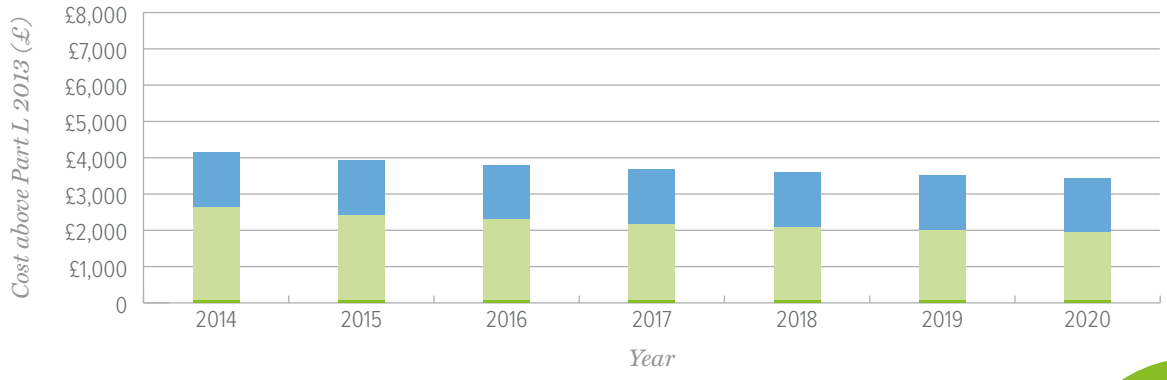
Figure 5.

Projections of the cost of meeting the Zero Carbon Standard via the lowest cost route (Scenario 1 FEES + Efficient gas boiler + PV + AS) for different house types between 2014 and 2020 (costs above Part L1A 2013)

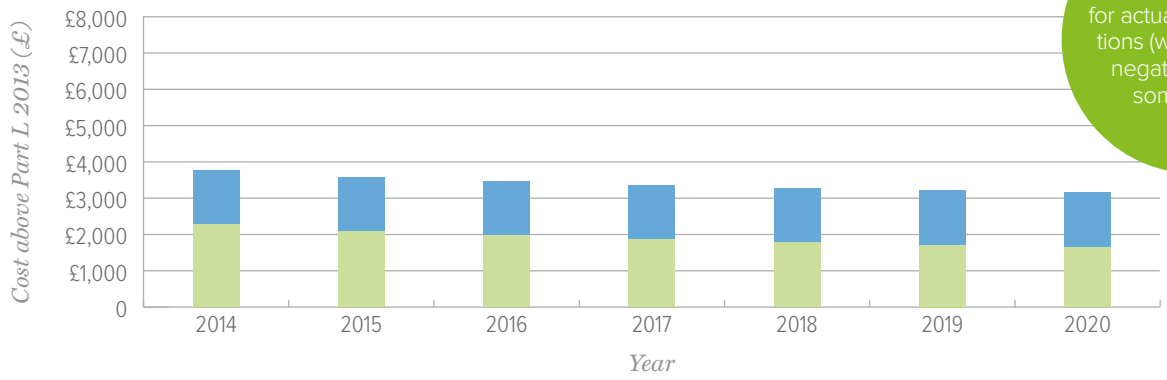
DETACHED HOUSE



SEMI-DETACHED

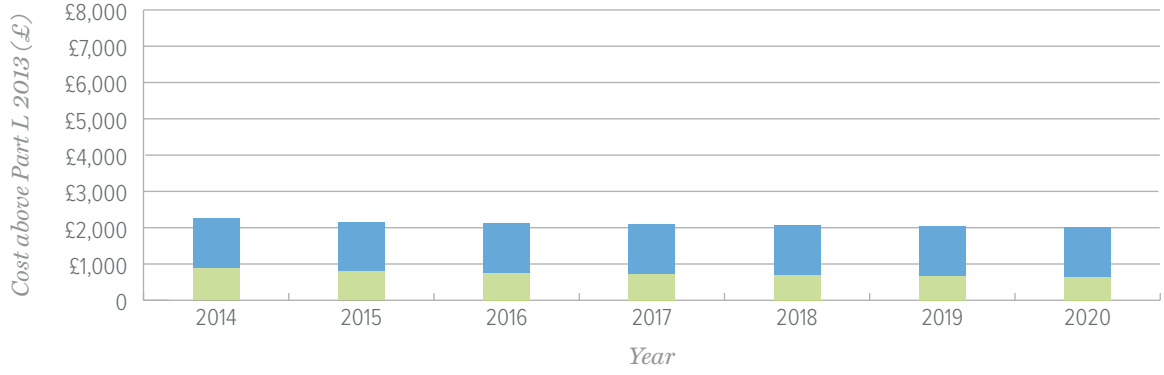


MID-TERRACED



See Appendix D for actual cost projections (which include negative value in some cases)

LOW-RISE APARTMENT



APPENDICES

APPENDIX A

Fabric specifications for 2010, 2013, FEES and Advanced Practice

Table 5 shows the specifications required to achieve the minimum FEES requirement or a higher 'advanced' practice energy efficiency standard. Tables 6 and 7 show the assumed baseline specifications used to meet current building regulations (Part L1A 2010) and forthcoming regulations which enter into force in April 2014 (Part L1A 2013).

Table 5.

Elemental performance standards required for FEES and 'Advanced' practice

ELEMENT	FEES				'ADVANCED PRACTICE' (ALL HOUSE TYPES)
	DETACHED HOUSE	SEMI-DETACHED HOUSE	MID-TERRACED HOUSE	LOW-RISE APARTMENT	
External Walls (W/m^2K)	0.15	0.18	0.18	0.18	0.15
Party Walls (W/m^2K)	n/a	0	0	0	0
Floor (W/m^2K)	0.13	0.13	0.15	0.15	0.15
Roof (W/m^2K)	0.13	0.13	0.13	0.13	0.11
Windows (W/m^2K)	1.2	1.4	1.4	1.4	0.8
Doors (W/m^2K)	1.0	1.0	1.2	1.2	1.0
Air tightness ($m3/hr/m^2$)	5.2	5.0	5.2	5.2	1.0
Thermal bridging (W/m^2K)	0.04 (ECDs [1])	0.051 (ECDs)	0.04 (ECDs Plus)	0.072 (average) (Part ECDs)	0.04 (ECDs Plus)
Ventilation type	Natural	Natural	Natural	Natural	MVHR

1. The calculation of thermal bridging for each house type was based on the use of Accredited Construction Details (ACDs) and in certain cases some or all of the available Enhanced Construction Details (ECDs). In particular individual cases better performing junction details were assumed ("ECDs Plus").

Table 6.

Baseline elemental performance standards required to meet Part L1A **2010**

ELEMENT	DETACHED HOUSE	SEMI-DETACHED HOUSE	MID-TERRACED HOUSE	LOW-RISE APARTMENT
External Walls (W/m^2K)	0.22	0.18	0.18	0.18
Party Walls (W/m^2K)	n/a	0	0	0
Floor (W/m^2K)	0.18	0.15	0.13	0.15
Roof (W/m^2K)	0.15	0.13	0.13	0.13
Windows (W/m^2K)	1.4	1.4	1.4	1.4
Doors (W/m^2K)	1.2	1.2	1.2	1.2
Air tightness ($m3/hr/m^2$)	5.9	5.9	5.5	5.4
Thermal bridging (W/m^2K)	0.077 (ACDs)	0.088 (ACDs)	0.077 (Part ECDs)	0.072 (average) (Part ECDs)
Ventilation type	Natural	Natural	Natural	Natural

Table 7.

Baseline elemental performance standards required to meet Part L1A **2013**[1]

ELEMENT	DETACHED HOUSE	SEMI-DETACHED HOUSE	MID-TERRACED HOUSE	LOW-RISE APARTMENT
External Walls (W/m^2K)	0.18	0.18	0.18	0.18
Party Walls (W/m^2K)	n/a	0	0	0
Floor (W/m^2K)	0.13	0.13	0.13	0.13
Roof (W/m^2K)	0.13	0.13	0.13	0.13
Windows (W/m^2K)	1.4	1.4	1.4	1.4
Doors (W/m^2K)	1.2	1.2	1.2	1.2
Air tightness ($m3/hr/m^2$)	5.0	5.0	5.0	5.0
Thermal bridging (W/m^2K)	0.04 (ECDs[2])	0.051 (ECDs)	0.04 (ECDs Plus)	0.072 (average) (Part ECDs)
Ventilation type	Natural	Natural	Natural	Natural

1. Note that modelling work was carried out prior to the Part L 2013 documentation being fully available so this is only an approximation of what Part L 2013 compliance might mean in terms of fabric specification. In particular, thermal bridging values have been assumed the same as the FEES case for each dwelling type.

2. The calculation of thermal bridging for each house type was based on the use of Accredited Construction Details (ACDs) and in certain cases some or all of the available Enhanced Construction Details (ECDs). In particular individual cases better performing junction details were assumed ("ECDs Plus").

APPENDIX B
Cost of PV and other low carbon technologies

PV

Consultations with trade associations, installers and a review of the literature has shown a continued reduction in the costs of PV arrays and associated system costs (e.g. inverters, mounts, etc). Costs are still highly variable reflecting the impact of location and relatively low price transparency (i.e. list prices can be highly negotiable depending on circumstances). Research indicates that as the overall system cost has fallen, the fixed costs of installation (e.g. labour, access, wiring and a large portion of the inverter cost) become increasingly important and the relative cost-effectiveness of larger installations increases.

In 2012, DECC published analysis on the cost of PV which provides a breakdown of the installation costs of a PV system together with cost benchmarks for different installation scenarios.[1] This data provides an indication of the split between fixed (per installation) and variable (per kWp installed) costs. Tender information from several house builders together with comments from the sector and technology specialists indicates that, since 2012, PV costs have continued to fall. Using the cost information gathered for a range of installations between 2 and 4 kWp, fixed and variable installation costs have been derived for new build installations up to 4kWp. The split between fixed and variable costs is based on that identified by DECC 2012 for aggregator installations of <4kWp. These costs are shown in Table 8 and have been used within this study.

Table 8.
Fixed and variable costs for PV

	FIXED COST (PER INSTALLATION)	VARIABLE (PER KWP)
PV cost per for systems up to 4kWp	£805	£1239

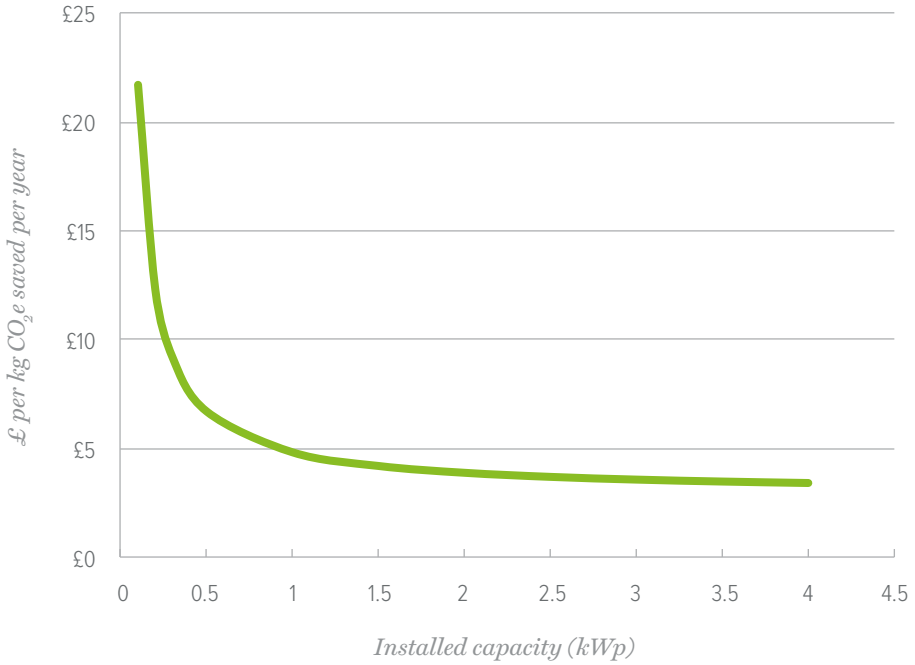
Source: Fixed / variable split derived from DECC, 2012. Solar PV cost update. Costs estimated based on consultations and recent tender price information for housing projects up to 150 units.

1. DECC, Solar PV cost update, May 2012 (see Appendix E).

Figure 6 shows that cost-effectiveness improves markedly after 0.5 kWp of PV has been installed and that after installations of 1kWp, costs per kg CO_2 saved per year reduce more slowly. The marginal cost effectiveness of PV installations (e.g. the cost effectiveness of the variable element of the cost, excluding any fixed costs) is between £3-4 per kg CO_2 per year saved.

Figure 6.

Capital cost effectiveness of carbon savings from PV at different installed capacities



Other LZC technologies

Costs for other LZC technologies were determined from discussions with suppliers and installers. The costs used within the study are shown in Table 9.

Table 9.

Costs used for highly efficient gas boilers, ASHP and solar hot water systems

TECHNOLOGY	DETACHED	SEMI-DETACHED	MID-TERRACED	LOW-RISE APARTMENT
Efficient gas boiler	£1,450	£1,330	£1,330	£1,910
ASHP	£7,182	£6,406	£6,406	£7,125
Efficient gas boiler with solar hot water	£5,209	£5,009	£5,009	£9,270
ASHP with solar hot water	£10,507	£9,693	£9,693	£9,741

APPENDIX C

Estimated costs of compliance for different scenarios

Table 10.

Breakdown of additional costs of achieving Zero Carbon Standard by different routes (above Part L1A 2010)

DETACHED HOUSE

ELEMENT	SCENARIO							
	1 FEES + GAS + PV	2 FEES + GAS + SHW + PV	3 FEES + ASHP + PV	4 FEES + ASHP + SHW + PV	5 ADVANCED + GAS + PV	6 ADVANCED + GAS + SHW + PV	7 ADVANCED + ASHP + PV	8 ADVANCED + ASHP + SHW + PV
Fabric	£3,632	£3,632	£3,632	£3,632	£7,953	£7,953	£7,953	£7,953
External walls	£1,798	£1,798	£1,798	£1,798	£1,798	£1,798	£1,798	£1,798
Party walls	£0	£0	£0	£0	£0	£0	£0	£0
Ground floor	£325	£325	£325	£325	£207	£207	£207	£207
Roof	£116	£116	£116	£116	£276	£276	£276	£276
Windows	£792	£792	£792	£792	£2,232	£2,232	£2,232	£2,232
Doors	£61	£61	£61	£61	£61	£61	£61	£61
Air tightness	£0	£0	£0	£0	£1,090	£1,090	£1,090	£1,090
Thermal Bridging	£540	£540	£540	£540	£540	£540	£540	£540
MVHR	£0	£0	£0	£0	£1,750	£1,750	£1,750	£1,750
Heating and LZC technology	£3,270	£6,211	£9,287	£11,460	£1,845	£5,183	£7,999	£10,481
Carbon Compliance (fabric + heat + LZC)	£6,902	£9,843	£12,919	£15,092	£9,799	£13,137	£15,952	£18,435
Allowable Solutions	£2,118	£2,120	£2,118	£2,118	£2,118	£1,859	£2,116	£1,919
Total cost (central)	**£9,020**	**£11,964**	**£15,037**	**£17,210**	**£11,917**	**£14,996**	**£18,068**	**£20,354**
Range	**£8,500-£9,500**	**£1,120-£12,800**	**£13,900-£16,100**	**£15,900-£18,500**	**£11,300-£12,500**	**£14,100-£15,900**	**£16,900-£19,300**	**£18,900-£21,800**

Table 11.

Breakdown of additional costs of achieving Zero Carbon Standard by different routes (above Part L1A **2010**)

SEMI-DETACHED HOUSE

ELEMENT	SCENARIO							
	1 FEES + GAS + PV	2 FEES + GAS + SHW + PV	3 FEES + ASHP + PV	4 FEES + ASHP + SHW + PV	5 ADVANCED + GAS + PV	6 ADVANCED + GAS + SHW + PV	7 ADVANCED + ASHP + PV	8 ADVANCED + ASHP + SHW + PV
Fabric	£439	£439	£439	£439	£4,838	£4,838	£4,838	£4,838
External walls	£0	£0	£0	£0	£502	£502	£502	£502
Party walls	£0	£0	£0	£0	£0	£0	£0	£0
Ground floor	£76	£76	£76	£76	£0	£0	£0	£0
Roof	£0	£0	£0	£0	£103	£103	£103	£103
Windows	£0	£0	£0	£0	£1,212	£1,212	£1,212	£1,212
Doors	£61	£61	£61	£61	£61	£61	£61	£61
Air tightness	£0	£0	£0	£0	£803	£803	£803	£803
Thermal Bridging	£302	£302	£302	£302	£557	£557	£557	£557
MVHR	£0	£0	£0	£0	£1,600	£1,600	£1,600	£1,600
Heating and LZC technology	£2,824	£5,760	£8,210	£10,444	£1,647	£5,103	£7,132	£9,787
Carbon Compliance (fabric + heat + LZC)	£3,263	£6,199	£8,649	£10,883	£6,485	£9,941	£11,970	£14,625
Allowable Solutions	£1,504	£1,508	£1,506	£1,511	£1,503	£1,165	£1,506	£1,242
Total cost (central)	**£4,767**	**£7,707**	**£10,155**	**£12,394**	**£7,988**	**£11,106**	**£13,476**	**£15,867**
Range	**£4,500-£5,100**	**£7,100-£8,300**	**£9,300-£11,000**	**£11,300-£13,500**	**£7,600-£8,400**	**£10,400-£11,900**	**£12,500-£14,400**	**£14,600-£17,100**

Table 12.

Breakdown of additional costs of achieving Zero Carbon Standard by different routes (above Part L1A **2010**)

MID-TERRACED HOUSE

ELEMENT	SCENARIO							
	1 FEES + GAS + PV	2 FEES + GAS + SHW + PV	3 FEES + ASHP + PV	4 FEES + ASHP + SHW + PV	5 ADVANCED + GAS + PV	6 ADVANCED + GAS + SHW + PV	7 ADVANCED + ASHP + PV	8 ADVANCED + ASHP + SHW + PV
Fabric	£374	£374	£374	£374	£4,328	£4,328	£4,328	£4,328
External walls	£0	£0	£0	£0	£263	£263	£263	£263
Party walls	£0	£0	£0	£0	£0	£0	£0	£0
Ground floor	-£76	-£76	-£76	-£76	-£76	-£76	-£76	-£76
Roof	£0	£0	£0	£0	£103	£103	£103	£103
Windows	£0	£0	£0	£0	£1,119	£1,119	£1,119	£1,119
Doors	£0	£0	£0	£0	£61	£61	£61	£61
Air tightness	£0	£0	£0	£0	£803	£803	£803	£803
Thermal Bridging	£450	£450	£450	£450	£455	£455	£455	£455
MVHR	£0	£0	£0	£0	£1,600	£1,600	£1,600	£1,600
Heating and LZC technology	£2,477	£5,413	£7,888	£10,134	£1,437	£3,679	£6,934	£8,363
Carbon Compliance (fabric + heat + LZC)	£2,851	£5,787	£8,262	£10,508	£5,765	£8,007	£11,262	£12,691
Allowable Solutions	£1,508	£1,508	£1,508	£1,506	£1,504	£1,415	£1,506	£1,503
Total cost (central)	**£4,360**	**£7,295**	**£9,770**	**£12,014**	**£7,269**	**£9,422**	**£12,768**	**£14,194**
Range	**£4,100-£4,600**	**£6,700-£7,900**	**£9,000-£10,600**	**£11,000-£13,000**	**£6,900-£7,600**	**£8,800-£10,000**	**£11,900-£13,700**	**£13,100-£15,200**

Table 13.

Breakdown of additional costs of achieving Zero Carbon Standard by different routes (above Part L1A **2010**)

LOW-RISE APARTMENT

ELEMENT	SCENARIO							
	1 FEES + GAS + PV	2 FEES + GAS + SHW + PV	3 FEES + ASHP + PV	4 FEES + ASHP + SHW + PV	5 ADVANCED + GAS + PV	6 ADVANCED + GAS + SHW + PV	7 ADVANCED + ASHP + PV	8 ADVANCED + ASHP + SHW + PV
Fabric	£0	£0	£0	£0	£3,439	£3,439	£3,439	£3,439
External walls	£0	£0	£0	£0	£79	£79	£79	£79
Party walls	£0	£0	£0	£0	£0	£0	£0	£0
Ground floor	£0	£0	£0	£0	£0	£0	£0	£0
Roof	£0	£0	£0	£0	£45	£45	£45	£45
Windows	£0	£0	£0	£0	£1,114	£1,114	£1,114	£1,114
Doors	£0	£0	£0	£0	£67	£67	£67	£67
Air tightness	£0	£0	£0	£0	£690	£690	£690	£690
Thermal Bridging	£0	£0	£0	£0	£445	£445	£445	£445
MVHR	£0	£0	£0	£0	£1,000	£1,000	£1,000	£1,000
Heating and LZC technology	£978	£7,756	£6,486	£8,189	£160	£7,360	£5,777	£7,831
Carbon Compliance (fabric + heat + LZC)	£979	£7,756	£6,486	£8,189	£3,599	£10,799	£9,216	£11,270
Allowable Solutions	£1,375	£1,375	£1,375	£1,375	£1,375	£1,142	£1,375	£1,236
Total cost (central)	**£2,354**	**£9,131**	**£7,861**	**£9,564**	**£4,974**	**£11,898**	**£10,591**	**£12,463**
Range	**£2,300-£2,500**	**£8,400-£9,900**	**£7,200-£8,500**	**£8,700-£10,400**	**£4,800-£5,200**	**£11,000-£12,800**	**£9,800-£11,300**	**£11,600-£13,500**

APPENDIX D. Approach to projecting future costs

Table 14 summarises the assumptions used to project the future costs[1] of different housing elements.
These assumptions are used to determine the cost projections for each house type (for Scenario 1) shown in Table 14.

Table 14. **Cost projections for different elements within the zero carbon cost model with supporting assumptions**

COST ELEMENTS SUBJECT TO LEARNING	LEARNING ASSUMPTION	% OF 2013 CAPITAL COST						
		2014	2015	2016	2017	2018	2019	2020
External walls (glass wool)	No learning – relatively mature technology	100%	100%	100%	100%	100%	100%	100%
Party walls	No learning – relatively mature technology	100%	100%	100%	100%	100%	100%	100%
Ground floor	No learning – relatively mature technology	100%	100%	100%	100%	100%	100%	100%
Roof	No learning – relatively mature technology	100%	100%	100%	100%	100%	100%	100%
Windows	No learning – relatively mature technology[2]	100%	100%	100%	100%	100%	100%	100%
Doors	No learning – relatively mature technology	100%	100%	100%	100%	100%	100%	100%
Gas heating	No learning – relatively mature technology	100%	100%	100%	100%	100%	100%	100%
Air tightness	It is estimated that costs associated with site supervision and design activities required to achieve air tightness levels of 1 m3/hr/ m^2 will decrease rapidly at ~20% year on year as the industry becomes more familiar with building to these standards. Cost associated with materials quantities and specifications are not subject to cost reductions in the model.	80%	60%	40%	20%	0 %	0%	0%
Thermal bridging	It is estimated that costs associated with the design and calculation time required to achieve lower y-values will decrease rapidly at ~20% year on year as the industry becomes more familiar with building to these standards. Materials costs, e.g. for enhanced lintel specifications, are not subject to cost reductions in the model.	80%	60%	40%	20%	0%	0%	0%
ASHP	Cost projections for these technologies are based on Sweett Group research for DECC[3] using the medium cost reduction scenario.	99%	99%	98%	97%	97%	96%	95%
Solar thermal		99%	97%	96%	95%	94%	93%	91%
PV fixed	Cost projections are based on Parsons Brinkerhoff research for DECC[4] using the medium cost reduction scenario.	95%	90%	84%	76%	73%	70%	68%
PV variable		90%	81%	77%	74%	71%	68%	66%

1. Projected costs are based on 2013 prices.

2. Whilst high performance triple glazed windows are not a mature technology, the cost model already takes account of significant reductions in costs in the last three to four years, while further cost reductions are possible, no significant further reductions are incorporated in the cost model underpinning the analysis because (unlike PV and renewable heat technologies) there is currently no specific policy incentive likely to drive a significant increase in uptake of glazing within the mainstream housing market.

3. DECC, Research on the costs and performance of heating and cooling technologies, February 2013 (see Appendix E).

4. DECC, Solar PV cost update, (see Appendix E).

Table 15.

Projections of the cost of meeting the Zero Carbon Homes Standard via the assumed lowest cost route (**Scenario 1** FEES + Efficient gas boiler + PV + AS) for different house types between **2014** and **2020** (costs above Part L1A **2013**)

DETACHED HOUSE

ELEMENT	YEAR						
	2014	2015	2016	2017	2018	2019	2020
Fabric	£1,728	£1,728	£1,728	£1,728	£1,728	£1,728	£1,728
External walls	£876	£876	£876	£876	£876	£876	£876
Party walls	£0	£0	£0	£0	£0	£0	£0
Ground floor	£0	£0	£0	£0	£0	£0	£0
Roof	-£2	-£2	-£2	-£2	-£2	-£2	-£2
Windows	£792	£792	£792	£792	£792	£792	£792
Doors	£61	£61	£61	£61	£61	£61	£61
Air tightness	£0	£0	£0	£0	£0	£0	£0
Thermal Bridging	£0	£0	£0	£0	£0	£0	£0
MVHR	£0	£0	£0	£0	£0	£0	£0
Heating and LZC technology	£2,983	£2,723	£2,588	£2,440	£2,341	£2,251	£2,168
Carbon Compliance (fabric + heat + LZC)	£4,711	£4,451	£4,315	£4,168	£4,068	£3,979	£3,896
Allowable Solutions	£2,118	£2,118	£2,118	£2,118	£2,118	£2,118	£2,118
Total cost (central)	**£6,830**	**£6,569**	**£6,434**	**£6,286**	**£6,187**	**£6,097**	**£6,015**
Range	**£6,400-£7,200**	**£6,200-£6,900**	**£6,100-£6,800**	**£6,000-£6,600**	**£5,900-£6,500**	**£5,800-£6,400**	**£5,700-£6,300**

Table 16.

Projections of the cost of meeting the Zero Carbon Homes Standard via the assumed lowest cost route (**Scenario 1** FEES + Efficient gas boiler + PV + AS) for different house types between **2014** and **2020** (costs above Part L1A **2013**)

SEMI-DETACHED HOUSE

ELEMENT	YEAR						
	2014	2015	2016	2017	2018	2019	2020
Fabric	£61	£61	£61	£61	£61	£61	£61
External walls	£0	£0	£0	£0	£0	£0	£0
Party walls	£0	£0	£0	£0	£0	£0	£0
Ground floor	£0	£0	£0	£0	£0	£0	£0
Roof	£0	£0	£0	£0	£0	£0	£0
Windows	£0	£0	£0	£0	£0	£0	£0
Doors	£61	£61	£61	£61	£61	£61	£61
Air tightness	£0	£0	£0	£0	£0	£0	£0
Thermal Bridging	£0	£0	£0	£0	£0	£0	£0
MVHR	£0	£0	£0	£0	£0	£0	£0
Heating and LZC technology	£2,582	£2,362	£2,242	£2,109	£2,024	£1,946	£1,875
Carbon Compliance (fabric + heat + LZC)	£2,643	£2,423	£2,303	£2,170	£2,085	£2,007	£1,936
Allowable Solutions	£1,504	£1,504	£1,504	£1,504	£1,504	£1,504	£1,504
Total cost (central)	**£4,147**	**£3,927**	**£3,807**	**£3,675**	**£3,589**	**£3,511**	**£3,441**
Range	**£3,900-£4,400**	**£3,700-£4,200**	**£3,600-£4,000**	**£3,500-£3,900**	**£3,400-£3,800**	**£3,300-£3,700**	**£3,300-£3,600**

Table 17.

Projections of the cost of meeting the Zero Carbon Homes Standard via the assumed lowest cost route (**Scenario 1** FEES + Efficient gas boiler + PV + AS) for different house types between **2014** and **2020** (costs above Part L1A **2013**)

MID-TERRACED HOUSE

ELEMENT	YEAR						
	2014	2015	2016	2017	2018	2019	2020
Fabric	-£76	-£76	-£76	-£76	-£76	-£76	-£76
External walls	£0	£0	£0	£0	£0	£0	£0
Party walls	£0	£0	£0	£0	£0	£0	£0
Ground floor	-£76	-£76	-£76	-£76	-£76	-£76	-£76
Roof	£0	£0	£0	£0	£0	£0	£0
Windows	£0	£0	£0	£0	£0	£0	£0
Doors	£0	£0	£0	£0	£0	£0	£0
Air tightness	£0	£0	£0	£0	£0	£0	£0
Thermal Bridging	£0	£0	£0	£0	£0	£0	£0
MVHR	£0	£0	£0	£0	£0	£0	£0
Heating and LZC technology	£2,270	£2,081	£1,973	£1,852	£1,777	£1,709	£1,647
Carbon Compliance (fabric + heat + LZC)	£2,194	£2,005	£1,897	£1,776	£1,701	£1,633	£1,571
Allowable Solutions	£1,508	£1,508	£1,508	£1,508	£1,508	£1,508	£1,508
Total cost (central)	**£3,702**	**£3,513**	**£3,406**	**£3,285**	**£3,209**	**£3,141**	**£3,079**
Range	**£3,500-£3,900**	**£3,300-£3,700**	**£3,200-£3,600**	**£3,100-£3,500**	**£3,000-£3,400**	**£3,000-£3,300**	**£2,900-£3,200**

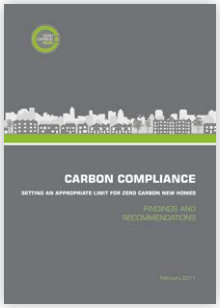
Table 18.

Projections of the cost of meeting the Zero Carbon Homes Standard via the assumed lowest cost route (**Scenario 1** FEES + Efficient gas boiler + PV + AS) for different house types between **2014** and **2020** (costs above Part L1A **2013**)

LOW-RISE APARTMENT

ELEMENT	YEAR						
	2014	2015	2016	2017	2018	2019	2020
Fabric	-£32	-£32	-£32	-£32	-£32	-£32	-£32
External walls	£0	£0	£0	£0	£0	£0	£0
Party walls	£0	£0	£0	£0	£0	£0	£0
Ground floor	-£32	-£32	-£32	-£32	-£32	-£32	-£32
Roof	£0	£0	£0	£0	£0	£0	£0
Windows	£0	£0	£0	£0	£0	£0	£0
Doors	£0	£0	£0	£0	£0	£0	£0
Air tightness	£0	£0	£0	£0	£0	£0	£0
Thermal Bridging	£0	£0	£0	£0	£0	£0	£0
MVHR	£0	£0	£0	£0	£0	£0	£0
Heating and LZC technology	£880	£792	£758	£725	£695	£668	£643
Carbon Compliance (fabric + heat + LZC)	£849	£761	£726	£694	£664	£637	£612
Allowable Solutions	£1,375	£1,375	£1,375	£1,375	£1,375	£1,375	£1,375
Total cost (central)	**£2,224**	**£2,136**	**£2,101**	**£2,069**	**£2,039**	**£2,012**	**£1,987**
Range	**£2,100-£2,300**	**£2,100-£2,200**	**£2,000-£2,200**	**£2,000-£2,100**	**£2,000-£2,100**	**£1,900-£2,100**	**£1,900-£2,000**

APPENDIX E
References



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Zero Carbon Hub
February 2011

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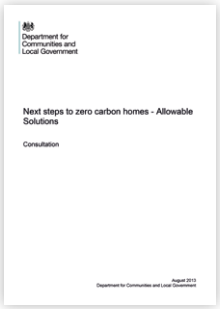

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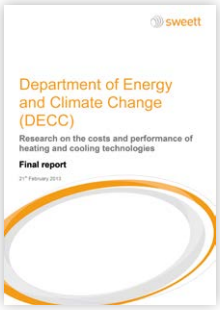

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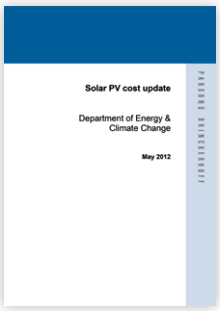

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