FINAL

London Carbon Offset Price

Greater London Authority

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Quality information

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Executive Summary

AECOM was appointed by the GLA to undertake a study to recommend suitable carbon prices for offsetting in London. This report sets out an evidence base for establishing carbon offset prices for London and recommends two sets of carbon offset prices for testing as part of viability assessment of the full review of the London Plan.

Policy context

Where developments do not achieve the Mayor's carbon reduction targets (set out in policy 5.2 of the London Plan) on site, the developer is expected to make up the shortfall (residual emissions) off-site or to make a cash-in-lieu contribution to the local borough's carbon offsetting fund. Guidance on this is provided in the Sustainable Design and Construction SPG published in April 2014. London boroughs are expected to "develop and publish" a price at which developers pay into an offsetting fund per tonne of residual carbon emissions, to set up a ring-fenced fund, and secure contributions through s106 agreements.

The SPG establishes that developer contributions should offset residual emissions for a period of 30 years, and indicates that London boroughs should set a carbon offset price based on either a nationally recognised carbon pricing mechanism or on the cost of carbon offsetting projects in the borough.

Study approach

To arrive at a recommended carbon price, the study considered and developed approaches to four underlying and interrelated questions.

Target offset ratio

The study assumed that Councils would typically manage their offset funds with the aim of achieving an offset ratio of 1 to 1 – i.e. "carbon equivalence", where the quantity of carbon saved through offsetting projects equals the residual emissions from development. This is not a policy requirement, but the offset ratio is a key performance indicator of any offset fund and a ratio of 1 to 1 is the obvious performance benchmark. The target offset ratio assumed is important because, given costs per tonne of carbon saving for potential offset projects, it determines which projects are 'affordable' to an offset fund at any carbon offset price considered.

Carbon accounting

The study assumes that offset funds would adopt a carbon accounting approach referred to as 'proportional shares by subsidy'. This means that the carbon savings from an offsetting project are shared among all public or regulatorily obligated co-funders[1] according to the proportion of capital funding provided, and that 'copayments' by the project beneficiaries are ignored when sharing out carbon savings. Under this approach, securing copayments reduces the cost per tonne of carbon saving of offsetting projects to the fund and effectively leverages those copayments, increasing the amount of carbon that can be saved, and broadening the range of projects that can be afforded with the funds available. Copayments increase the value for money that can be obtained by an offset fund and may be important in the context of State Aid rules and ensuring fair and appropriate use of public money. The study team considered two other possible carbon accounting approaches and concluded that it is essential to assume 'proportional shares by subsidy' as it clearly offers the best balance of outcomes, incentivising offset funds to secure copayments while reducing 'double-counting' of carbon savings claimed in relation to other existing carbon saving policy instruments.

A critical consequence of adopting 'proportional shares by subsidy' carbon accounting is that the cost per tonne of carbon saving for offsetting projects is no longer fixed based on the total cost and carbon savings of projects. The cost per tonne floats between a maximum – where the project is fully funded through offsetting – and a minimum – depending on the the largest copayment that the beneficiary is

[1] for example, companies funding projects to meet their obligations under the Energy Company Obligation scheme

willing or able to make. To calculate a cost per tonne of carbon saving, both the total project cost and carbon savings (already widely variable in many cases) and an assumed copayment percentage would need to be established for each type of offsetting project.

Basis for carbon price recommendations

The study team took the view that given the wide variability in the costs and carbon savings for potential carbon offsetting projects combined with the uncertainty in the percentage copayments that could be secured, it would be difficult to assemble sufficient evidence from which to calculate robust costs per tonne of carbon for selected types of offsetting projects. Consequently it would be difficult to analytically derive a robust carbon price based on the cost of offsetting projects. As such, the approach adopted in this study is to continue to base carbon prices for offsetting in London on a nationally recognised carbon pricing mechanism rather than on the cost of carbon savings derived from potential offsetting projects.

The carbon prices recommended by this study for further testing are sourced from the projection of non-traded carbon prices published in "Valuation of Energy Use and Greenhouse Gas Emissions – Supplementary guidance to the HM Treasury Green Book on Appraisal and Evaluation in Central Government".

Viability considerations and carbon offset price zones

It is clear from the London Plan and the SPG that the carbon offset price set by London boroughs "should not put an unreasonable burden on development and must enable schemes to remain viable". The viability of development varies across London and this was recognised in the study brief, which called for "[r]ecommendations for a London carbon price, either London-wide or set by zones". Rather than identifying a single carbon price, the study identifies a set of carbon prices consisting of a low, a central, and a high price that could support the setting of carbon prices in three zones. This was primarily a pragmatic decision, reflecting the source data.

The study team reviewed potential bases for zoning carbon prices on a London-wide level and within boroughs. Zoning for charging of Community Infrastructure Levy was identified as a relevant point of comparison as CIL charging must also take account of development viability. CIL charging approaches were taken as a loose proxy for viability, to see if CIL charging zones could be used as a basis for zoning carbon offset prices.

London is divided into three charging zones for Mayoral CIL. Viability assessment of local CIL charges must take account of Mayoral CIL, which was set first. A review of local CIL charging schedules found between one and three zones within London boroughs, with multiple charging zones being the norm.

Overlaying the background of three London-wide Mayoral CIL zones with multiple local zones within each borough suggests a complex pattern of combined CIL charging within boroughs across London. It seems unlikely that a set of three London-wide carbon offset price levels would map neatly onto this complexity. As such, the study concluded that London boroughs remain in the best position to use information on development viability to set carbon offset prices and to decide whether and how to apply zoning. The publication by GLA of a set of recommended carbon offset prices rather than a single price would provide London boroughs with additional information to support the setting of appropriate local prices that account for viability.

Indicative costs and 'affordability' of selected offsetting projects

While this study proposes that carbon offset prices for London continue to be based on a nationally recognised carbon pricing mechanism, it is important to establish indicative costs per tonne of carbon saving of potential offsetting projects so as to understand which types of projects are likely to be affordable at a given carbon price and (for the reasons explained in 'carbon accounting') varying percentage copayments.

Selection of illustrative offsetting project types

To that end, the study team selected 18 potential offsetting project types, each involving the implementation of one or more carbon saving measures. The majority of the projects selected involve retrofitting measures to homes and non-domestic buildings, as these are likely to be the most deliverable opportunities. A couple of the projects involve energy infrastructure, to give some indication of the wider range of offsetting projects that could be funded. The list of selected projects is intended to be illustrative, and is not an exhaustive compilation of carbon offsetting opportunities, which was outside the scope of this study.

Indicative costs of carbon savings for selected projects

Indicative implementation costs, annual carbon savings, the lifetime of the measures, and hence the lifetime carbon savings, and 'raw' (without copayments) cost per tonne of carbon saved were established for each selected project type, as summarised in Table 1.

Measure	Installation cost [£]	Annual carbon saving [kg]	Lifetime [years]	Lifetime carbon saving [t]	Cost of carbon saving [£/t]
Cavity Wall Insulation (Low Cost)	£595	577	42	24.2	£25
Cavity Wall Insulation (High Cost)	£3,500	577	42	24.2	£144
Internal SWI	£5,300	1,187	36	42.7	£124
External SWI	£8,100	1,187	36	42.7	£190
Loft Insulation	£300	108	42	4.5	£66
Double Glazing (old single to A)	£4,500	492	20	9.8	£457
Flat roof insulation	£1,050	594	20	11.9	£88
Draughtproofing	£100	140	10	1.4	£71
New or replacement storage heaters	£350	562	20	11.2	£31
Solar water heating [~3.0 kW]	£4,615	289	20	5.8	£800
Photovoltaics [~2.0 kW]	£3,365	828	25	20.7	£163
Whole house refurb (SWI)	£14,400	1,672	30	50.7	£284
Whole house refurb (high cost CWI)	£9,800	1,215	30	36.8	£266
Whole house refurb (low cost CWI)	£6,895	1,215	30	36.8	£187
RE:NEW (average, easy measures)	£111	171	13	2.2	£51
RE:FIT Retrofit 11 non-domestic buildings	£730,000	595,000	19	11,210	£65
1km DHN to 850 homes & 2 leisure centres	£3,800,000	1,800,000	40	72,000	£53
1,000 LED streetlamps	£892,600	166,400	20	3,328	£268

Table 1

What the overview of results in Table 1 clearly shows is the broad variability in the cost of carbon savings of different types of projects.

Affordability analysis for selected projects

The analysis then explored the affordability of the projects under different carbon prices and with varying levels of copayment. Projects are considered affordable to the offset fund if they have an offset ratio of 1 to1, or better. (Note that the offset ratio is more properly a performance indicator for the offset fund as a whole, and the analysis in this study is not suggesting it should be used as a hard and fast yes/no funding criteria for individual projects.) Projects can be made affordable either by setting higher carbon prices or by assuming a higher percentage copayment is secured.

The summary results of the analysis for all 18 selected measures is summarised in Figure 1. The carbon price at which each project is affordable is the point on the chart where the plotted line for the project crosses the vertical axis corresponding to an offset ratio of 1 to 1. The background shading on the charts corresponds to 2017 non-traded carbon price bands of interest: low to central price (£32 – £64) is shaded green; central to high price (£64 – £95) is shaded yellow; an alternative upper price band (£95 – £191) is shaded blue with prices above or below these ranges (>£191 or <32) shaded red and grey respectively.

Figure 1 illustrates how the range of projects that is affordable at a given carbon price changes, and in particular how the range of projects affordable in the price ranges of interest changes, depending on the percentage copayment assumed.

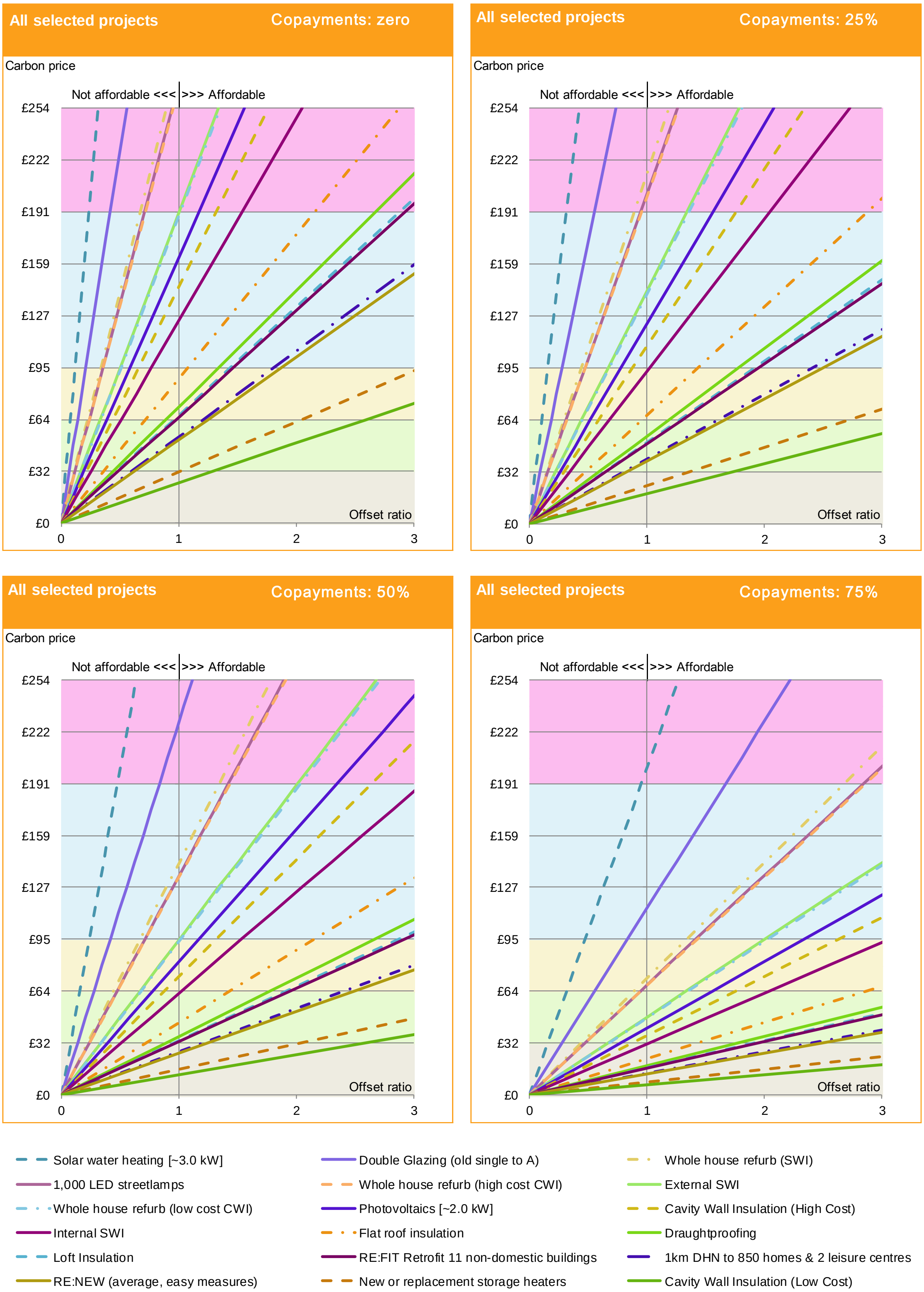
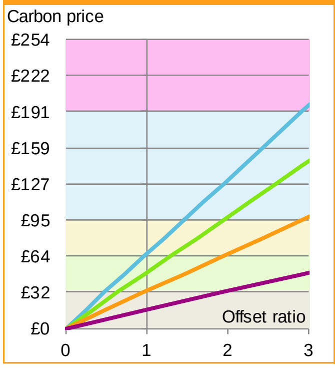


Figure 1

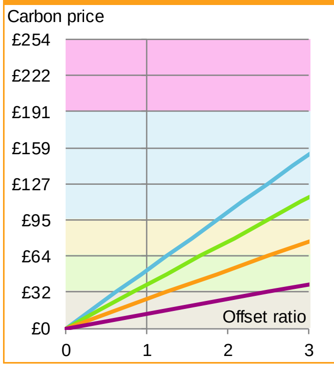
The summary results in Figure 1 do not provide insight into the absolute copayments (in pounds) implied by the percentage level, and therefore the likelihood that these would be affordable to beneficiaries. To provide that sort of insight, the study report also includes a detailed set of charts, looking at each project in turn, illustrating the affordability to the offset fund at each percentage copayment, and setting out the corresponding project costs, copayments, and the price of carbon that would make the project affordable. An example of this presentation for two of the 18 selected measures is shown in Figure 2.

3 RE:NEW (average, easy measures)



Copay-ment	Total project cost [£]	Carbon cost @ 1:1 [£/tCO_2]
None	£111	£51
Copayment		**£/tCO_2**
25% =	£28	£38
50% =	£56	£25
75% =	£84	£13

4 1km DHN to 850 homes & 2 leisure centres



Copay-ment	Total project cost [£]	Carbon cost @ 1:1 [£/tCO_2]
None	£3,800,000	£53
Copayment		**£/tCO_2**
25% =	£950,000	£40
50% =	£1,900,000	£26
75% =	£2,850,000	£13

Figure 2

Conclusions from the project cost and affordability analysis for carbon offset price-setting

The analysis suggests that there are measures that can be fully funded at offset ratios of 1 to 1 within the range of non-traded carbon prices that have informed carbon offset price setting to date (~£32 – £95 tCO_2). Copayments increase the number of project types likely to be affordable in this range. Higher carbon prices would, logically, enable a wider range of projects to be fully funded or delivered with copayments. There are no glaringly obvious price points to test between the high non-traded carbon price of £95 /tCO2 and the upper end of the price range considered, £254 /tCO2. However, of the selected measures, whole house refurbishment (with low cost cavity wall insulation) and standalone external solid wall insulation could both be fully funded at a carbon price of around £191 /tCO2. External solid wall insulation in particular is a totemic measure, with significant unrealised saving potential in the stock and therefore the carbon price that enables it to be fully funded represents a notable price marker.

Carbon offset price recommendations

Based on the approach and analysis set out above, the outcomes of this study are two options for sets of recommended carbon offset prices for London.

Carbon offset price sets for viability testing

Two options for carbon price sets have been identified for testing:

1. A price set centred on a carbon price of £64 /tCO_2, similar to the £60 /tCO_2 most widely adopted to date across London; and
2. A higher price set that would inherently enable a wider range of measures including, at the high end of the range set at £191 /tCO_2, notable project types like external solid wall insulation that have significant undelivered technical potential in the stock and could deliver 'deep' carbon savings in homes.

The carbon price sets recommended for testing are as follows:

Option	Low	Central	High	Comments
Option1	32	64	95	Treasury Green Book non-traded carbon prices for 2017; same source as 'Zero Carbon Hub price' of £60 /tCO_2 cited as an example in the Sustainable Design and Construction SPG to the London Plan and widely adopted across London
Option 2	64	127	191	High price set based on indicative cost of external solid wall insulation and whole house refurbishment (with low cost cavity wall insulation); low price set to central non-traded carbon price; results in wide price range

These carbon price options are subject to viability testing, and subsequent consideration by GLA before a decision is taken on recommending any carbon offset prices for London.

Carbon offset price review and indexing

The study team considered the drivers for updating carbon offset prices, and the necessary frequency of changes, balancing the benefits of keeping prices up to date against the drawbacks of managing the change process. The conclusions were that GLA should reviews its recommended carbon offset prices for London every three to five years. Reviews may be trigerred by changes to Part L of Building Regulations, which are likely to affect both residual emissions and the calculated carbon savings for many building retrofitting projects. Price reviews should also tie in with wider planning policy review processes if possible, to take advantage of feedback from comprehensive viability assessments. Annual indexation of GLA's recommended carbon offset prices for London is not considered necessary.

1. Introduction

1.1 Study scope

AECOM was appointed to undertake a study with the objective of recommending "suitable carbon price[s]" for offsetting in London. As specified in the project brief, this report sets out:

- *Recommendations for a London carbon price, either London-wide or set by zones with specific prices and a robust evidence base, including analyses of carbon prices conducted by London boroughs and other local authorities in England.*
- *Recommendations on the frequency and method for updating the recommended carbon price and whether it is index-linked.*
- *The analysis, assumptions and evidence base used to determine the recommended carbon price, including viability assessments.*

1.2 Policy context

London Plan policy 5.2 sets out carbon targets for new development, and policy on the use of offsetting to meet shortfalls in on-site delivery. Further guidance on this is provided in the Sustainable Design and Construction SPG published in April 2014 (the SPG). Where developments do not achieve the Mayor's carbon reduction targets on site, the developer is expected to make up the shortfall (residual emissions) off-site or to make a cash-in-lieu contribution to the local borough's carbon offsetting fund.

Accordingly, London boroughs are expected to:

- Set up a planning related carbon offsetting fund, that is ring fenced and used to secure delivery of carbon savings.
- Set a price for carbon, i.e. price per tonne of carbon that developers pay into the fund based on the shortfall in on site carbon savings, and secure contributions through s106 agreements.

The SPG establishes that developer contributions should offset the shortfall in carbon savings for a period of 30 years, and states that London boroughs should set a price based on either:

1. "*A nationally recognised carbon pricing mechanism*" – Two such prices are referred to in the SPG: "*the Zero Carbon Hub price, currently £60 per tonne; and the non-trading price of carbon*". Or
2. "*The cost of offsetting carbon emissions across the borough*" – The SPG expects that this would involve an assessment of possible saving measures in the borough, taking account of practical (deliverability) and policy (CIL) constraints.

This study considers both approaches to offset price-setting allowed for in the SPG, before adopting one as the basis for recommending carbon offset prices for London.

1.3 Study Approach and Methodology

To arrive at a recommended carbon price, choices needed to be made between alternative approaches in relation to the following:

1. The offset ratio (i.e. the quantity of carbon saved through offsetting projects vs. the residual emissions from development) that will be assumed, which affects how the costs of measures and projects would translate into a corresponding carbon offset price.
2. The carbon accounting approach that will be used to determine the cost per tonne of carbon savings when offsetting projects are co-funded by other parties in addition to receiving money from the offset fund.
3. Whether to base recommended carbon prices on a nationally recognised carbon pricing mechanism or on the cost of offsetting carbon, as represented by the cost of available carbon saving measures and projects. And

4. The way that constraints on the price of carbon, particularly the impact on development viability, should be accounted for in making carbon price recommendations.

In deciding on a carbon offset price-setting approach, AECOM took account of previous direct involvement in supporting the development of carbon offsetting schemes in London and drew broad insights from offsetting schemes that have been established to date.

The rationale behind the approach and methodology adopted for this study, and the positions adopted in relation to the four points above, is set out in the remainder of this section.

1.3.1 Lessons from previous offsetting studies

AECOM has undertaken several previous studies reviewing carbon saving projects in the context of establishing offset schemes and setting carbon offset prices. Several points emerge from these previous studies and other reviews of offsetting projects undertaken to date:

1. There is a broad range of potential projects across a variety of sectors: energy efficiency and renewable energy measures at a variety of scopes and scales in homes and non-domestic buildings, but also standalone decentralised energy generation, transport, energy 'infrastructure', etc.
2. There is a wide range in the cost per tonne of carbon savings for these offsetting projects.
3. Many of the cheaper[2] projects, particularly in homes, are already eligible for support under other existing programmes like ECO[3], Green Deal[4], and in London RE:FIT and RE:NEW.
4. Most significantly, few of the projects that deliver deeper[2] carbon savings can be fully funded at the non-traded 'central' price of carbon[5], which has previously been used as a benchmark – £60 / tCO_2e when DCLG consulted on carbon prices for Allowable Solutions, and cited as the 'Zero Carbon Hub price' in the SPG. This implies that carbon prices would need to be higher for offsetting to fully fund deep carbon saving projects in the building stock.

Point one (broad range of project types) suggests that it may be difficult to identify any specific set of projects that form the right basis for price setting. Point two (wide range in the cost per tonne for this broad range of project types) suggests it may be difficult to derive a recommended price point from the data on project costs. Point three (many cheaper measures eligible for support under other existing programmes) is linked to the issue of the relationship between carbon offset pricing and ensuring the 'additionality' of savings from carbon offset projects. Point four (the cost of carbon for projects that deliver deep carbon savings exceeds prevailing carbon prices) highlights the importance of the carbon accounting approach for sharing carbon savings among funders, assuming that costly projects with large carbon savings would rely on co-funding. Points three and four together suggest that the cost of offsetting may turn out relatively high if the measures undertaken provide greater 'additionality'.

The broad insights drawn by the study team from offsetting projects to date were that it is difficult to derive a carbon price recommendation analytically, i.e. calculate a "suitable price that reflects the cost of offsetting" from the cost of projects. Many existing offset schemes have effectively tested and adopted a recognised carbon price rather than derive a bespoke local price. The potentially high cost of offsetting is problematic because it is clear from the SPG that the carbon price must also be consistent with the ongoing viability of development across London. This points to adopting a carbon accounting approach that allows co-funding of offsetting projects by other parties to reduce the cost of carbon to the offset fund, increasing the range of project types that can be supported. As development viability varies both within and between boroughs, it follows that carbon pricing might need to vary by

[2] 'Cheaper' and 'deeper' are admittedly loose terms. As an indication, 'deep' carbon savings for a home might correspond to undertaking one or more measures with total costs above five thousand pounds, saving perhaps a fifth or more of annual carbon emissions. 'Cheaper' covers projects short of that level of intervention, cost and savings.
[3] Energy Companies Obligation
[4] The Government announced the end of its funding of the Green Deal Finance Company in July 2015. Households could still theoretically get Green Deal loans from Providers with other sources of finance. Private investors acquired the Green Deal Finance Company in January 2017, announcing plans to commence financing of new loans "in Q1, 2017".
[5] In 2015 £/tCO_2e from the current September 2015 version of the DECC/HM Treasury Green Book supplementary appraisal guidance on valuing energy use and greenhouse gas (GHG) emissions, supporting Table 3. The non-traded carbon price and sensitivities for 2017 are £64 (central), £32 (low), and £96/tCO2e (high).

location, and indeed the brief refers to carbon price recommendations being "*London-wide or set by zones*".

1.3.2 Assumed target offset ratio – carbon savings vs. residual carbon emissions

Before embarking on a carbon offset pricing study there needs to be clarity on the assumed relationship between the quantity of residual carbon emissions and the carbon savings to be achieved through offsetting projects.

Implicit in the concept of offsetting is the idea of saving as much carbon in remote location(s) as was emitted from the subject site(s). Expressed in concrete terms: the principle is that an offset fund should ideally achieve an overall offset ratio of 1 to 1, i.e. 1 tonne of carbon savings from offsetting projects for each tonne of residual carbon emissions from developments. There is support for this principle in para. 2.5.8 of the SPG:

> *2.5.8 An assessment should be made by the Council or beneficiary of the off-setting measure so that the off-setting measures either have carbon dioxide or financial equivalence to the carbon dioxide saving that would otherwise be required on the development site.*

AECOM's reading of this paragraph is that the support for measures having "*carbon dioxide… equivalence*" (i.e. a 1 to 1 offset ratio) is tempered in the same phrase by the reference to "*…or financial equivalence*", the intended meaning of which is less clear.

The call for offsetting measures to "*either have carbon dioxide or financial equivalence to the carbon dioxide saving that would otherwise be required [on site]*" seems to meaningfully apply to a case where a developer opted to directly implement carbon saving measures off site rather than pay into an offset fund. In that case, the developer might be able to deliver the required carbon savings ("*carbon dioxide…equivalence*") at a cost at or below the price of paying into the offset fund. If not, the developer would not be required to spend more on offsetting than if they had opted to pay into the offset fund ("*financial equivalence*"). So "*financial equivalence*" strongly implies acceptance of cases where the carbon saving measures delivered have an offset ratio of less than 1 to 1.

Once a developer opts to pay into an offset fund, the amount available to spend on offsetting measures is fixed based on the price of carbon and it is up to the Council to secure carbon savings. If the Council were able to fund carbon saving projects with costs at or below the carbon price, they could conceivably secure savings equal to or greater than the residual emissions. (There has never been any suggestion in offsetting or allowable solutions policy, nor in practice to date, that contributors could be reimbursed if a fund made excess savings. In any case, it is extremely difficult to see how refunds could be implemented in practice.) Policy calls for offset funds to be ring fenced, so all funds collected would inherently be dedicated to saving carbon. So in this case, the call for individual projects to achieve "*financial equivalence*" is inherently met because the developer paid into the offset fund at the agreed carbon price.

If developers opted to fund carbon saving projects directly, "*financial equivalence*" allows for an offset ratio of less than 1 to 1. Councils are effectively accorded the same flexibility in para 2.5.16 of the SPG, in relation to the spending of the offset fund:

> *2.5.16 Unless the price set for carbon dioxide fully reflects the delivery of the identified carbon dioxide reduction projects, it is not considered necessary that the ratio of carbon dioxide saving to the off-setting price has to be 1:1.*

AECOM's interpretation of paragraphs 2.5.8 and 2.5.16 of the SPG taken together is that it is intended to ensure that one of the following conditions is met in relation to the offsetting of residual carbon emissions from new development:

1. Carbon equivalence – The developer directly secures carbon savings equal to residual carbon emissions by implementing projects off site. (The developer may conceivably be able to achieve equal savings at a carbon cost at or below the carbon offset price. The Council would only need evidence that equal savings were achieved.)
2. Financial equivalence – The developer directly funds carbon saving projects up to an amount equal to the contribution to the offset fund, at the prevailing carbon price, that would otherwise have been required. (The Council would only need evidence that the sum spent on carbon

saving projects was at least as much as the payment to the offset fund that would otherwise have been required.)

3. Payment into the offset fund at the prevailing carbon price – the Council secures carbon savings on behalf of developers and has the same aim as developers – to achieve 'carbon equivalence' (i.e. an offset ratio of 1 to 1), but is afforded the same flexibility in that the achievable offset ratio for deliverable saving measures and projects may be less than 1 to 1.

Based on the reasoning above, AECOM's interpretation of London Plan policy and related guidance in the SPG is that the achievement of "carbon equivalence" is not a policy requirement. However, it is a reasonable objective in principle, and it is assumed in this study that offset funds would typically be managed by Councils to achieve an offset ratio of 1 to 1, as far as possible. In any case, the offset ratio is clearly a key performance indicator for offset funds, and a ratio of 1 to 1 is the most obvious benchmark against which to judge performance.

1.3.3 Carbon accounting approach – calculating the cost of carbon of offset projects with multiple sources of funding

Another aspect of this study requiring definition is the approach to calculating the cost per tonne of carbon for a saving measure or project when there are multiple parties providing funding, including the beneficiary, i.e. the household, company or organisation benefiting (in terms of energy bill savings or improved comfort or other utility) from the implementation of the carbon saving measure(s).

The simplest interpretation of setting *"a suitable carbon price that reflects the cost of offsetting in London"* is that offset funds collected from developers based on the carbon price will fund carbon savings from offset projects at an equivalent carbon cost, i.e.:

£Price/tCO_2 = £(Average[6] Cost)/tCO_2

Implicit in this interpretation is the idea that offset funds would pay for projects in full and claim all of the resulting carbon savings. In practice, this interpretation is impractical for two reasons.

First, full funding – effectively 100% public grant – raises a range of potential issues about appropriate use of public funds, limitations on State Aid, and question marks about 'additionality', all somewhat dependent on who is receiving the support. Full funding is undesirable because it takes no account of the ability or willingness of the parties that benefit from the offsetting measures to pay for them. A reasonable response to this problem is, where possible, to seek a financial contribution from the beneficiary (copayment) and private co-investment in projects (co-funding). Securing additional investment effectively leverages the offset fund, increasing the total amount available to spend on offsetting projects. As long as the carbon savings are additional (would not have happened without offset funding), this leverage increases the overall quantity of carbon savings brought about by the use of public money through an offset fund. It also raises a new issue: where a project has multiple funders, those funders potentially have competing claims on the carbon savings, and different perspectives on the cost of those carbon savings. This carbon accounting issue is closely related to the second problem with the default 'Carbon Price = Average Carbon Cost' interpretation of carbon price setting.

The second problem is that past studies show that the range of measures that can be fully funded at low carbon prices (less than £60 /tCO_2, for example) is small. Part-funding projects appears an obvious, common-sense solution to increasing the range of projects that can be supported. But the effect of part-funding on the cost of carbon is entirely dependent on how carbon savings are accounted for, i.e. who claims what share of the carbon savings delivered by a project.

[6] I.e. the average cost of all projects in London funded by offset funds

Carbon accounting

In an Offset Solutions Study for the London Legacy Development Corporation, AECOM set out three broad approaches to accounting and calculating the cost of carbon for a carbon savings project supported by an Offset Fund, as follows:

Accounting Option	Description	Effect on carbon cost calculation outcomes
Option 1: Proportional shares	Carbon savings are shared according to the proportion of capital funding provided by each party, including the beneficiary	This always gives the same cost of carbon as assuming that the Offset Fund provides 100% project funding
Option 2: Proportional shares by subsidy (public)	Carbon savings are shared among all public, third party or regulatorily obligated[7] co-funders according to the proportion of capital funding (i.e. subsidy) provided. Any capital contributions by beneficiaries[8] are ignored when sharing out the carbon savings	Copayments reduce the cost of carbon to the Offset Fund. The effect of co-funding is neutral (unless it displaces copayments)
Option 3: Fund takes all	All savings are attributed to the Offset Fund (i.e. effectively assuming that the offset funding 'unlocks' the project, which would otherwise not go ahead)	Cofunding and copayments both reduce the cost of carbon to the Offset Fund

National carbon saving programmes, such as the Energy Company Obligation, allow the funder to claim all of the savings for projects that they enable through part-funding (i.e. option 3). The study team's view is that option 2, 'proportional shares by subsidy', strikes the right balance between encouraging leveraging of both private and other public funds to deliver carbon savings, while avoiding obvious 'double counting' of carbon savings delivered by overlapping policy instruments. In undertaking this study, AECOM assumed that accounting option 2 is used to calculate the cost of carbon for projects, and as such that beneficiary copayments reduce the cost of carbon to the Offset Fund.

The approach to accounting for carbon savings when offset funds provide only a proportion of the total costs of a measure also needs to be considered in relation to offset fund administration.

The critical thing to understand about adopting the 'proportional shares by subsidy' accounting approach is that it fundamentally breaks the idea that a particular type of project has a fixed carbon price.

The carbon cost of a carbon saving project to an offset fund now floats between a maximum – where the project is fully funded through offsetting – and a minimum that depends on the beneficiary's ability or willingness to pay. Any co-funding from other public bodies proportionally reduces the carbon savings the offset fund can claim, and so also affects the cost of carbon, if there is both a copayment and co-funding). Under the 'floating carbon costs' perspective, the carbon price needed to support a project is:

£Price/tCO_2 = [£(Average cost for project type)/tCO_2 x Indicative offset fund contribution %]

Or

£Price/tCO_2 = [£(Average cost for the project type)/tCO_2 x (1 – copayment %)]

The benefit of this change in perspective is that it underlines that desirability of leveraging offset funds with copayments to increase the range of measures that can be delivered at a given carbon price. The

[7] E.g. energy companies obligated to make carbon savings under the Energy Company Obligation
[8] 'Capital contriputions by beneficiaries' are henceforth referred to as copayments, as distinct from co-funding from public bodies or regulatorily obligated parties)

downside is that floating costs make it harder to derive a carbon price *"that reflects the cost of offsetting"* directly from the total cost of offsetting measures because there is an additional variable to be considered: the desirable or achievable level of copayments from beneficiaries. This study did not have the means to establish beneficiaries' willingness to pay for different carbon saving measures. Rather, the study established how the effective carbon costs of projects to the offset fund vary depending on the level of beneficiary copayments, which provides additional information for decision-making on carbon price setting.

1.3.4 Basis for carbon price recommendations

As explained above, fixed costs per tonne for carbon saving measures can only be derived using a carbon accounting approach that ignores or disincentivises financial contributions other than offset funding. Deriving the cost of carbon in a way that recognises and incentivises other funding leads to the cost of carbon for a project 'floating' depending on the proportion of other funding provided. AECOM took the view that it is important to set carbon accounting rules for offset schemes that encourage 'copayments' and reduce the effective cost of carbon to the offset fund. This means accepting 'floating' costs of carbon for saving measures, making it very difficult to analytically derive recommended carbon prices for London as a whole.

This led AECOM to adopt a study approach to carbon offset price-setting based on nationally recognised carbon prices: the government's 2017 non-traded price of carbon. This price would then be tested against the cost per tonne of carbon for selected carbon saving measures and projects.

Alternative approaches to carbon price setting based on project costs that have been used by some London Boroughs are briefly described in Appendix A.

1.3.5 Approach to carbon price constraints related to development viability

Higher carbon prices will essentially always enable a wider range of carbon saving project types to be delivered, making it easier to achieve a 1 to 1 offset ratio with collected offset funds. So if carbon prices are based solely on the costs of potential offsetting projects, the tendency will be to set high carbon prices. The main countervailing constraints on carbon prices are related to considerations of development viability.

In this study, consideration of any viability-related constraints on carbon prices was limited to a review of existing viability assessments in London, with a view to understanding the extent to which existing carbon prices have been tested and found to be consistent with viable development.

The carbon price options identified in this study are due to be tested as part of the viability assessment of the London Plan Review. It was agreed with GLA that two sets of carbon prices would be provided for viability testing.

The broad approach to carbon price setting in this study was set out above. The details of how the two sets of carbon offset prices were identified are set out in sections 2.1 and 3.5.

1.4 Study methodology

1.4.1 Kick-off meeting

The AECOM project team attended a kick-off meeting with the client to clarify the project scope and review and agree the project approach and methodology.

1.4.2 List of offsetting measures and costs

AECOM collated a broad list of indicative offset project types and costs based on existing studies, including:

- published London offsetting and carbon price setting studies (including AECOM studies for Islington, LLDC and Lewisham); and
- available data from nationwide and London carbon saving programmes such as ECO (and its predecessor, CERT), RE:FIT, RE:NEW, etc.

Project types considered included building energy efficiency and building-based decentralised and low carbon energy generation options in both existing homes and non-domestic buildings, and also opportunities in other sectors such as transport and standalone low carbon energy generation (e.g. energy from waste). The project types selected for analysis and presentation in this report were limited to those included in existing published information judged to be of sufficient quality and providing broadly comparable project cost information. Some selectivity was also applied to limit the number of individual building energy efficiency measures, to focus on those with significant remaining carbon saving potential in the stock at lower costs per tonne of carbon saved. In line with the approach above, the range across which the cost of carbon could 'float' was identified, as well as an indicative level of support (percentage contribution) that would be needed from an offset fund to enable each of the identified project types to proceed.

1.4.3 Review of carbon price constraints (information from existing viability assessments)

The study team reviewed available Borough-wide and London-wide viability assessments to identify instances and locations for which particular carbon price levels have been found to be compatible with ongoing development viability. Spot reviews of borough level viability assessments were carried out to identify any indications regarding the viability of development in representative locations within the borough (characterised by existing land uses and values) under the overall set of planning policies and obligations that apply, including assumptions about on-site carbon savings and offset payments for residual emissions at the carbon price established by the borough, or at £60/tCO_2[9]. The strength of conclusions that can be drawn about the affordability of different carbon prices in boroughs and locations across London depends on the number of assessments available and the range of carbon prices they cover.

1.4.4 Consideration of carbon price zones

Borough-wide viability assessments provide some information on which to base proposals for carbon price zones. AECOM considered the applicability of other bases for zoning carbon prices in London, focusing on the three zones into which boroughs are grouped for the purpose of mayoral CIL charging. (These are based on average borough house prices, which are used as a proxy for all types of property value.)

1.4.5 Review of existing carbon price setting approaches in London

The study team reviewed the carbon price setting approaches used by London Boroughs that have set a carbon price and compared the existing range of carbon prices with the price points suggested by the proposed review of project costs within this study.

1.4.6 Analysis, synthesis and reporting

The analysis of project costs, findings from the reviews of viability assessments and previous price-setting studies outlined above are synthesised, presented and discussed in the remainder of this report, under the following sections:

Section 2 Carbon pricing options and issues

Section 3 Potential offsetting measures and costs

Section 4 Review of carbon prices in London

Section 5 Recommendations on carbon offset pricing for London

[9] Cited in the SPG and adopted by London boroughs that have not set their own carbon price.

2. Carbon pricing options and issues

2.1 Establishing initial carbon price points of interest in the analysis

The approach to carbon price setting in this study is to accept that the cost of carbon saving measures is both widely variable and 'floating', depending on the level of copayments secured from beneficiaries, and that viability considerations may impose constraints on carbon price that are unrelated to the cost of delivering carbon savings. The analysis aims to illustrate what types of measures are likely to be affordable, i.e. enable the offset fund to achieve an average offset ratio of 1 to 1, at different price points and levels of copayments.

The 'Zero Carbon Hub price' of £60 /tonne is widely perceived to be the GLA's current default or recommended carbon price for London. The origin of that price is the government's central non-traded price of carbon[10] in 2013. The projections from which the £60 /tonne is drawn consist of low, central and high annual carbon prices up to the year 2100. The full set of non-traded carbon prices for 2013, and the current 2017 prices are set out in Table 2.

Year	Low	Central	High	Comments
2013	30	**60**	90	The central value in 2013 is widely used as the carbon offset price for London. Some Boroughs have adopted the high value as their carbon offset price
2017	32	64	95	These are the values used, as thresholds for understanding the affordability of carbon saving measures in this study

Table 2 2013 and 2017 non-traded carbon prices.

The 2017 low, central and high carbon prices are used in the carbon cost analysis presented in section 3, as thresholds for understanding the affordability of carbon saving measures. The appropriateness of these price points, in terms of the types of measures enabled, is then reviewed based on the results of the cost analysis, in section 3.5. The results of the cost analysis are also used as the basis for identifying a second set of potential carbon price points for viability testing.

2.2 Zoning

2.2.1 Rationale for zoning of carbon offset prices

The study team was asked to consider options for zonal carbon prices as an alternative to assuming that a single carbon price is recommended for the whole of London.

The option of zonal carbon prices arises from the potential effect of carbon prices on development viability. Two of the main factors in development viability are the market value of developed property and the alternative land use value, which depend on location, with the result that development viability generally varies by location. This is reflected in viability assessments, which tend to establish the viability of different types of new development in defined zones, and in approaches to securing contributions from developers in relation to Planning Obligations (Section 106) and towards necessary infrastructure (Community Infrastructure Levy).

Notably, Boroughs fall into one of three zones in terms of charging for Mayoral CIL. Many Boroughs also set CIL rates based on local charging zones, with four of the seven Boroughs reviewed in section 4 having three charging zones, and the other three Boroughs having two zones.

[10] See "Valuation of Energy Use and Greenhouse Gas Emissions – Supplementary guidance to the HM Treasury Green Book on Appraisal and Evaluation in Central Government" (Department for Business, Energy & Industrial Strategy, March 2017)

Applying zoning to carbon prices appears to be both useful – in addressing potential impacts on development viability – and practical – in that relevant zones to which differential carbon prices could be applied are already in place at a London-wide level (for Mayoral CIL) and within Boroughs (for local CIL charging).

2.2.2 How this study addresses zoning

Mayoral CIL charging zones may provide some proxy information about the relative viability of development on average for London boroughs. The challenge in applying zonal carbon prices is that development viability is ultimately dependent on local property market and land use values, and any proxy for borough-wide average viability is likely to mask wide variation in local viability within London boroughs. It follows that for carbon price zoning to closely reflect viability it would have to be applied wihin boroughs, along the lines of local CIL charging. Alternatively, for carbon price zoning to work at a London-wide level with each borough assigned to a carbon price zone, on the Mayoral CIL model, viability testing would need to establish which of the set of potential carbon prices (combined with all other development costs) "enable[s] schemes to remain viable" across each borough. Neither of these approaches could be taken further within the scope of the current study.

To enable GLA to recommend carbon prices that would support zoning, a set of three (low, central, and high) carbon prices has been considered throughout the study rather than a single carbon price. This ties in with both the current source of carbon prices widely used in London (the Treasury Green Book non-traded price of carbon) and the precedent of three London-wide charging zones for the Mayoral CIL.

If GLA opts to propose carbon price zones at a London-wide level, zones and pricing levels would need to be supported by feedback from the viability assessment of the full London Plan review. Alternatively, GLA may opt to recommend a set of three carbon prices with a view to enabling London Boroughs to set local carbon offset price zones accounting for development viability. In that case, the GLA should devlelop and publish guidance on how carbon prices for each zone should be calibrated relative to the set of recommended prices and taking account of information on local development viability. Further progress on options for carbon offset prices zones is outside the scope of this study.

2.3 Carbon price review and indexation

The study team was asked to consider the frequency and method for updating recommended carbon prices for London and whether these carbon offset prices should be index linked.

2.3.1 Price reviews – purpose and comparative references

The purpose of periodic price reviews would be to ensure that carbon prices reflect the cost of the remaining technical potential for carbon savings in the building stock and other sectors that provide savings opportunities.

The Government has published projections of the non-traded prices of carbon (low, central, and high) for every year up to 2100 for use in policy analysis. Annual price changes are in the order of 1.5% a year up to 2030.

The main national programmes that provide financial support to households and businesses to implement carbon saving measures are the Renewable Heat Incentive and Feed in Tariffs. Periodic tariff changes are an integral part of both RHI and FiTs, but the main driver for tariff changes is budget management rather than the cost of implementing measures. Broader reviews of the programmes, including tariffs, are initiated reactively to deal with any other issues that arise, typically every few years.

2.3.2 Indexation – purpose and comparative references

The purpose of indexation would be to increase carbon prices in line with price inflation, to ensure that the purchasing power of offset funds keeps pace with the cost of carbon saving measures. Indexation could be based on the retail or consumer prices index, which reflect general price inflation in the UK, or an index of inflation in a specific relevant sector, which for the majority of measures of interest to carbon prices would be the construction sector in London.

Tariffs for both RHI and FITs are adjusted annually in line with inflation, using the Consumer Price Index. Indexation is important because these schemes are predicated on providing an improved rate of return to their users. The costs of the renewable technologies funded are well understood and the tariffs are tightly tailored to match.

2.3.3 Recommendations on carbon offset price review and indexation

Decisions on the approach to price reviews and indexation of carbon offset prices should weigh the benefits of keeping prices up to date against the drawbacks of managing the change process, both at a policy level and in the administration of individual development and offsetting projects.

Regardless of the approach to carbon offset price setting, a price review mechanism would seem to be essential to ensuring that the price is maintained at a level that strikes a good balance between affordability to developers and providing the purchasing power (with leverage) to realistically enable offset funds to secure carbon savings from offsetting projects equal to residual emissions from development. However, there is also flexibility to manage the overall offset ratio achieved by an offset fund through the types of projects funded and the levels of copayments secured from beneficiaries. As such, it should not be necessary to review carbon offset prices with a high frequency. The frequency of price reviews might reasonably be left flexible or set to tie in with other planning policy review processes and critical external factors, such as updates to Part L of the Building Regulations. It would make sense to review the recommended offset prices at a time when updated prices can be tested as part of a viability assessment that is required to address other proposed policy changes. On that basis, it might reasonably be expected that carbon offset prices would be reviewed once every three to five years.

The view of the study team ss that it does not seem essential to apply annual indexation to carbon offset prices. Given the flexibility of offset funds to manage offset ratio through project selection and copayments, there is no overriding technical necessity for indexation to ensure that a fund can continue to operate. On the other hand, annual price updates would impose a definite administrative burden on funds.

The conclusions are that GLA should reviews its recommended carbon offset prices for London every three to five years. Reviews may be trigerred by changes to Part L of Building Regulations, that is likely to affect both residual emissions and the calculated carbon savings for many building retrofitting projects. Reviews should also tie in with wider planning policy review processes if possible, to take advantage of feedback from comprehensive viability assessments. Annual indexation of GLA's recommended carbon offset prices for London is not considered necessary.

3. Potential offsetting measures and costs

3.1 Unlimited range of potential offsetting measures

Neither the London Plan and related guidance nor Government policy announcements on Allowable Solutions establish explicit limitations on acceptable offsetting measures. (This is discussed further in Appendix A.) As such, a reasonable starting position is that offset funds raised through section 106 could be used to support any type of carbon saving project. Any limitations relate not to the types of project, but to legal strictures on Local Authority spending in general and particular rules around the use of section 106 funds (generally and in terms of overlap with Community Infrastructure Levy) and State Aid. This means that, in theory, offset funds could be used to fund a wide range of project types (efficiency, renewables, behaviour change, embodied carbon, etc.) in any sector of the economy (buildings, industry, transport, etc.)

3.2 Offsetting measures selected for analysis

In practice, the scale of funds, level of administrative capacity available, and the likely priorities of Local Authorities mean that offset funds are likely to be targeted at certain types of projects. These will be project types that councils and their partners have experience of delivering, or where they can draw on existing delivery expertise, e.g. at the London-wide level through RE:NEW, RE:FIT, and LEEF, or nationally through ECO, the Green Deal, SALIX, etc. Projects that fit this profile tend to be of the following types:

1. Fitting of energy efficiency measures in existing homes (especially in the social housing sector) and non-domestic (especially public) buildings;
2. Installation of small scale renewable energy systems to existing domestic and non-domestic buildings; and
3. Installation or enabling of specific low carbon technologies and ‘infrastucture’ that are the focus of national support and investment programmes, e.g.
    a. Connecting existing homes and non-domestic buildings to Local Authority sponsored district heating networks;
    b. Conversion of existing street lighting to LED lanterns;
    c. Installation of electric vehicle charging points; etc.

From the wide range of potential project types, the study team selected a set of 18 projects that fit the profile outlined above. Indicative implementation costs, annual carbon savings, lifetime of savings, and hence the lifetime carbon savings and cost per tonne of carbon saved were established for each measure or project type, as set out in Table 3. Costs and savings were based on impact assessments of Government policy, or on case studies (see Appendix B). For some potential project types, like electric vehicle charging points, it is inherently very difficult to establish even indicative carbon savings and corresponding costs, and these were not selected for analysis.

	Measure	Installation cost [£]	Annual carbon saving [kg]	Lifetime [years]	Lifetime carbon saving [t]	Cost of carbon saving [£/t]
1	Cavity Wall Insulation (Low Cost)	£595	577	42	24.2	£25
2	Cavity Wall Insulation (High Cost)	£3,500	577	42	24.2	£144
3	Internal SWI	£5,300	1,187	36	42.7	£124
4	External SWI	£8,100	1,187	36	42.7	£190
5	Loft Insulation	£300	108	42	4.5	£66
6	Double Glazing (old single to A)	£4,500	492	20	9.8	£457
7	Flat roof insulation	£1,050	594	20	11.9	£88
8	Draughtproofing	£100	140	10	1.4	£71
9	New or replacement storage heaters	£350	562	20	11.2	£31
10	Solar water heating [~3.0 kW]	£4,615	289	20	5.8	£800
11	Photovoltaics [~2.0 kW]	£3,365	828	25	20.7	£163
12	Whole house refurb (SWI)	£14,400	1,672	30	50.7	£284
13	Whole house refurb (high cost CWI)	£9,800	1,215	30	36.8	£266
14	Whole house refurb (low cost CWI)	£6,895	1,215	30	36.8	£187
15	RE:NEW (average, easy measures)	£111	171	13	2.2	£51
16	RE:FIT Retrofit 11 non-domestic buildings	£730,000	595,000	19	11,210	£65
17	1km DHN to 850 homes & 2 leisure centres	£3,800,000	1,800,000	40	72,000	£53
18	1,000 LED streetlamps	£892,600	166,400	20	3,328	£268

Table 3: Costs and carbon savings for selected carbon saving measures.

Measures 1 to 15 in Table 3 are applicable to homes, 16 to non-domestic buildings, and 17 & 18 are infrastructure measures.Individual measures for homes (1 to 11) are likely to be applied in varying combinations to an aggregated group of homes, such as private homes recruited through direct marketing to households, or to part of a social housing provider's stock. Measures 12 to 14 reflect the costs of implementing pre-selected packages of insulation measures to homes, and measure 15 reflects the average mix of measures applied to homes as part of the first phase of RE:NEW.

The cost of carbon for the selected measures range from £25 /tCO_2 for low cost cavity wall insulation to £800 /tCO_2 for solar water heating.

Note that on its own, the simple (capital) cost of carbon savings provides no information about the relative cost-effectiveness of measures as it does not take account of other cash flows related to energy savings and any income from energy sales. This is a reasonable approach to take for an offset fund that essentially provides capital grants for carbon saving measures because the cash flow benefits accrue to third party beneficiaries, and not to the offset fund.

3.3 Offset ratios for selected measures at various carbon prices

The cost of carbon savings shown in the right hand column of Table 3 is the cost of carbon based on the total cost of implementing the measure and the total lifetime carbon savings from the measure. If the measure is fully funded by an offset fund, this is the cost of carbon to the offset fund, and the offset ratio is the price of carbon (charged to developers) divided by the cost of carbon for the measure. The offset ratio for each measure at various carbon prices is shown in Table 4.

	Measure	Offset ratio @ £16 / tonne	£32 / tonne	£64 / tonne	£95 / tonne	£175 / tonne	£254 / tonne
1	Cavity Wall Insulation (Low Cost)	0.65	1.30	2.59	3.89	7.12	10.36
2	Cavity Wall Insulation (High Cost)	0.11	0.22	0.44	0.66	1.21	1.76
3	Internal SWI	0.13	0.26	0.51	0.77	1.41	2.05
4	External SWI	0.08	0.17	0.34	0.50	0.92	1.34
5	Loft Insulation	0.24	0.48	0.96	1.44	2.64	3.83
6	Double Glazing (old single to A)	0.03	0.07	0.14	0.21	0.38	0.56
7	Flat roof insulation	0.18	0.36	0.72	1.08	1.98	2.88
8	Draughtproofing	0.22	0.45	0.89	1.34	2.45	3.56
9	New or replacement storage heaters	0.51	1.02	2.04	3.06	5.61	8.16
10	Solar water heating [~3.0 kW]	0.02	0.04	0.08	0.12	0.22	0.32
11	Photovoltaics [~2.0 kW]	0.10	0.20	0.39	0.59	1.07	1.56
12	Whole house refurb (SWI)	0.06	0.11	0.22	0.34	0.61	0.89
13	Whole house refurb (high cost CWI)	0.06	0.12	0.24	0.36	0.66	0.95
14	Whole house refurb (low cost CWI)	0.08	0.17	0.34	0.51	0.93	1.36
15	RE:NEW (average, easy measures)	0.31	0.62	1.25	1.87	3.43	4.99
16	RE:FIT Retrofit 11 non-domestic buildings	0.24	0.49	0.98	1.46	2.68	3.90
17	1km DHN to 850 homes & 2 leisure centres	0.30	0.60	1.20	1.81	3.31	4.81
18	1,000 LED streetlamps	0.06	0.12	0.24	0.36	0.65	0.95

Table 4: Offset ratio for selected carbon saving measures at various carbon prices.

The figures presented in Table 4 should be understood as values for x where the offset ratio is then in the form x to 1, where values of x less than 1 indicate offset ratios below (i.e. worse) than 1 to 1, i.e. that the cost per tonne of carbon saving is higher than the price of carbon. Investing in projects with offset ratios less than 1 to 1 means carbon savings are less than the residual emissions from the developments from which offset funds were collected. Conversely, values of x greater than 1, mean the offset ratio at that price is above (i.e. better than) 1 to 1, cost is below price, and carbon savings are more than residual emissions.

Figure 3 shows how the offset ratio (horizontal axis) of the selected projects vary with carbon price (vertical axis). The vertical axis in the chart is positioned at an offset ratio of 1 to 1. Where the line for a measure cuts the vertical axis gives the carbon price at which the offset ratio for that measure is 1 to 1. Equally, all measures that cross the vertical axis below a given carbon price have offset ratios better than 1 to 1 at that price. For example, measures from ‘Cavity wall insulation…’ to ‘1km DHN…’ (as listed in reading order in the legend to Figure 3) have offset ratios better than 1 to 1 at a carbon price of £64 /tCO_2.

All selected projects

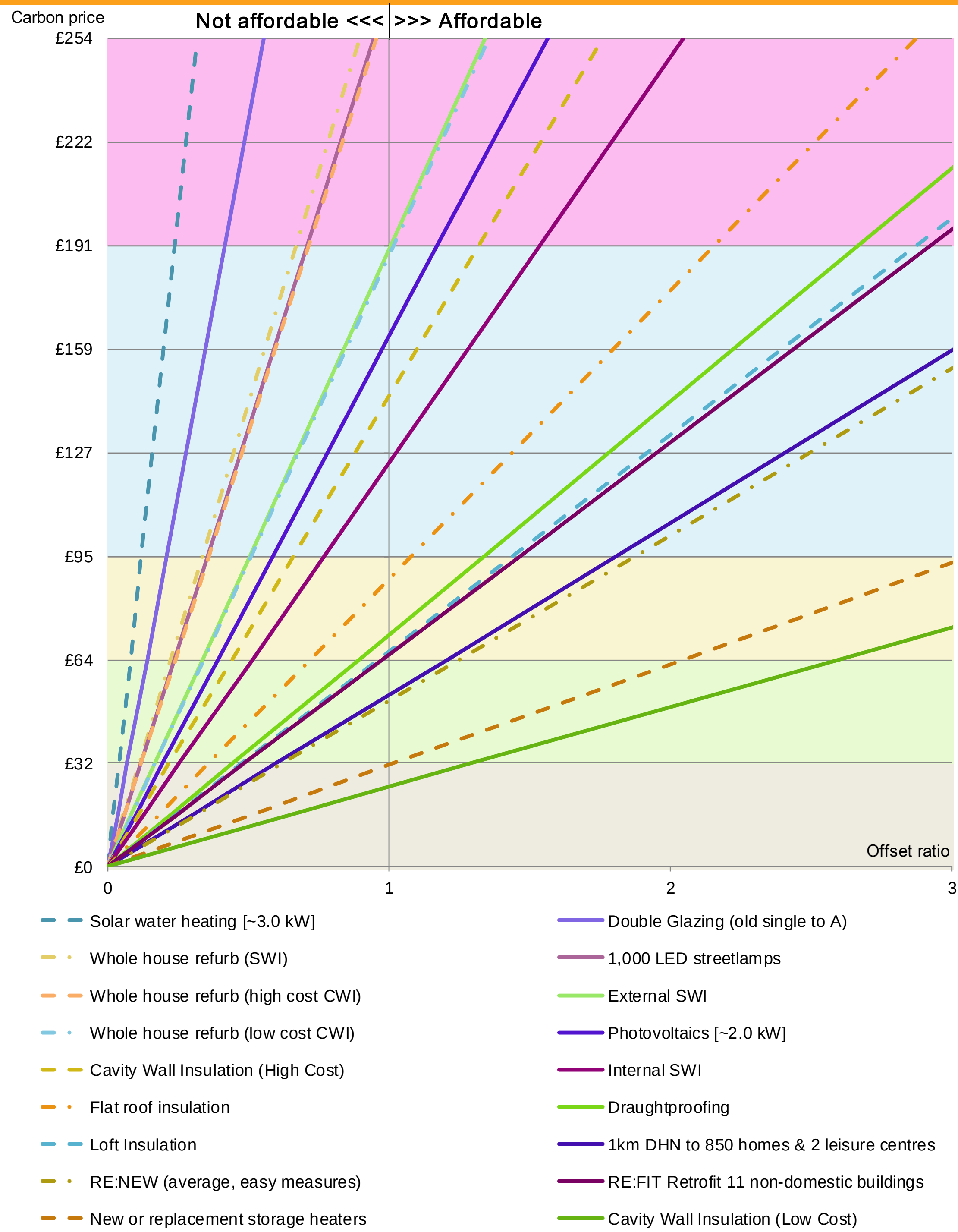


Figure 3. Variation of offset ratio with carbon price for selected measures

3.4 The effect of copayments on offset ratios

As described in the introduction, an offset fund may not pay the full cost of a carbon saving measure. The owner of the building or infrastructure or (where relevant) the beneficiary of energy bill savings, such as a householder or business, may pay part of the implementation costs. Assuming that owner and beneficiary contributions towards the implementation costs are ignored for the purposes of offset fund carbon accounting (see discussion in Appendix A), such 'copayments' effectively improve the offset ratio of a measure. To illustrate, Table 5 presents the fully funded offset ratios for the selected projects alongside the ratios assuming a 50% copayment.

	Offset ratio @						Offset ratio with copayment of 50% @					
	£16 / tonne	£32 / tonne	£64 / tonne	£95 / tonne	£175 / tonne	£254 / tonne	£16 / tonne	£32 / tonne	£64 / tonne	£95 / tonne	£175 / tonne	£254 / tonne
1	0.65	1.30	2.59	3.89	7.12	10.36	1.30	2.59	5.18	7.77	14.25	20.73
2	0.11	0.22	0.44	0.66	1.21	1.76	0.22	0.44	0.88	1.32	2.42	3.52
3	0.13	0.26	0.51	0.77	1.41	2.05	0.26	0.51	1.02	1.54	2.82	4.10
4	0.08	0.17	0.34	0.50	0.92	1.34	0.17	0.34	0.67	1.01	1.84	2.68
5	0.24	0.48	0.96	1.44	2.64	3.83	0.48	0.96	1.92	2.88	5.27	7.67
6	0.03	0.07	0.14	0.21	0.38	0.56	0.07	0.14	0.28	0.42	0.76	1.11
7	0.18	0.36	0.72	1.08	1.98	2.88	0.36	0.72	1.44	2.16	3.96	5.75
8	0.22	0.45	0.89	1.34	2.45	3.56	0.45	0.89	1.78	2.67	4.90	7.12
9	0.51	1.02	2.04	3.06	5.61	8.16	1.02	2.04	4.08	6.12	11.22	16.32
10	0.02	0.04	0.08	0.12	0.22	0.32	0.04	0.08	0.16	0.24	0.44	0.64
11	0.10	0.20	0.39	0.59	1.07	1.56	0.20	0.39	0.78	1.17	2.15	3.12
12	0.06	0.11	0.22	0.34	0.61	0.89	0.11	0.22	0.45	0.67	1.23	1.79
13	0.06	0.12	0.24	0.36	0.66	0.95	0.12	0.24	0.48	0.72	1.31	1.91
14	0.08	0.17	0.34	0.51	0.93	1.36	0.17	0.34	0.68	1.02	1.86	2.71
15	0.31	0.62	1.25	1.87	3.43	4.99	0.62	1.25	2.50	3.74	6.86	9.98
16	0.24	0.49	0.98	1.46	2.68	3.90	0.49	0.98	1.95	2.93	5.36	7.80
17	0.30	0.60	1.20	1.81	3.31	4.81	0.60	1.20	2.41	3.61	6.62	9.63
18	0.06	0.12	0.24	0.36	0.65	0.95	0.12	0.24	0.47	0.71	1.30	1.89

Table 5: Offset ratio for selected carbon saving measures at various carbon prices.

The shading in Table 5 indicates measures with offset ratios below 1 to 1 (red), or above 1 to 1 (green). As would be expected, a 50% copayment doubles the offset ratio at a given carbon price, increasing the number of projects with offset ratios better than 1 to 1 at a given price.

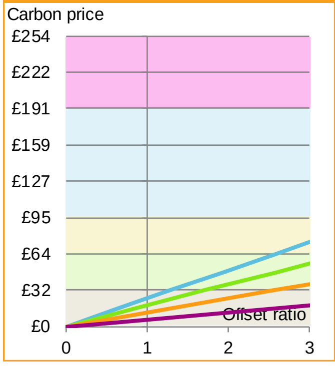
The 'dashboards', Figure 4 to Figure 6, on the following pages present the project costs, copayment amounts, and 'Carbon cost @ 1:1' (i.e. where the line crosses the vertical axis) for total project costs (fully funded from the offset fund), and 25%, 50% and 75% copayments. Horizontal shading in the plot areas indicate bands:

1. Between zero and the current low non-traded carbon price (grey),
2. Between the low and central non-traded carbon price (green),
3. Between the central and high non-traded carbon price (yellow), and
4. Between the high non-traded carbon price and (approximately[11]) the highest carbon price set in London (Westminster).

The measures have been presented (and renumbered, compared with the tables above) in increasing order of carbon cost.

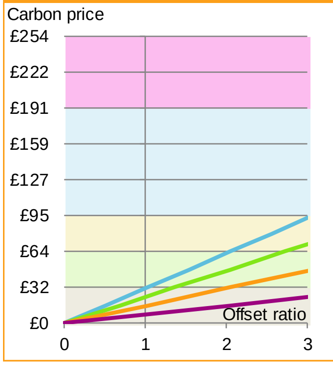
[11] The interval used between chart points is half the interval between the current non-traded carbon prices. This makes the maximum value on the chart £254, compared to the Westminster carbon price of £252.

1 Cavity Wall Insulation (Low Cost)



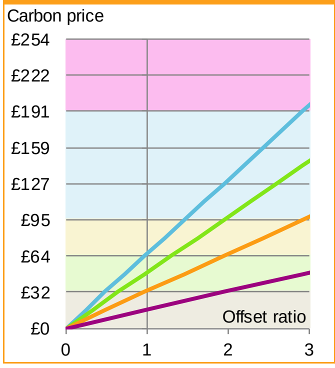
Copay-ment	Total project cost [£]	Carbon cost @ 1:1 [£/tCO_2]
None	£595	£25
Copayment		£/tCO_2
25% =	£149	£18
50% =	£297	£12
75% =	£446	£6

2 New or replacement storage heaters



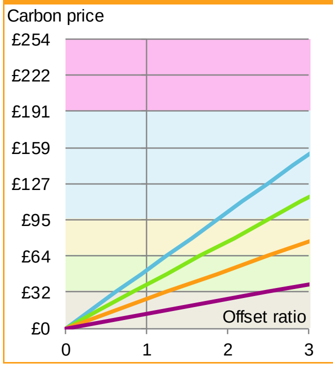
Copay-ment	Total project cost [£]	Carbon cost @ 1:1 [£/tCO_2]
None	£350	£31
Copayment		£/tCO_2
25% =	£88	£23
50% =	£175	£16
75% =	£263	£8

3 RE:NEW (average, easy measures)



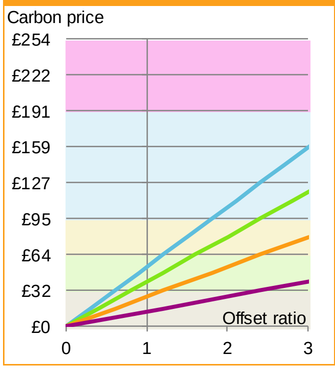
Copay-ment	Total project cost [£]	Carbon cost @ 1:1 [£/tCO_2]
None	£111	£51
Copayment		£/tCO_2
25% =	£28	£38
50% =	£56	£25
75% =	£84	£13

4 1km DHN to 850 homes & 2 leisure centres



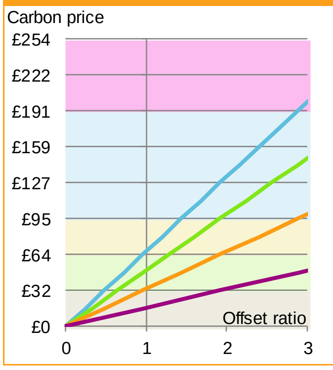
Copay-ment	Total project cost [£]	Carbon cost @ 1:1 [£/tCO_2]
None	£3,800,000	£53
Copayment		£/tCO_2
25% =	£950,000	£40
50% =	£1,900,000	£26
75% =	£2,850,000	£13

5 RE:FIT Retrofit 11 non-domestic buildings



Copay-ment	Total project cost [£]	Carbon cost @ 1:1 [£/tCO_2]
None	£730,000	£65
Copayment		£/tCO_2
25% =	£182,500	£49
50% =	£365,000	£33
75% =	£547,500	£16

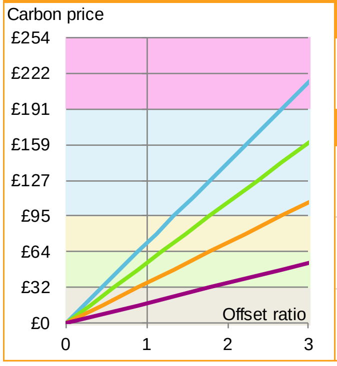
6 Loft Insulation



Copay-ment	Total project cost [£]	Carbon cost @ 1:1 [£/tCO_2]
None	£300	£66
Copayment		£/tCO_2
25% =	£75	£50
50% =	£150	£33
75% =	£225	£17

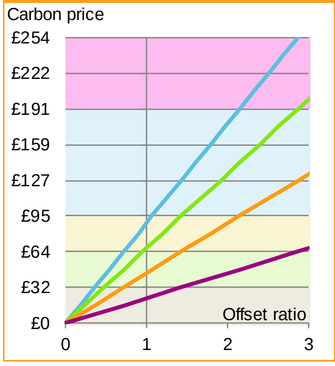
Figure 4 Variation of offset ratio with carbon price & copayment for selected measures (1)

7 Draughtproofing



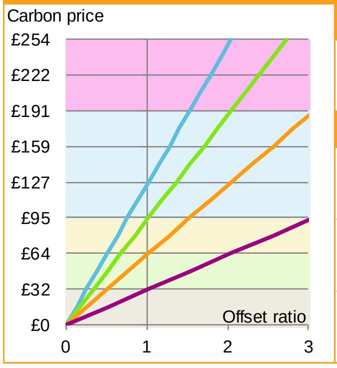
Copay-ment	Total project cost [£]	Carbon cost @ 1:1 [£/tCO$_2$]
None	£100	£71
Copayment		**£/tCO$_2$**
25% =	£25	£54
50% =	£50	£36
75% =	£75	£18

8 Flat roof insulation



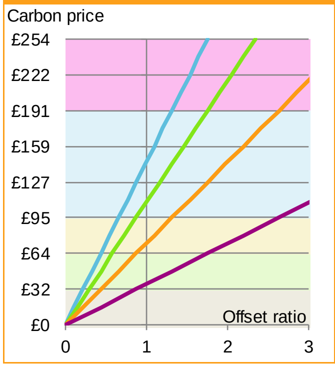
Copay-ment	Total project cost [£]	Carbon cost @ 1:1 [£/tCO$_2$]
None	£1,050	£88
Copayment		**£/tCO$_2$**
25% =	£263	£66
50% =	£525	£44
75% =	£788	£22

9 Internal SWI



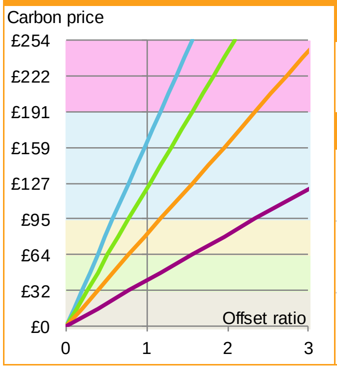
Copay-ment	Total project cost [£]	Carbon cost @ 1:1 [£/tCO$_2$]
None	£5,300	£124
Copayment		**£/tCO$_2$**
25% =	£1,325	£93
50% =	£2,650	£62
75% =	£3,975	£31

10 Cavity Wall Insulation (High Cost)



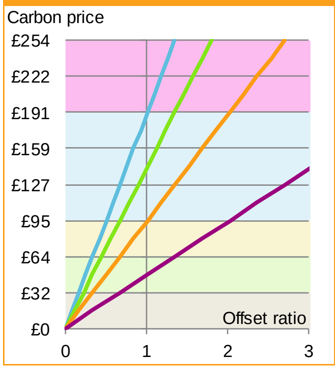
Copay-ment	Total project cost [£]	Carbon cost @ 1:1 [£/tCO$_2$]
None	£3,500	£144
Copayment		**£/tCO$_2$**
25% =	£875	£108
50% =	£1,750	£72
75% =	£2,625	£36

11 Photovoltaics [~2.0 kW]



Copay-ment	Total project cost [£]	Carbon cost @ 1:1 [£/tCO$_2$]
None	£3,365	£163
Copayment		**£/tCO$_2$**
25% =	£841	£122
50% =	£1,683	£81
75% =	£2,524	£41

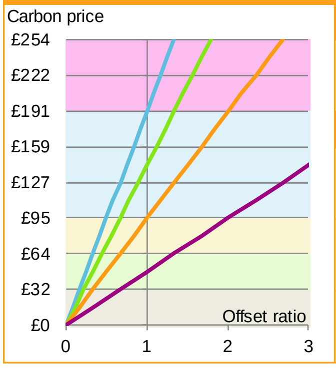
12 Whole house refurb (low cost CWI)



Copay-ment	Total project cost [£]	Carbon cost @ 1:1 [£/tCO$_2$]
None	£6,895	£187
Copayment		**£/tCO$_2$**
25% =	£1,724	£140
50% =	£3,447	£94
75% =	£5,171	£47

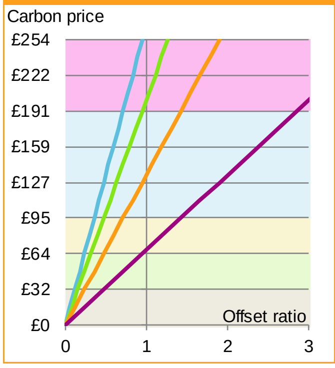
Figure 5 Variation of offset ratio with carbon price & copayment for selected measures (2)

13 External SWI



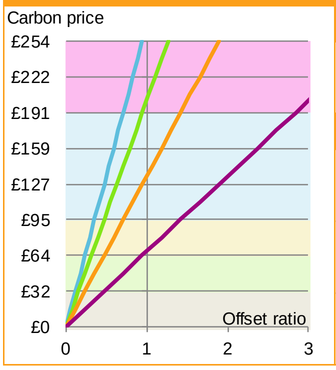
Copay-ment	Total project cost [£]	Carbon cost @ 1:1 [£/tCO_2]
None	£8,100	£190
Copayment		£/tCO_2
25% =	£2,025	£142
50% =	£4,050	£95
75% =	£6,075	£47

14 Whole house refurb (high cost CWI)



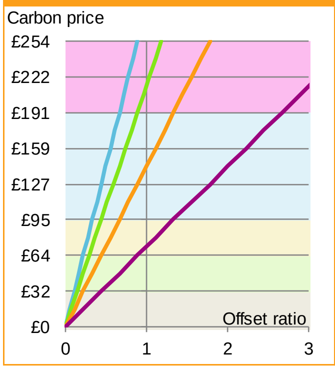
Copay-ment	Total project cost [£]	Carbon cost @ 1:1 [£/tCO_2]
None	£9,800	£266
Copayment		£/tCO_2
25% =	£2,450	£200
50% =	£4,900	£133
75% =	£7,350	£67

15 1,000 LED streetlamps



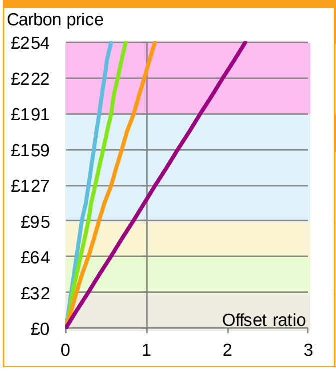
Copay-ment	Total project cost [£]	Carbon cost @ 1:1 [£/tCO_2]
None	£892,600	£268
Copayment		£/tCO_2
25% =	£223,150	£201
50% =	£446,300	£134
75% =	£669,450	£67

16 Whole house refurb (SWI)



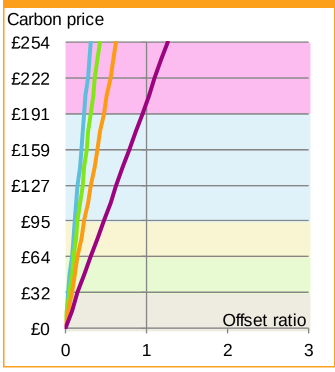
Copay-ment	Total project cost [£]	Carbon cost @ 1:1 [£/tCO_2]
None	£14,400	£284
Copayment		£/tCO_2
25% =	£3,600	£213
50% =	£7,200	£142
75% =	£10,800	£71

17 Double Glazing (old single to A)



Copay-ment	Total project cost [£]	Carbon cost @ 1:1 [£/tCO_2]
None	£4,500	£457
Copayment		£/tCO_2
25% =	£1,125	£343
50% =	£2,250	£228
75% =	£3,375	£114

18 Solar water heating [~3.0 kW]



Copay-ment	Total project cost [£]	Carbon cost @ 1:1 [£/tCO_2]
None	£4,615	£800
Copayment		£/tCO_2
25% =	£1,154	£600
50% =	£2,308	£400
75% =	£3,462	£200

Figure 6 Variation of offset ratio with carbon price & copayment for selected measures (3)

3.5 Implications of project cost analysis for carbon price setting

As discussed in the introduction, the analysis of project costs can provide a broad indicative basis for carbon price setting, rather than a definitive carbon price value. The dashboards above are a means for considering the implications of different carbon prices in terms of the deliverability of each of the selected measures. NB. all of the discussion in this section applies only to the specific set of selected measures and indicative project costs, carbon savings, and consequent costs of carbon.

The first five measures can deliver offset ratios above 1 to 1 at the central non-traded carbon price of £64 /tCO_2, even without copayments. Note that securing copayments even for measures that could be fully funded at offset ratios above 1 to 1 would free up offset funds to support projects with ratios below 1 to 1 while aiming to achieve an offset ratio of 1 to 1 for the offset fund as a whole.

Measures 6 through 13 require increasing levels of copayments (of up to 75%) to deliver offset ratios above 1 to 1 at £64 /tCO_2. And the last 5 measures require copayments of more than 75% to deliver offset ratios of 1 to 1 at that price.

The cost of carbon then rises sharply. Only three additional measures have ratios of 1 to 1 below the high non-traded carbon price of £95 /tCO_2, giving a total of 8 measures affordable below this price level. None of the remaining 11 measures can deliver ratios of 1 to 1 at £95 /tCO_2 or below without copayments above £1000 /project, which would likely constrain interest from householders.Five further project types could be fully funded at a ratio of 1 to 1 within the carbon price range considered, up to £254 /tCO_2. The remaining 5 measures would require a carbon price above £254 /tCO_2 in order to achieve a 1 to 1 ratio.

The carbon price vs. offset ratio lines for the selected measures are generally more even spaced than clustered, so there are no glaringly obvious price points at which setting carbon prices would enable a group of the selected measures to be fully funded. However, whole house refurbishment (with low cost cavity wall insulations) and standalone external solid wall insulation are close together and could both be fully funded at a carbon price of around £191 /tCO_2.

The absolute amount of copayment (£) required to deliver a measure at an offset ratio of 1 to 1 is likely to be more important than the percentage of total project cost this represents. For example, it is likely to be easier to secure a copayment of £25 towards (7) draughtproofing than one of £263 towards (8) flat roof insulation. Many of the measures with higher cost of carbon also have high total costs and hence high copayments to achieve 1 to 1 offset ratios in the range of carbon prices of interest. For measures applicable to homes, householders are unlikely to contribute these levels of copayments. This implies that the more expensive measures with high carbon costs will only be delivered by other types of building owners (e.g. social housing providers), or where the offset fund is prepared to accept offset ratios below 1 to 1 for those types of measures.

Notably from the analysis of selected measures, it appears that project types like RE:NEW and RE:FIT (that install relatively cheap, cost-effective measures in homes and non-domestic buildings) could be fully funded through an offset fund and deliver offset ratios of 1 to 1 or better at the current central non-traded price of carbon (£64 /tCO_2). It appears that important project types for achieving large cuts in carbon savings (e.g. solid wall insulation, and various types of whole house refurbishment) could only be delivered at higher carbon prices or with significant proportion of copayment (in the order of several thousand pounds).

The broad conclusion that can be drawn from the analysis of project costs is that there are measures that can be fully funded at offset ratios of 1 to 1 within the range of non-traded carbon prices that have informed carbon offset price setting to date. Higher carbon prices would, logically, enable a wider range of projects to be fully funded or delivered with copayments from willing beneficiaries or building / infrastructure owners. There are no glaringly obvious price points to test between the high non-traded carbon price of £95 /tCO_2 and the upper end of the price range considered, £254 /tCO_2. However, for the selected measures, whole house refurbishment (with low cost cavity wall insulations) and standalone external solid wall insulation could both be fully funded at a carbon price of around £191 /tCO_2. External SWI in particular is a totemic measure, recognised to represent significant unrealised saving potential in the stock. As such, the study team proposes £191 /tCO_2 as the upper carbon price for the second set of carbon prices for viability testing.

4. Review of carbon prices in London

AECOM reviewed the carbon prices set by Boroughs who had adopted a price independent of the £60 /tCO_2 cited as an example in the SPG. AECOM also reviewed the basis for setting this price and whether prices had been zoned according to the characteristics of local areas. This included carbon prices established by:

- Islington
- Croydon
- Enfield
- Camden
- Haringey
- Lewisham
- Westminster

Table 6 provides a summary of the range of carbon offset prices adopted by the Boroughs and the basis on which these were set.The review did not reveal any zoning of carbon offsetting prices but did identify that CIL charges set out in CIL charging schedules of each Borough are typically zoned with two or three charging zones. Table 6 provides a summary of the approach taken to CIL zoning and pricing for each Borough.

The scope of this study does not include undertaking viability assessments but does include recommending the price ranges that GLA should test as part of its own viability assessment for the London Plan. The range of prices adopted by Boroughs, as shown in Table 6, is one of the factors that has informed AECOM's recommended price range. GLA's viability assessment should include commentary on the materiality of carbon offsetting payments to development viability, for the range of carbon prices proposed for testing.

Borough	Price (annual)	Justification	CIL Charging Schedule for Dwellings only (rate/m²)
Islington	£920 - one off payment /tonne	Local assessment carried out by consultants in 2012 – based on yearly operational emissions spent on measures to offset one tonne of carbon year on year.	Two Zones: Area A: £300; Area B: £250 Charging schedule effective on 01 September 2014.
Croydon	£1,380 (£46)	A 'conservative' marginal cost of carbon abatement adopted in early government consultations on Allowable Solutions.	Two Zones: Croydon Metropolitan Centre: £0; Rest of the borough: £120. Charging Schedule effective on 01 April 2013
Enfield	£2,250 (£75)	Illustrative figure used by the Zero Carbon Hub in their document 'Carbon compliance: setting an appropriate limit for zero carbon in new homes (February 2011).*	Three Zones: Lower rate: £40; Intermediate rate: £60; Higher rate:£120. Charging Schedule effective on 01 April 2016.
Camden	£2,700 (£90)	High Price Cap Option from early government consultations on Allowable Solutions	Three Zones and two development scenarios: Residential below 10 dwellings (or 1000sqm): Zone A (central): £500; Zone B (Rest of Camden): £500; Zone C (Highgate, Hampstead): £500. Residential of 10 or more dwellings (or above 1000sqm) and private care residential homes with a degree of self-containment: Zone A: £150; Zone B: £250; Zone C: £500. Charging Schedule effective on 01 April 2015.
Haringey	£2,700 (£90)	High Price Cap Option from early government consultations on Allowable Solutions	Three zones: Western: £265; Central: £165; Eastern: £15. Charging Schedule effective on 01 October 2014.
Lewisham	£3,210 (£104)	Lewisham Cost of Carbon Report 2014	Two CIL zones: Zone 1: £100; Zone 2: £70. Charging Schedule effective on 1 April 2015.
Westminster	£7,560 - one off payment /tonne	Local assessment carried out in 2013/14. Price derived from an assessment of the cost of delivering a range of carbon saving measures in the Borough which are costly due to large number of heritage buildings and designations making energy efficiency measures more expensive.	Three CIL zones: Prime: £550; Core: £400; Fringe: £200. Charging Schedule effective on 01 May 2016.

Table 6: Findings from desk review of carbon prices in 7 London Boroughs

5. Recommendations on carbon offset pricing for London

AECOM has arrived at recommendations for carbon offset prices to be included in the GLA's viability assessment based on the:

- Policy background set out in section 1.2
- Approach to carbon price-setting based on a recognised national carbon pricing mechanism, described in section 1.3.4;
- Discussion of carbon pricing options in section 2;
- Analysis of indicative costs of carbon savings for selected measures set out in section 3; and
- The carbon offset price of London Boroughs who have independently established their own value as summarised in section 4.

Recognising that the viability of development varies across London and within London Boroughs, rather than identifying a single carbon price, the study team has identified a set of carbon prices consisting of a low, a central, and a high price. Two options for carbon price sets have been identified to allow for testing of a price range centred on a carbon price similar to the one most widely adopted to date across London (£60 /tCO_2) and a higher price range that would inherently enable a wider range of measures, including notable project types recognised to have significant undelivered technical potential in the stock and that could deliver 'deep' carbon savings in homes.

The carbon price sets recommended for testing are as follows:

Option	Low	Central	High	Comments
Option1	32	64	95	Treasury Green Book non-traded carbon prices for 2017; same source as 'Zero Carbon Hub price' of £60 /tCO_2 cited as an example in the Sustainable Design and Construction SPG to the London Plan and widely adopted across London
Option 2	64	127	191	High price set based on indicative cost of external solid wall insulation and whole house refurbishment (with low cost cavity wall insulation); low price set to central non-traded carbon price; results in wide price range

These carbon price options are subject to viability testing, and subsequent consideration by GLA before a decision is taken on recommending any carbon offset prices for London.

Appendix A Carbon offsetting background

Alternative approaches to carbon price setting

Seven London boroughs have set carbon prices other than the £60 /tCO_2 cited as the "Zero Carbon Hub price" in the SPG. Four of those boroughs – Croydon (£46 /tCO_2), Enfield (£75 /tCO_2), Camden and Harringey (both £90 /tCO_2) – set prices by reference to a nationally recognised source or carbon pricing mechanism.

Three London Boroughs have set carbon prices based on analysis of the cost of carbon saving projects. Two broad approaches have been used.

Illustrative mix approach to carbon price setting

This approach derives a fixed average cost of carbon savings based on an 'illustrative mix' of offsetting projects. This requires assumptions to be made about the mix of projects (i.e. the number of each type of project) delivered to offset an assumed quantity of residual emissions (calculated based on projections of future development in the borough).

The use of an illustrative mix essentially underpinned the approach to setting carbon prices in Islington (£920 /tCO_2/year[12] = £31 /tCO_2 approx.[13]) and Lewisham (£3,210 tCO_2/year = £107 tCO_2). Different carbon prices emerging from this approach can be a reflection of differences in one or more of: the quantity of residual emissions to be offset, the mix of offsetting projects that the council wants to promote or expects to come forward, and the underlying assumptions about the cost and carbon savings of offsetting projects.

Marginal abatement cost approach to carbon price setting

This approach derives the carbon price needed to offset an assumed quantity of residual emissions based on constructing a marginal abatement cost curve of potential offsetting measures in the borough. The price is taken from the point on the cost curve where the carbon savings from projects equals the projected quantity of residual emissions from new development in the borough.

Westminster (£7,560 tCO_2/year = £252 tCO_2) used the marginal abatement cost approach for setting its original carbon offset price.

The implicit assumption in these two price setting approach, as they were implemented, is that projects are fully funded through contributions from the offset fund.

Alternative carbon accounting approaches – worked example

The table below sets out a worked example of three alternative methods of accounting for the carbon savings achieved by an offsetting project with multiple sources of funding. The example includes three types of funder:

1. The offset fund;
2. Any other provider of subsidy – which in this context is likely to mean companies acting to meet regulatory obligations to save carbon, in particular energy companies contributing to carbon saving projects to meet their targets under the Energy Company Obligations scheme, ECO); and
3. The beneficiary of the offsetting project – which could be a household (in a home of any tenure), or a public or private business. Copayments from beneficiaries raised through green loans such as SALIX and Green Deal are treated the same as money drawn from cash reserves or bank loans, because the beneficiary ultimately pays the capital in all cases.

[12] In the early days of offsetting policy development carbon prices were sometimes quoted 'per annual tonne', referring to the annual residual carbon emissions calculated for the subject development. Even when the period for which emissions must be offset (the SPG specifies 30 years) is also clear, this approach to citing carbon prices causes confusion. In particular, it encourages equivalent citing of annual carbon savings for projects, even though measures have varying lifetimes, often different from the 30 years-worth of carbon savings that offsetting should deliver. The use of absolute price per tonne of carbon (which can be compared to the cost per tonne of carbon savings over whatever the lifetime of a measure) is less prone to confusion.
[13] assuming residual emissions must be offset for 30 years

The three alternative carbon accounting approaches set out in the main body of the report are considered:

Option 1: Proportional shares – Carbon savings are shared according to the proportion of capital funding provided by each party, including the beneficiary

Option 2: Proportional shares by subsidy – Carbon savings are shared among all public, third party or regulatorily obligated co-funders according to the proportion of capital funding (i.e. subsidy) provided. Any capital contributions by beneficiaries are ignored when sharing out the carbon savings

Option 3: Fund takes all – All savings are attributed to the Offset Fund (i.e. effectively assuming that the offset funding 'unlocks' the project, which would otherwise not go ahead)

The example sets out the varying results in terms of the different carbon savings claimed by the offset fund, and hence the different offset ratio outcomes for the same project, depending on the carbon accounting approach adopted.

Offsetting project – RE:NEW (easy energy retrofit measures) in 10 homes			
Carbon saving measures	Low energy lightbulbs, radiator reflector panels, hot water tank insulation, visual display meter units, draught proofing		
Lifetime of measures [years]	13*		
Annual carbon savings per home [tCO_2/year]	171		
Annual carbon savings, 10 homes [tCO_2]	1,710		
Lifetime carbon savings, 10 homes [tCO_2]	22.2		
Project funding			
Cost per home	£111		
Total project implementation cost	£1,110		
Breakdown by funder			
1. Offset Fund contribution	£555 (50%)		
2. Other subsidy: ECO**	£278 (25%)		
3. Beneficiary copayment	£277 (25%)		
Carbon accounting	**Proportional shares**	**Proportional shares by subsidy**	**Fund takes all**
Proportion of saving claimed by offset fund	555 / 1,110 = 50%	555 / (555 + 278) = 67%	100%
Carbon saving claimed by offset fund [tCO_2]	11.1	14.8	22.2
Cost per tonne of carbon [£/tCO_2]	£50	£37.5	£25
Project offset ratio = £46 / (cost/tCO_2)	1.28	1.71	2.56
Offset ratio if fully funded by the offset fund	1.28		
Notes * this is the weighted average, as the lifetime of individual measures varies ** assuming, for the purpose of illustration, that some of the measures implemented are eligible for ECO funding *** assuming a carbon price of £64 /tCO_2			

Example of alternative carbon accounting options applied to an offsetting project

What this example shows is that the different accounting approaches produce different carbon savings for the offset fund, and different offset ratios for the project considered:

The best offset ratio for the fund is obtained by claiming all the savings, but as other providers of subsidy would also be claiming these savings to meet their policy-related targets, the 'fund takes all' accounting approach is vulnerable to the charge of 'double counting' of carbon savings.

Under 'proportional shares', regardless of the percentage contribution from the offset fund, the offset ratio is always the same as it would have been if the project had been fully funded through offsetting.

Under 'proportional shares by subsidy' the copayment improves the offset ratio – which does not happen under 'proportional shares' – and the offset fund only claims a share of total project carbon savings in proportion to the share of all subsidy funding – avoiding 'double counting' of carbon savings that could reasonably be claimed by other providers of subsidy.

In practice, 'proportional shares by subsidy' carbon accounting may not avoid all questionable double counting of savings, as the carbon accounting rules adopted by offset funds would not apply to other providers of subsidy, such as parties obligated under ECO or other regulations. The savings claimed by such parties will be governed by the relevant regulations and administrative guidelines, which may allow them to claim savings also claimed by the offset fund under 'proportional shares by subsidy' accounting. However, this is not something that can be addressed by the choice of carbon accounting approach for offset funds and does not change the relative assessment of the alternative carbon accounging approaches identified.

The 'proportional shares by subsidy' carbon accounting approach was adopted in this study because:

- It incentivises the securing of copayments which improve the offset ratio, which equates to better value for public money (more carbon savings per pound of offset funds spent);
- Allows offset funds to cofund projects alongside other subsidy funding, which enables more expensive projects with potentially 'deeper' carbon savings to be implemented; and
- Avoids or reduces double counting of carbon savings in cases where offset funds are contributed alongside other grants of subsidy funding.

Additionality

Additionality is a straightforward idea in principle: a carbon saving scheme (or project) such as an offset fund (or carbon saving project funded by such a fund) is delivering 'additionality' if it saves carbon that would not have been saved without the fund (or project). Schemes or projects are not delivering additionality if the same carbon savings would be delivered in any case (free riding) or at equal or lower costs by other policy mechanisms (policy overlap).

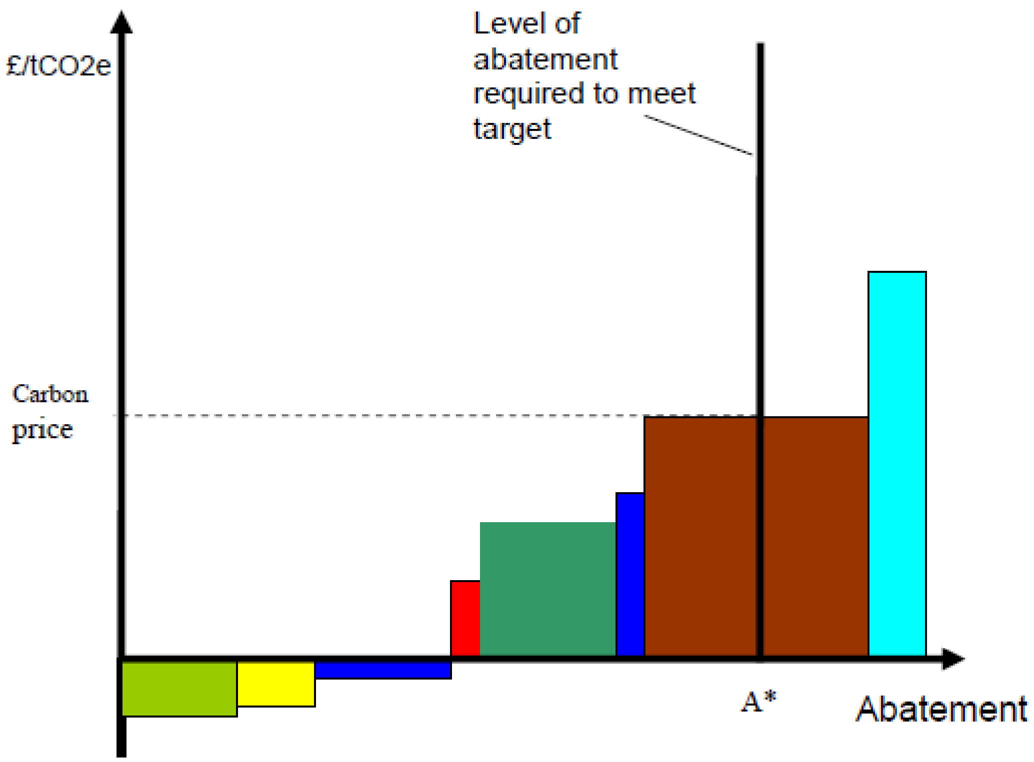
In practice it is difficult to construct a working definition of additionality that can determine whether, or to what extent, a scheme or project delivers additional carbon savings.

Acceptable types of carbon offset project

London Plan policy places no explicit limits on the types of offsetting projects that can be undertaken. The impetus and model for carbon offsetting originally came from Allowable Solutions, which was part of the Government's policy approach for zero carbon homes. The Zero Carbon Hub investigated how the zero carbon homes policy might be implemented, and their publication "Allowable Solutions for Tomorrow's New Homes" is often-cited as a reference on Allowable Solutions and offsetting. The report includes a list of potential "options" for carbon saving project types, grouped into "'On-site'… 'Near-site'" and "'Off-site' options", but cautions that "that these are only indicative of the types of projects that might be included in the Government's list of acceptable Allowable Solutions." However, development of that policy did not advance as far as defining project types that would be allowed.

Allowable Solutions for Tomorrow's New Homes is the source of the 'Zero Carbon Hub price' of £60 /tonne. The origin of that price is the government's non-traded price of carbon[14], which is "based on estimates of the marginal abatement cost required to meet the UK's non-traded sector emissions reduction target" (Department of Energy and Climate Change, Climate Change Economics, July 2009). In other words, the carbon price of £60 /tonne is related to the cost of all carbon saving measures in the UK (as notionally illustrated in Figure 7) that reduce emissions not covered by the EU Emissions Trading Scheme.

Figure 7: Abatement cost curve.



Given the use of the non-traded carbon price, a reasonable deduction is that any of the project types included in the derivation of that price – i.e. identifiable carbon saving projects in all non-traded sectors – could be acceptable offsetting projects.

[14] See "Valuation of Energy Use and Greenhouse Gas Emissions – Supplementary guidance to the HM Treasury Green Book on Appraisal and Evaluation in Central Government" (Department for Business, Energy & Industrial Strategy, March 2017)

Appendix B Basis of costs for selected carbon saving measures

Cost sources

	Measure	Installation cost [£]	Annual carbon saving [kg]	Lifetime [years]	Lifetime carbon saving [t]	Cost of carbon saving [£/t]	Cost source
1	Cavity Wall Insulation (Low Cost)	£595	577	42	24.2	£25	a
2	Cavity Wall Insulation (High Cost)	£3,500	577	42	24.2	£144	a
3	Internal SWI	£5,300	1,187	36	42.7	£124	a
4	External SWI	£8,100	1,187	36	42.7	£190	a
5	Loft Insulation	£300	108	42	4.5	£66	a
6	Double Glazing (old single to A)	£4,500	492	20	9.8	£457	a
7	Flat roof insulation	£1,050	594	20	11.9	£88	a
8	Draughtproofing	£100	140	10	1.4	£71	a
9	New or replacement storage heaters	£350	562	20	11.2	£31	a
10	Solar water heating [~3.0 kW]	£4,615	289	20	5.8	£800	b
11	Photovoltaics [~2.0 kW]	£3,365	828	25	20.7	£163	c
12	Whole house refurb (SWI)	£14,400	1,672	30	50.7	£284	a*
13	Whole house refurb (high cost CWI)	£9,800	1,215	30	36.8	£266	a*
14	Whole house refurb (low cost CWI)	£6,895	1,215	30	36.8	£187	a*
15	RE:NEW (average, easy measures)	£111	171	13	2.2	£51	d
16	RE:FIT Retrofit 11 non-domestic buildings	£730,000	595,000	19	11,210	£65	e
17	1km DHN to 850 homes & 2 leisure centres	£3,800,000	1,800,000	40	72,000	£53	f
18	1,000 LED streetlamps	£892,600	166,400	20	3,328	£268	g

Cost source	
a	DECC. (June 2012). Final Stage Impact Assessment for the Green Deal and Energy Company Obligation IA No: DECC0072. London: DECC. Table 49: Energy savings, Green Deal finance and ECO subsidy available for eligible measures, p. 138. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/70265/5533-final-stage-impact-assessment-for-the-green-deal-a.pdf
b	DECC. (March 2016). Non-Domestic RHI and domestic RHI installation cost estimate: October 2015. London: DECC. Domestic RHI reported installation costs (Oct 2015). https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/505269/RHI_Reported_Installation_Costs_Oct_2015_03032016.xlsx
c	Parsons Brinkerhof. (August 2015). Small-scale generation cost update (3514055A Final). London: DECC. Untitled table, p. 16. https://beisgovuk.citizenspace.com/decc-policy/fit-review-2015/supporting_documents/SmallScale%20Generation%20Costs%20Update.PDF
a*	Based on a combination of measures in source a (see explanation in section below)
d	EST. (Undated). RE:NEW Roll-out Evaluation Report – 2011/12. London: GLA. Table 3: Key carbon outputs, p. 23/24. Table 7: Total cost to the GLA, p. 36/37. https://www.london.gov.uk/sites/default/files/RENEW%20report%20full%20FINAL.pdf
e	GLA. (Undated). West London Alliance (WLA) Case Study. London: GLA. https://www.london.gov.uk/sites/default/files/west_london_alliance.pdf. And unpublished information provided by the programme manager, via GLA.
f	Islington. (Undated). Bunhill Heat and Power Case Study. London: Islington Sustainable Energy Partnership. http://www.isep.org.uk/wp-content/uploads/BUNHILL-case-study-2013.pdf
g	Glasgow City Council. (March 2015). New LED Sustainable Lighting Project. Glasgow: Glasgow City Council. https://www.glasgow.gov.uk/councillorsandcommittees/viewSelectedDocument.asp?c=P62AFQUTNTT10GT1

Assumed make-up and costs for whole house refurbishment projects

	Combination measures	Installation cost [£]	Annual carbon saving [kg]	Lifetime [years]	Lifetime carbon saving [t]	Cost of carbon saving [£/t]	Cost source
12	Whole house refurb (SWI)	£14,400	1672	30	50.7	£284.25	a
	External SWI	£8,100	1187	36	32.0	£189.60	a
	Loft Insulation	£300	108	42	3.4	£66.27	a
	Floor insulation	£400	234	36	6.3	£47.45	a
	Double Glazing (old single to A)	£4,500	492	20	7.4	£456.87	a
	High performance replacement doors	£1,000	68	9	0.5	£1,622.72	a
	Draughtproofing	£100	140	10	1.1	£71.33	a
13	Whole house refurb (high cost CWI)	£9,800	1215	30	36.8	£266.27	a
	Cavity Wall Insulation (High Cost)	£3,500	577	42	18.2	£144.33	a
	Loft Insulation	£300	108	42	3.4	£66.27	a
	Floor insulation	£400	234	36	6.3	£47.45	a
	Double Glazing (old single to A)	£4,500	492	20	7.4	£456.87	a
	High performance replacement doors	£1,000	68	9	0.5	£1,622.72	a
	Draughtproofing	£100	140	10	1.1	£71.33	a
14	Whole house refurb (low cost CWI)	£6,895	1215	30	36.8	£187.33	a
	Cavity Wall Insulation (Low Cost)	£595	577	42	18.2	£189.60	a
	Loft Insulation	£300	108	42	3.4	£66.27	a
	Floor insulation	£400	234	36	6.3	£47.45	a
	Double Glazing (old single to A)	£4,500	492	20	7.4	£456.87	a
	High performance replacement doors	£1,000	68	9	0.5	£1,622.72	a
	Draughtproofing	£100	140	10	1.1	£71.33	a

Cost source

a	DECC. (June 2012). Final Stage Impact Assessment for the Green Deal and Energy Company Obligation IA No: DECC0072. London: DECC. Table 49: Energy savings, Green Deal finance and ECO subsidy available for eligible measures, p. 138. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/70265/5533-final-stage-impact-assessment-for-the-green-deal-a.pdf

Basis of costs for non-domestic and infrastructure projects

	Measure	Installation cost [£]	Annual carbon saving [kg]	Lifetime [years]	Lifetime carbon saving [t]	Cost of carbon saving [£/t]
16	RE:FIT Retrofit 11 non-domestic buildings	£730,000	595,000	19	11,210	£65.12

RE:FIT West London Alliance Case Study

Project	retrofit of 11 buildings
Guaranteed energy and cost savings	28 per cent annual energy saving £ 98,700 annual cost saving
Value	£730,000 capital investment seven year payback period
CO2 saving	595 tonnes each year
Timescale	installation completed in 2015
The energy conservation measures installed across WLA buildings include:	lighting and controls upgrade; loft and cavity walls insulation; solar photovoltaic systems
Sources	GLA. (Undated). West London Alliance (WLA) Case Study. London: GLA.
	https://www.london.gov.uk/sites/default/files/west_london_alliance.pdf
	And unpublished information provided by the programme manager, via GLA

	Measure	Installation cost [£]	Annual carbon saving [kg]	Lifetime [years]	Lifetime carbon saving [t]	Cost of carbon saving [£/t]
17	1km DHN to 850 homes & 2 leisure centres	£3,800,000	1,800,000	40	72,000	£52.78

Bunhill Heat and Power Case Study

General description	Bunhill energy centre houses a 1.9MWe gas CHP engine and 115m3 thermal store, and the network comprises of one kilometre of trenching which holds two kilometres of insulated district heating pipework. The £3.8 million energy centre and heat network were funded by grants secured from the Greater London Authority and the Homes and Community Agency.
850 homes connected	• Three council estates and a new housing development have been connected to the 1km network. • Council residents will benefit from a reduction in heating bills.
Two leisure centres connected	• Finsbury Leisure Centre and Ironmonger Row Baths benefitting from cheaper, greener heat.
Carbon emissions reduction	• CO2 savings of approximately 1,800 tonnes CO2/year. • This represents CO2 savings of around 60% for the estates and leisure centres compared to their previous heating systems.

	Measure	Installation cost [£]	Annual carbon saving [kg]	Lifetime [years]	Lifetime carbon saving [t]	Cost of carbon saving [£/t]
18	10,000 LED streetlamps	£8,926,000	1,664,000	20	33,280	£268.21
	1,000 LED streetlamps	**£892,600**	**166,400**	**20**	**3,328**	**£268.21**

LED Streetlighting Case Study

Sources	Glasgow City Council. (March 2015). New LED Sustainable Lighting Project. Glasgow: Glasgow City Council.
	https://www.glasgow.gov.uk/councillorsandcommittees/viewSelectedDocument.asp?c=P62AFQUTNTT10GT1
	Glasgow City Council. (December 2013). Street Lighting Lantern Replacement Programme. Glasgow: Glasgow City Council.
	https://www.whatdotheyknow.com/request/313981/response/776338/attach/5/GIB.PDF.pdf