Local Development Framework
Sustainable design and construction evidence base

February 2010

CROYDON COUNCIL
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Local Development Framework

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Executive Summary

Introduction – the policy background

In recent decades, environmental sustainability has become an increasingly important policy issue as a growing body of research has demonstrated the need for societies to regulate and reduce consumption of natural resources and reduce the impacts of human activity on the environment.

This is reflected in a range of government policy initiatives which seek to encourage higher standards of sustainable design and construction in buildings.

Planning Policy Statement 1 (PPS1) requires local authorities to incorporate policies that promote sustainable development and mitigate the environmental impacts of development into local development plans. It also requires that development plan documents are supported by an evidence base evaluating the impacts and viability of policies.

At the same time, government is seeking to reduce CO_2 emissions from new buildings through Part L of Building Regulations and reduce the impacts of development through environmental performance methodologies such as the Code for Sustainable Homes and BREEAM.

This study has been produced to investigate policy options to require developments to reduce their CO_2 emissions and to achieve standards of sustainable design and construction that surpass regulatory minima.

This study will:

- Review the national, regional and local policy background
- Review the key environmental issues facing the borough
- Analyse the potential for low and zero carbon technologies in the Borough
- Assess the viability of requiring new developments to meet certain standards of environmental performance (e.g. Code for Sustainable Homes and BREEAM)
- Assess the impact of these different policy options and provide policy recommendations

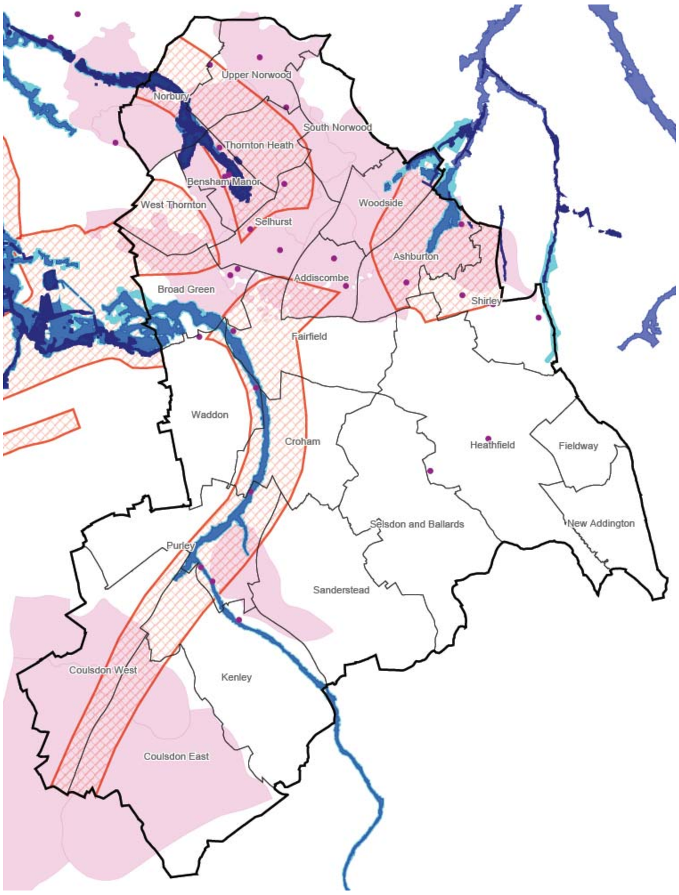
Context – Croydon's Environment

Croydon's per capita CO_2 emissions are currently below average for both London and the UK as a whole, but this does not tell the whole story. Much of the borough's existing housing stock is very inefficient in terms of energy and the majority of these buildings will still be standing in 40 years' time. This will present a significant barrier to the government target of reducing the area's CO_2 emissions by at least 80% by 2050. The Council must seek ways to improve the efficiency of existing housing as well as setting high standards for new buildings.

Sector	2005	2006	2007
Industry and Commercial	560	544	512
Domestic	803	806	785
Road transport	350	341	345
Land use, land use change and farming	4	4	4

Croydon's CO_2 emissions by sector

The imperative to improve the energy efficiency of buildings and move to cleaner forms of energy generation where possible is increased by air quality standards in key development locations in the Borough. Concentrations of oxides of nitrogen and particulates are above statutory maxima in several of these areas; while this is principally due to transport emissions, emissions from buildings are playing an increasingly important role.



Flood risk in Croydon*

At the same time, the Council must give consideration to how the borough will adapt to the pressures of population growth and climate change. The South East is already a region of water stress due to increasing population, high levels of consumption, relatively low rainfall and ageing infrastructure.

* Blue areas indicate flood risk from watercourses. Red hatching indicates flood risk from surface water.

Croydon itself has several areas where flood risk is high, which largely coincide with key development areas. Development must be undertaken in such a way so as to reduce water consumption and reduce risk of flooding.

Future development in Croydon

Three possible scenarios have been identified for growth in Croydon's population and the construction of new housing in the period 2010-2031, which are summarised below.

Scenario	Housing type	Under construction *	2011-2021	2021-2031
1) Growth concentrated in central Croydon and A23 corridor. Equal numbers of family and non-family housing	Family	231	6,375	3,165
	Non-family	2,202	6,674	2,959
	2031 Total completions			21,606
2) Growth concentrated in central Croydon and A23 corridor. Equal numbers of family and non-family housing	Family	231	5,467	2,246
	Non-family	2,202	8,309	4,549
	2031 Total completions			23,004
3) Dispersed growth – greater numbers of family housing with lower overall housing growth	Family	231	5,474	1,814
	Non-family	2,202	4,755	1,789
	2031 Total completions			16,265

Summary of housing growth scenarios for Croydon 2011-2031

It is most likely that both residential and non-residential development will be concentrated in the areas around the A23 corridor and Croydon Metropolitan Centre.

Low and zero carbon technologies

Since 2004, Croydon Council has required major residential and commercial developments to offset a proportion of their CO_2 emissions through the use of renewable energy on site. This has seen a significant increase in the proliferation of renewable technologies in the Borough; at least 100 major completed sites have complied with the Council's requirement that site CO_2 emissions should be reduced by 10% through on site renewables. Some installations have also been made in schools and at community sites.

The technology installed in a given development is largely dependent on:

- The development's location and density
- Form of the buildings
- Size and type of energy demand

Certain technologies may be highly suitable for some sites, but not for others. The table below summarises which technologies are likely to be most suited to which types of development in Croydon.

* As of 31/03/09

Technology	Energy generated	Most suitable for…	Less suitable for…
Wind	Electricity	Open sites with high wind speed away from other buildings and obstructions.	Dense urban locations with low wind speeds
Solar PV	Electricity	Any building with an electricity demand and a suitable roof	Buildings that do not have a suitable roof
Solar thermal	Hot water	Any building with a year-round hot water demand and a suitable roof	Buildings that do not have a year-round hot water demand or a suitable roof
Ground source heat pumps	Hot water , space heating and space cooling	Buildings that have a heating or cooling demand and sufficient open space for ground loops	Buildings that do not have sufficient space for ground loops
Air source heat pumps	Hot water, space heating and space cooling	Buildings that have a heating or cooling demand	Buildings that have a relatively high hot water demand
Combined heat and power (CHP)	Electricity, hot water and space heating	Large, dense sites that have a high heat load	Low-density sites that do not have a constant or high heat load
Biomass	Hot water and space heating	Large, dense sites that have a high heat load	high

Suitability of low and zero carbon technologies in Croydon

It is not considered necessary to set a specific renewables target for new developments, although it is expected that a proportion of a new development's energy will come from renewable sources. Instead, it is considered preferable to set an overall CO_2 reduction target through requiring a particular level of the Code for Sustainable Homes or BREEAM. This target can be met through a combination of energy efficiency and low carbon technologies.

Policy recommendations

- It is recommended that no specific renewable energy target should be set for new developments. Instead, a minimum level of the CSH or BREEAM should be set, with the expectation that renewable energy will provide a proportion of site energy demand. This will allow developers flexibility while ensuring that the CO_2 emissions of new buildings are significantly reduced.
- The Core Strategy should include a policy allowing the installation of renewable technologies provided that any forthcoming benefits are not outweighed by adverse impacts.

District energy

There are currently a number of CHP engines in operation or pending installation in the Borough, predominantly in large residential and mixed use sites in Croydon town centre.

Significant potential exists for the development of a town centre-wide energy network given current density of heat demand and the planned regeneration over the next 20 years. This new wave of development will see the improvement of public realm, services and infrastructure and will provide an excellent opportunity to install heat mains and other utilities to serve both existing and new buildings, achieving substantial savings in resources and CO_2.

In order to confirm the feasibility of a town-centre energy network and assess the potential for CO_2 reduction, Croydon Council commissioned a study from AECOM. This study was completed in December 2009 and will form part of the LDF evidence base for low carbon energy technologies in the Borough.

In other locations in the Borough, much smaller heat networks or stand-alone CHP systems may be viable. The areas that could be suitable for smaller district networks include district centres located in the A23 corridor that is earmarked for concentration of development in the Core Strategy Issues and Options - Initial Report, i.e. Waddon, Purley and Coulsdon / Cane Hill. There may also be potential for other district centres where significant development is brought forward including Addiscombe, Broad Green and Selhurst and New Addington.

The Council should provide a suitable policy framework to encourage developers to utilise and help grow these networks, based on the findings of this study by AECOM and ongoing work on district energy feasibility.

Policy Recommendations

The Core Strategy should include policies covering the following issues in relation to energy networks:

- Major developments should select energy systems according to the hierarchy set out by the London Plan
- Where a new communal heating system is proposed, opportunities to extend the system to other sites in the surrounding area should be investigated.
- In order to facilitate the above, the Council should map areas of high heat density, indicating where it will enforce:
    - connection to an existing heat network
    - future-proofing a development for a connection to a planned network
    - a contribution from each development that connects to an existing heat network against avoided capital costs that would otherwise have been spend on individual boiler plant

The Code for Sustainable Homes

The cost of achieving different levels of the Code for Sustainable Homes (CSH) was calculated for a number of notional dwelling types. This information will be used in the Affordable Housing Viability Assessment, which is being undertaken by Fordham Research. Code for Sustainable Homes pre-assessments were also carried out for each type of unit. The cumulative costs of achieving different standards relative to meeting energy requirements (Part L) for Building Regulations 2006 can be found below.

	Detached	End terrace	Mid-terrace	Flat – infill site	Flat – city centre
2006 Part L base build cost	80,172	56,620	56,620	80,640	80,520
Increase to meet 2010 Part L [£]	3,916	3,916	3,916	3,298	5,238
Increase to meet 2010 Part L [%]	4.9%	6.9%	6.9%	4.1%	6.5%
Increase to meet CSH 3 [£]	4,961	5,201	5,121	4,263	5,828
Increase to meet CSH 3 [%]	6.2%	9.2%	9.0%	5.3%	7.2%
Increase to meet CSH 4 [£]	10,101	10,393	9,293	7,423	8,053
Increase to meet CSH 4 [%]	12.6%	18.4%	16.4%	9.2%	10.0%

Additional costs of Code Levels 3 and 4

The cumulative environmental impacts of these different policy options were analysed. This information, which can be found in Section 7 of the main report, suggests that a policy requiring Level 4 of the CSH with immediate effect is preferable, given the significant environmental benefits is will provide, not only in terms of reducing CO_2 emissions and water consumption but in providing cycle storage, a better quality built environment and resilience against flooding.

Where sites are unable to meet this requirement, it is suggested that the Council should seek a financial contribution, to be invested in energy efficiency and low carbon energy projects in the borough. It is also recommended that the possibility of introducing such a retrofit contribution on top of CSH Level 4 is considered for 2013, as this has potential to substantially reduce the Borough's CO_2 emissions.

Policy recommendations

- The Council should require all new-build housing to achieve Level 4 of the Code for Sustainable Homes upon adoption of the Core Strategy, subject to confirmation from the affordable housing viability study that this will be viable. Where developments are unable to achieve this standard, the Council should seek a financial contribution from the developer, to be used to reduce CO_2 emissions in the Borough. The Council should identify suitable projects where these contributions could be spent, as well as how the contribution would be calculated.
- The above policy should be reviewed by 2013 to determine whether this requirement should be increased. Policy options of increasing the on-site requirement for CO_2 emissions reductions or adding a requirement for a contribution to be used to reduce CO_2 emissions elsewhere in the Borough should be explored (see Section 7).

Existing domestic buildings

Given that a large number of new dwellings in Croydon are refurbishments and conversions, consideration was given to how the environmental performance of these dwellings might be improved.

It is also recommended that the Council should consider whether the energy efficiency of existing housing can be improved when a planning application for an extension is submitted.

Policy recommendations

- The Council should require all residential conversions of existing buildings to meet a high standard of BREEAM Domestic Refurbishment, to be decided after publication of this methodology and further analysis.
- For domestic extensions, the Council should require a percentage of the cost of the extension to be spent on improving the energy and water efficiency of the existing building.

BREEAM

The costs of achieving different BREEAM standards in relation to construction costs were calculated for a number of notional developments. It was not possible to calculate the viability of these different standards, given difficulty in obtaining information on land and resale values and the substantial variation in building requirements for non-residential buildings.

Given Croydon's previous experience with requiring BREEAM Excellent for major non-residential development, it is considered that this standard is achievable for the majority of new build sites if sustainability is included in the design process from an early stage. For refurbishments and conversions, Excellent may be substantially more difficult to attain, but a Very Good rating is achievable.

Policy Recommendations

- All non-residential development greater than 500 m^2 floor space should be required to achieve a BREEAM Excellent standard or equivalent if BREEAM is replaced by a Code for Sustainable Buildings.
- This policy should be subject to review before 2016 to determine whether this requirement should be changed
- All non-residential major refurbishments or conversions greater than 500 m^2 floor space should be required to achieve a BREEAM Very Good standard or equivalent is BREEAM is replaced by a Code for Sustainable Buildings.

Green roofs

The installation of green roofs can have several benefits in terms of reducing surface water run-off, increasing biodiversity, reducing the likelihood of a building overheating and providing a limited amount of insulation.

The costs of installing green roofs were estimated for notional residential and non-residential developments. For residential developments, it was considered that the costs of installing a green roof would be relatively high. Given that a policy requirement for CSH Level 4 would encourage developers to address flood risk and surface water run-off, the benefits of having a policy specifically requiring a green roof could be unjustifiable and ineffective.

The costs of installing a green roof on a major non residential development will depend on the layout and form of the buildings. The benefits however are likely to be greater in terms of reducing the energy requirement for cooling, although this is currently difficult to quantify for new buildings. Given the greater benefits for non-residential buildings, the Council may seek to require major non-residential developments in high flood-risk areas, or perhaps the whole of the Borough, to incorporate green roofs unless there is a strong technical or financial justification why this should not be done.

Policy Recommendations

- All new residential development should be required to achieve two Sur 1 credits under the CSH, in order to ensure that surface water run-off is managed on site and flood risk reduced.
- All major non-residential developments in the Borough should consider installing green roofs to reduce site surface water run-off and the need for summer cooling, unless it can be demonstrated that this is:
    - Technically unfeasible
    - Financially unviable

1 Introduction

1.1 Environmental sustainability and planning

In recent decades, environmental sustainability has become an increasingly important policy issue as a growing body of research has demonstrated the need for societies to regulate and reduce consumption of natural resources and reduce the impacts of human activity on the environment.

In particular, there is an increasingly pressing requirement to reduce greenhouse gas emissions and reliance on fossil fuels and increase proliferation of energy efficiency measures low and zero carbon energy technologies to mitigate the risks associated with climate change and insecure energy supply. This is reflected in recent government legislation and guidance.

Planning Policy Statement 1 (PPS1) requires local authorities to incorporate policies that promote sustainable development and mitigate the environmental impacts of development into local development plans. It also requires that development plan documents are supported by an evidence base evaluating policy impacts and viability.

This study has been produced to investigate the policy options to require developments to reduce their CO_2 emissions and to achieve standards of sustainable design and construction that surpass regulatory minima.

This study will:

- Review the national, regional and local policy background
- Review the key environmental issues facing the borough
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1.2 Structure of study

The study is structured in the following way:

Chapter	Content
Context	
2	Provides an overview of the national, regional and local policy relevant to the study
3	Outlines the key environmental issues in Croydon that are relevant to this study
4	Provides an overview of patterns of development in Croydon over the past three years and looks at projected development scenarios under the emerging Local Development Framework.
5	Discusses energy efficiency and passive design in buildings
6	
7	
8	Examines the financial and environmental impact of different policy options for sustainable design and construction standards in non-residential buildings and provides policy recommendations
Appendices	and BREEAM assessments

2 Policy and strategy background

2.1 National planning policy and regulation

Requirements for Local Authorities to develop policies encouraging sustainable design and construction and low and zero carbon energy technologies stem from a series of Planning Policy Statements (PPSs) produced by the Department for Communities and Local Government (DCLG), most importantly PPS1 and its addendum.

At the same time the Building Research Establishment (BRE) has, in tandem with government, developed a number of certification schemes that can be used to provide an indicator of the environmental performance of a given development, namely the Code for Sustainable Homes (CSH) and the various versions of BRE Environmental Assessment Method (BREEAM).

This section provides an overview of the policy guidance provided by PPS1 as well as an introduction to the CSH and BREEAM.

2.1.1 PPS1 and PPS1a – sustainable development and climate change

PPS1 (2005) is focussed on embedding sustainable development in local and regional plans and covers the following issues: Contributing to sustainable economic growth; building cohesive, diverse, safe and sustainable communities; ensuring high quality and inclusive design; providing of suitable land in line with economic, social and environmental objectives to improve overall quality of life; ensuring that human impacts on the natural and historic environment are minimised[1].

The elements of this document that are most relevant to the current study are summarised as follows:

- Local development plans must “address…the causes and impacts of climate change, the management of pollution and natural hazards, the safeguarding of natural resources and the minimisation of impacts from the management and use of resources”[2].
- Local authorities must not “impose disproportionate costs, in terms of environmental and social impacts, or by unnecessarily constraining otherwise beneficial economic or social development”[3].
- Planning policies “should not replicate, cut across or detrimentally affect matters within the scope of other legislative requirements”[4].

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[1] Paragraph 3, PPS 1
[2] Paragraph 27(x), PPS 1
[3] Paragraph 26(iii), PPS 1
[4] Paragraph 30, PPS 1

The above underlines that while there is a need for policies that mitigate the environmental impacts of development these must be justified with regard to other social and economic considerations.

While PPS1 outlines the general approach to planning and sustainability, the addendum to PPS1, "PPS1a: Planning and Climate Change" (2007), provides further guidance. This states that tackling climate change should be a particular priority for the planning system and that this should be reflected in regional and local development plans.

PPS1a sees the role of the planning system as follows:

- To support the delivery of the government's timetable for reducing emissions from all buildings, as outlined in "Building a Greener Future"[5]
- To contribute to Government strategies on climate change and energy
- To secure development that provides resilience to the impacts of climate change
- To conserve and enhance biodiversity
- To maximise opportunities for low and zero carbon energy sources and infrastructure and set targets for energy generation from these sources[6]
- To encourage the delivery of sustainable buildings and, where appropriate, to set requirements for buildings in advance of national standards.

PPS1a also requires that policies relating to sustainable energy and higher standards of sustainable design and construction are evidence-based and viable, taking into account the needs of communities and the costs of bringing sites to market.

2.1.2 Building Regulations

The energy efficiency and CO_2 emissions of new and refurbished buildings are regulated and limited by Part L of Building Regulations. Part L requires that the CO_2 emissions a building produces[7] are below a threshold based on those of a nominal building[8] of the same size and shape as calculated by the approved methodology[9].

Part L is reviewed periodically with the maximum allowable level of CO_2 emissions reduced each time in accordance with government targets for new buildings, as outlined in the government publication "Building a greener future". The government has set out a timetable whereby all new dwellings to

[5] DCLG policy statement, 2007
[6] Further guidance on this issue can be found in "PPS22: Renewable energy" (2004)
[7] This is known as the Dwelling Emission Rate (DER) for residential buildings and the Building Emission Rate (BER) for non-residential buildings
[8] Known as the Target Emission Rate (TER)
[9] This is the Standard Assessment Procedure (SAP) for residential buildings and the Standard Building Energy Model (SBEM) for non residential buildings

be zero carbon by 2016 and for all other buildings to be zero carbon by 2019[10]:

- 2010: Building CO_2 emissions to be 25% below Part L 2006
- 2013: Building CO_2 emissions to be 44% below Part L 2006
- 2016: All new dwellings to be zero carbon
- 2019: All new non-residential buildings to be zero carbon

Currently water consumption in new buildings is not limited, although there have been strong indications that the 2010 revision of Building Regulations will include a provision to regulate this.

There is currently no regulation that limits CO_2 emissions from existing buildings[11]. However, from 2008, all buildings that are sold, rented out or constructed have been required to have an Energy Performance Certificate (EPC), which provides in indication of the energy performance and CO_2 emissions of the building. Public buildings with a floor area of over $1,000m_2$ are also required to display a Display Energy Certificate (DEC).

As part of its Heat and Energy Saving Strategy[12], the government is currently developing plans to reduce CO_2 emissions from current buildings. This will review the current financial incentives for installing energy efficiency measures and low carbon heating systems in existing buildings and provide a policy framework to increase the uptake of these measures.

2.1.3 A national energy efficiency standard for new homes

As part of the government consultation on zero carbon homes, a working group has been set up to define a national minimum energy efficiency standard for new homes. At the time of writing, consultation was ongoing on what this standard would be, but the likely features of this standard are summarised below:

- The standard will cover the energy required to heat or cool the building only and therefore places a strong emphasis on passive design and improving building fabric.
- The standard will be expressed as a performance metric, rather than by a set of prescriptive U-values and air permeability standards.
- The standard will be expressed in kWh/m^2 and not $kgCO_2/m^2$; issues such as the type of fuel used and how it is supplied will be covered by the Dwelling Emission Rate (DER).

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[10] Zero carbon for new housing is currently defined as a minimum 70% reduction in Part L 2006 CO_2 emissions, with the remainder or emissions to be offset through a number of "allowable solutions". For more information on the government definition of "zero carbon", see http://www.communities.gov.uk/statements/corporate/ecozerohomes?utm_source=UK-GBC+Updates+2009&utm_campaign=09e5d627bf-UK_GBC_Newsletter_July_20097_31_2009&utm_medium=email

[11] Not including conversions and extensions where Building Regulations compliance is required

[12] http://hes.decc.gov.uk/

- In order to reflect the differences between types of dwelling, a range of values will be used instead of a flat standard for all housing.
- The range of values that is likely to be used is 35 kWh/m^2 – 45 kWh/m^2.
- It is likely that an intermediate standard will be introduced in 2013 with the anticipated changes to Building Regulations, with the full standard introduced in 2016.

2.1.4 The Code for Sustainable Homes (CSH)

The CSH is a nationally-approved methodology for assessing the environmental performance of new dwellings. It was launched in December 2006 to replace BREEAM EcoHomes[13] and in from May 2008 it became mandatory for all new dwellings to achieve a CSH rating[14].

Under the CSH, homes are assessed against a number of credits which are grouped into nine areas[15]. In order to achieve a given level of the CSH, a dwelling must achieve a number of specific mandatory standards as well as a minimum total number of points from across all credit areas.

The first of these mandatory requirements is Ene 1, which relates to the relative improvement in a dwelling's CO_2 emissions over the maximum allowed by Part L 2006. The second (Wat 1) relates to the average water consumption per person per day. There are four other mandatory requirements related to the environmental impact of construction materials, controlling surface water run off, provision of waste facilities and implementing a site waste management plan.

Figure 1 shows the requirements for Ene 1, Wat 1 and the required points total for each level of the Code. It should be noted that the minimum CO_2 reduction for Level 3 corresponds to the projected 2010 revision of Part L, while Level 4 corresponds to the projected 2013 revision of Part L.

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[13] EcoHomes can still be used to assess conversions or major refurbishments
[14] This can be a zero rating, where no assessment takes place and a certificate is issued to that effect.
[15] These are: Energy, Water, Materials, Surface water runoff, Waste, Pollution, Health and wellbeing, Management and Ecology.

CSH Level	Ene 1: Required reduction over Part L regulated emissions	Wat 1: Maximum water Consumption [l/p/d[16]]	Required points total
1	10%	120	36
2	18%	120	48
3	25%	105	57
4	44%	105	68
5	100%	80	84
6	Zero carbon[17]	80	90

Figure 1: CO_2 water and points requirements for the CSH

2.1.5 BREEAM

BREEAM is the name give to the nationally-approved methodologies for assessing the performance of non-residential buildings[18]. Achieving a BREEAM rating is currently voluntary, although new government buildings are expected to achieve a Very Good rating and many local authorities require non-residential developments to achieve a certain BREEAM level.

As with the CSH, there are a number of different credit areas[19] and in order to achieve the target rating, each site must fulfil a number of mandatory requirements, as well as achieving a minimum points score (see Figure 2[20]).

Rating	Minimum score
Pass	30
Very Good	
Outstanding	

Figure 2: Points requirements for BREEAM standards

In 2009, the UK Green Buildings Council (UK-GBC) published a report on behalf of the government, recommending that a Code for Sustainable Buildings should be adopted[21] to replace BREEAM, much in the same way that the CSH has replaced EcoHomes.

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[16] Litres per person per day
[17] "Zero carbon" in this context takes into account all Part L regulated emissions and other non-regulated emissions from appliances and cooking. The reduction in CO_2 emissions must be achieved through energy efficiency and on site zero carbon energy sources. The government has consulted on the definition of zero carbon and it is expected that the CSH will be revised to take this into account.
[18] Current version of BREEAM comprise: Courts, Healthcare, Industrial, Multi-Residential, Prisons, Offices, Retail, Education and Bespoke, which covers all other buildings
[19] These are: Management, Health and Wellbeing, Energy, Transport, Water, Materials, Waste, Land Use and Ecology, and Pollution.
[20] For the sake of simplicity, a full summary of the mandatory requirements has not been included here as they are somewhat more complicated than those for the CSH
[21] UK-GBC – "Making the case for a Code for Sustainable Buildings"

2.1.6 The feed-in tariff and renewable heat incentive

Over the next two years, the government will introduce two incentives that will provide a guaranteed price for every unit of energy produced by microgeneration installations in order to encourage the uptake of these technologies.

The feed-in tariff (FIT), which will be introduced in April 2010, will reward those who install technologies that produce electricity, such as solar photovoltaics and wind turbines. The renewable heat incentive (RHI), which will be introduced a year later, will reward those who install technologies that generate heat, such as biomass boilers or solar thermal panels.

2.2 Regional Policy – The London Plan

2.2.1 London Plan (2008)

In 2008, the GLA formally adopted an updated London Plan[22] that sets out the planning framework for the region. The most relevant section for this study is Chapter 4A, which deals with climate change, sustainable design and construction and renewable energy. Key policies are outlined below. Boroughs are expected to adopt these policy requirements in their DPDs.

<u>Policy 4A.1</u> sets out a preferred hierarchy to minimise CO_2 emissions from new development:

- Be lean: Use less energy by adopting sustainable design and construction measures (see also 4A.3)
- Be clean: Supply energy efficiency through decentralised energy networks and community systems (see also 4A.6)
- Be green: Use renewable energy (see also 4A.7)

<u>Policy 4A.2</u> outlines medium-term CO_2 reduction targets for the region[23]:

- 15% by 2010
- 20% by 2015
- 25% by 2020
- 30% by 2025

<u>Policy 4A.3</u> covers passive design and energy efficiency requirements for new buildings as well as other aspects of sustainable design and construction, including water consumption, pollution, waste, biodiversity, sustainable drainage and health and wellbeing. All developments are expected to meet the highest standards possible.

This policy also requires that a sustainability statement including an energy statement is submitted with every major planning application.

[22] London Plan – Consolidated with Alterations since 2004 - http://www.london.gov.uk/thelondonplan/thelondonplan.jsp
[23] All targets are in relation to a 1990 baseline

Policy 4A.5 requires that Boroughs should identify and safeguard existing energy networks and maximise opportunities for the development of new ones, in tandem with the Mayor.

Policy 4A.6 requires that heating and cooling systems in new developments are selected to maximise CO_2 savings and, where possible, to allow for connection to a district network at a later date.

Policy 4A.7 requires that developments should achieve a 20% reduction in their CO_2 emissions from on-site renewable energy generation, unless it can be demonstrated by the applicant that this is not feasible. Boroughs are also required to identify opportunities for renewable energy and zero carbon development where possible, in line with PPS1.

Policy 4A.9 requires that boroughs should support effective adaptation to the risks posed by climate change. The scope of this policy is not restricted to new buildings, but it does state that developments should minimise risk of overheating and flooding and seek to minimise water use (see also Policies 4A.10, 4A.11, 4A.13 and 4A.3)

Policy 4A.11 identifies green roofs and green walls as being of particular importance to climate change mitigation and adaptation. It states that boroughs should expect major developments to incorporate these where feasible, due to the multiple benefits they provide in terms of cooling, surface water runoff, encouraging biodiversity and potentially creating additional amenity space.

2.2.2 The draft replacement London Plan (2009)

In October 2009, the Mayor of London published a draft replacement London Plan for consultation. Although the proposed policies relating to sustainable design and construction are generally in line with the objectives set out in the 2008 version of the London Plan, there are a number of important distinctions that are highlighted below.

Policy 5.2 sets a timetable for minimum reductions in CO_2 emissions from major new developments ahead of the anticipated changes in Building Regulations, which is outlined in Figure 3.

Period	Domestic	Non-domestic
2010-2013	44%	44%
2013-2016	55%	55%
2016-2019	Zero Carbon	As per Building Regulations requirements
2019-2031	Zero Carbon	Zero Carbon

Figure 3: CO_2 emissions reduction targets from draft replacement London Plan

Policy 5.3 lays out the expectation that the highest standards of sustainable design and construction should be achieved to improve the environmental performance of new development.

Policy 5.4 covers retrofitting existing buildings and puts the onus on the boroughs to identify opportunities and develop policies for retrofitting buildings in their LDFs. In particular, boroughs are expected to "identify synergies between new developments and existing buildings, particularly through the retrofitting of energy efficiency measures, decentralised energy and renewable energy opportunities".

Policy 5.11 requires that major development proposals are designed to include green roofs and walls. Boroughs are encouraged to include policies promoting and supporting the inclusion of green roofs in their LDFs.

2.2.3 Draft Mayor's Housing Standards

The Mayor of London published a draft London Housing Design Guide for consultation in July 2009. This guide is intended to be used for publicly-funded housing from 2011, but the intention is to extend its requirements to all new housing in London. The key requirement in relation to sustainable design and construction is that all new homes must achieve a minimum standard of CSH Level 4.

2.3 Croydon Policy and Strategy

2.3.1 The Croydon Plan

Along with boroughs such as Merton, Croydon has been a pioneering local authority in setting and enforcing planning policies for sustainable design and construction. Croydon's replacement Unitary Development Plan (UDP) was adopted in 2006 and includes several specific policies relating to sustainable design and construction.

The key planning objectives of the Council with regard to sustainable design and construction, as outlined in the UDP, can be summarised as follows:

- To require the highest possible standards of environmental performance
- To require high standards of design that will make buildings comfortable to use
- To minimise energy and resource consumption from new developments
- To make buildings accessible and secure
- To require major developments to supply a proportion of their own energy

Requirements for sustainable design and construction and renewable energy are discussed in greater depth below.

The Croydon Plan and environmental assessment methodologies

At the time of writing, consulting on and approving the Croydon Plan, the Code for Sustainable Homes had not been devised and so could not be included in the UDP. The policies relating to particular methodologies of environmental assessment, which had been included in the draft UDP, were adapted to remove reference to a specific methodology.

The reason for this was that, given that assessment methodologies for new buildings are subject to change or replacement, policy needed to remain flexible and robust. In practice EcoHomes was superseded by the Code for Sustainable Homes within 18 months.

The policies in the Croydon Plan do make it clear that the Council expects that new developments will meet high standards of sustainable design and construction above and beyond statutory minima. The interpretation of these policies, which takes into account subsequent changes to assessment methodologies, is outlined in Croydon's Environmental Performance Statement Guidance[24].

Croydon currently expects that major residential developments should achieve Level 4 of the CSH and that major non-residential developments should achieve BREEAM Excellent. The Council's position is that this is supported by a multiplicity of separate policy requirements in the Croydon Plan[25], even though there is currently no specific policy requirement for these standards.

In practice, given that these standards can be difficult to achieve for certain sites, Croydon has adopted a flexible approach, seeking to negotiate with developers that are unable to achieve these requirements in order to achieve the highest standard possible for each site.

<u>The Croydon Plan and renewable energy</u>
The Croydon Plan contains two policies that relate specifically to renewable energy; the first, EP15, relates to stand alone renewable energy installations, while the second, EP16, deals with requirements for renewables in new developments.

EP15 permits the installation of stand alone renewable technologies, provided that any benefits provided are not outweighed by any negative impacts on landscape, townscape and amenity. There are a handful of small stand alone renewables installations in the Borough, such as the wind turbine at Spa Hill Allotments on Crystal Palace Hill. All of these installations have been undertaken to supply a proportion of the energy requirements of nearby buildings and there are currently no stand alone installations that exclusively supply energy to the grid or to a remote private wire network.

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24 http://www.croydon.gov.uk/planningandregeneration/planningadvice/businesses/advicenotes

25 Namely: SP1, SP2, SP3, SP9, SP13, UD1, UD2, UD3, UD7, UD14, UD15, EP1, EP5, EP6, EP16, H14

Figure 4: A 2.5 kW Proven wind turbine installed at Spa Hill Allotments

EP16 requires that the CO_2 emissions of major new developments[26] are reduced by 10% through the installation of renewable energy technologies on site. Since the introduction of this policy, over 100 installations of renewable technologies have been made, including communal biomass boilers, solar PV arrays, solar thermal systems and a limited number of building-integrated wind turbines.

Where developers are unable to reach this target, a S106 planning obligation can be sought. Money accrued in this way is then used to finance renewables and energy saving measures across the Borough, for example, to provide renewables installations in schools or help provide low-cost insulation to householders.

[26] Defined as 10 units or 1,000m^2 or more

Figure 5: PV panels installed at Virgo Fidelis School

2.3.2 Environment and Climate Change Strategy

Croydon's Environment and Climate Change Strategy identifies the key environmental challenges and outlines the relevant targets for the borough up until 2011.

The targets that are most relevant to this study are summarised as follows:

- To achieve a 9.5% reduction in borough-wide CO_2 emissions over a 2005 benchmark
- To ensure that pollutants from housing are minimised (in terms of oxides of nitrogen)
- To ensure that risks of climate change are managed

The ways in which these targets will be achieved that are most relevant to this study are outlined below:

- To analyse where the greatest CO_2 savings can be made in existing housing stock and target resources accordingly
- To extend the Council's requirements for achieving CO_2 reductions from new developments
- To publish and implement a strategy to reduce emissions of local air pollutants
- To ensure that management of climate change risks is embedded in the Local Development Framework, for example by requiring new developments to meet certain standards

3 Key environmental issues in Croydon

This section summarises the environmental issues in Croydon that are of greatest relevance to the built environment and to this study.

3.1 Energy and CO2 emissions

According to the latest data published by the Department for Energy and Climate Change (DECC)[27], Croydon's per capita CO_2 emissions fell by 5.9% between 2005 and 2007 to 4.8 tCO_2. This was the 9th lowest total out of all the London boroughs, and well below the national average (Figure 6).

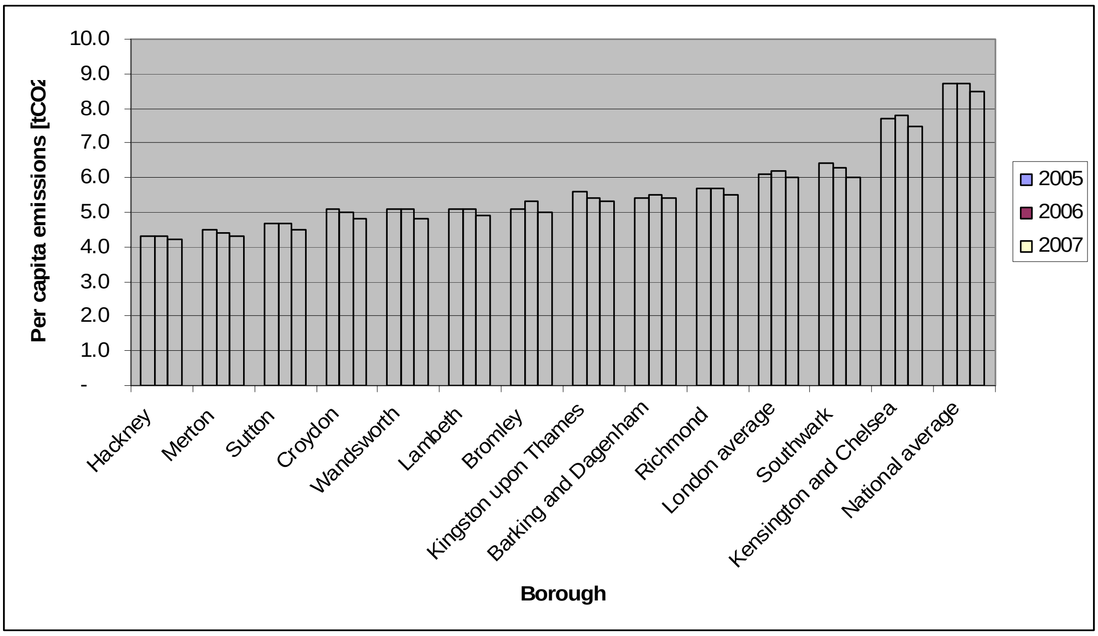

Figure 6: Per capita emissions across selected London boroughs 2005-2007

Sector	2005	2006	2007
Industry and Commercial	560	544	512
Domestic	803	806	785
Road transport	350	341	345
LULUCF[28]	4	4	4

Figure 7: Breakdown of Croydon's aggregate CO_2 emissions by sector

[27] http://decc.gov.uk/en/content/cms/statistics/climate_change/climate_change.aspx
[28] Land use, land use change and farming

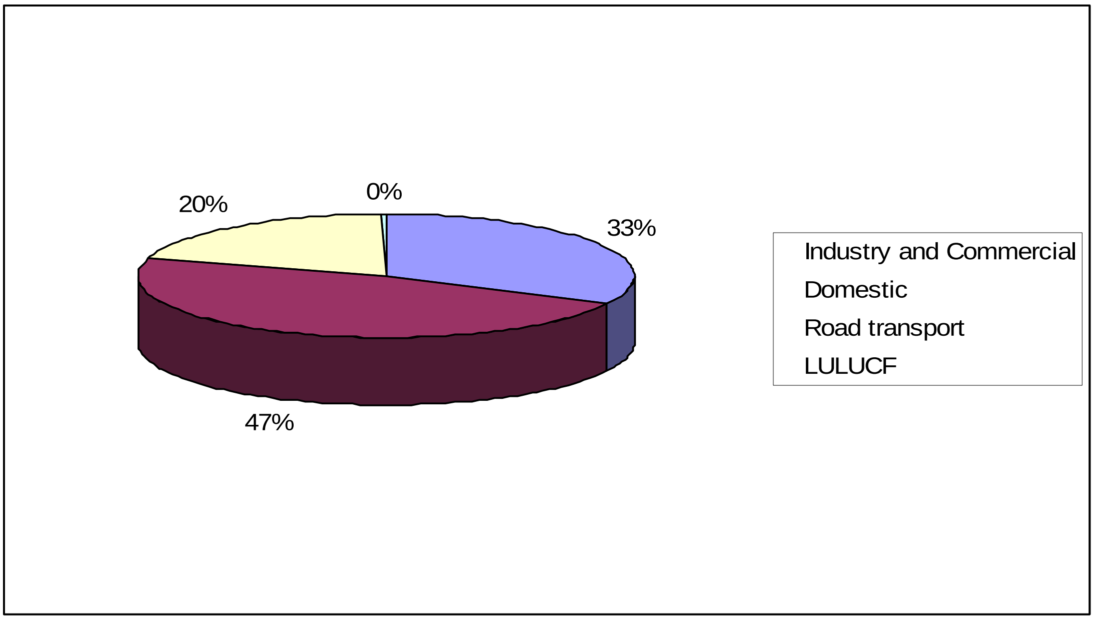

Figure 8: Croydon's CO2 emissions by sector 2005

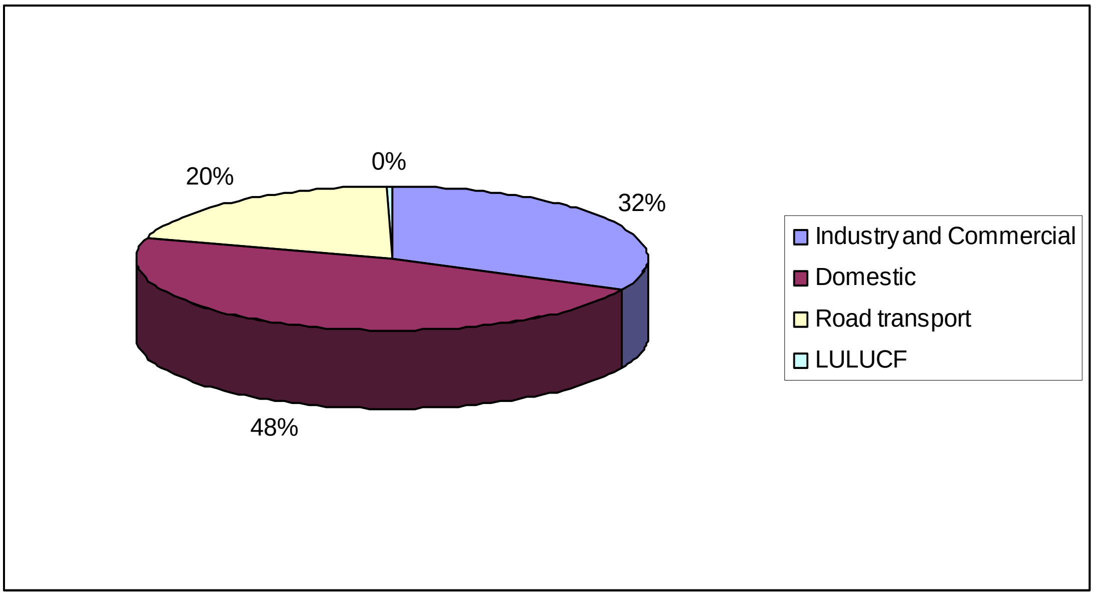

Figure 9: Croydon's CO_2 emissions by sector 2006

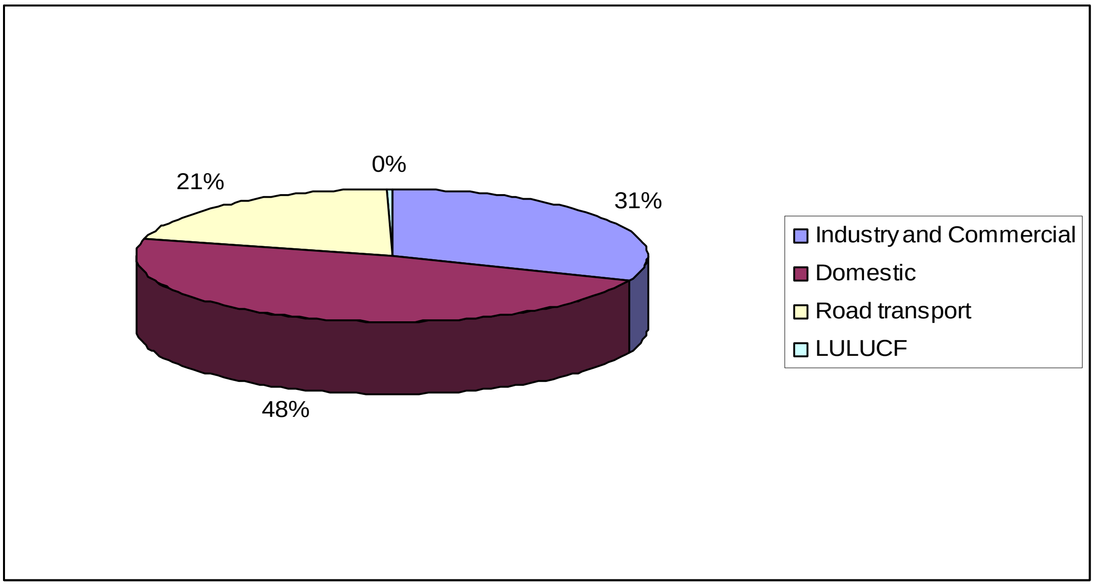

Figure 10: Croydon's CO_2 emissions by sector 2007

Further analysis reveals that the reason for Croydon's relatively low per capita CO_2 emissions is that emissions from industry and commerce and transport are well below both the regional and national average.

Domestic emissions on the other hand are above the London average and place Croydon joint 25th out of 33 boroughs with 2.3 tCO_2 per capita, or approximately 5.5 tCO_2 per household.

In addition, data disclosed by DECC to the House of Commons[29] shows that 7,700 households in Croydon (approximately 5.4% of households) are classified as being fuel poor[30]. This is the 7th highest rate in London.

One of the main reasons for this is that much of Croydon's housing was built before energy standards were introduced to Building Regulations and are therefore very inefficient.

A glance at the Energy Saving Trust's Homes Energy Efficiency Database (HEED) suggests that the majority of existing housing in Croydon lacks adequate wall and loft insulation and efficient gazing.

While any planning policy that regulates emissions from new buildings will have an impact on the Borough's domestic emissions, it is likely that this impact will be relatively small as the majority of housing in 2031 will be made up of housing that already exists today.

Given the above, seeking cost-effective means to reduce domestic emissions and increase the energy efficiency of housing in the borough should remain a priority for the Council.

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[29] http://www.publications.parliament.uk/pa/cm200809/cmhansrd/cm090520/text/90520w0022.htm#09052058000067
[30] I.e. At least 10% of household income is spent on energy bills.

3.2 Flood risk and drainage

Croydon's Strategic Flood Risk Assessment (SFRA) indicates that areas of high flooding risk are present throughout large areas of the borough. Sewer flooding events have occurred primarily in the north and south west of the borough. Areas identified as having an increased risk of surface water flooding, include the A23 corridor. Groundwater flooding has been experienced in parts of the north, the centre and along the course of the River Wandle in recent years (see Figure 11).

Minimising risk of flooding to vulnerable communities is a key concern, especially given that there is a high probability that climate change will increase the number of flood events in London (see Figure 12). Given that there is a significant overlap between flood risk areas and those that have been identified at suitable for growth, it is essential that surface water drainage conditions are not be worsened by intensified development; new development must actively improve surface drainage conditions as far as possible.

This can be secured by requiring developments to be assessed under the Code for Sustainable Homes or BREEAM, or by specific policies and guidance relating to sustainable drainage systems (SuDS) and based on the SFRA.

The SFRA notes that, given the varied geology of the borough, the appropriate mix of SuDS techniques will vary from site to site. However, it is likely that green roofs will be applicable to a high proportion of development sites for the following reasons[31]:

- Good potential for removal of pollutants, including suspended solids, heavy metals and urban atmospheric pollution
- Suitable for high density development with no additional land take
- Can be retrofitted
- Reduces peak runoff
- Provides other benefits in terms of amenity, biodiversity, microclimate and conservation of energy in buildings

Furthermore, green roofs can be installed regardless of the geology of the surrounding area, unlike some other commonly used SuDS techniques, which cannot be installed in areas where ground permeability is low. Due to these benefits, it could be argued that this is a technology that merits special attention.

Indeed, both the current London Plan and the draft Replacement London Plan encourage boroughs to adopt policies that support the proliferation of green roofs. For this reason, Chapter 9 of this study has been dedicated to exploring policy options to encourage green roofs.

[31] Source: CIRIA SUDS handbook

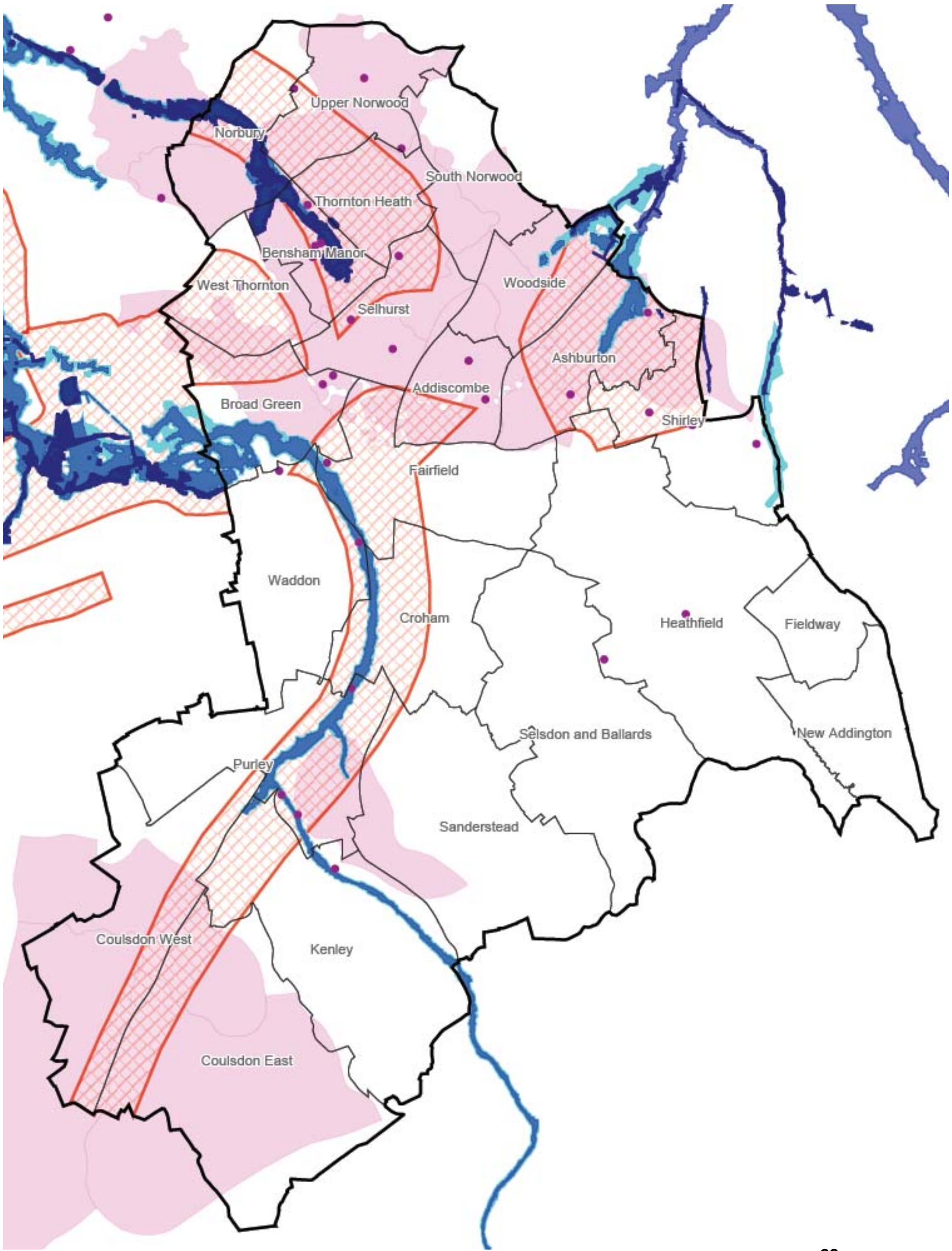

Figure 11: Croydon Strategic Flood Risk Assessment Map[32]

[32] Blue areas indicate flood risk from watercourses. Red hatching indicates flood risk from surface water

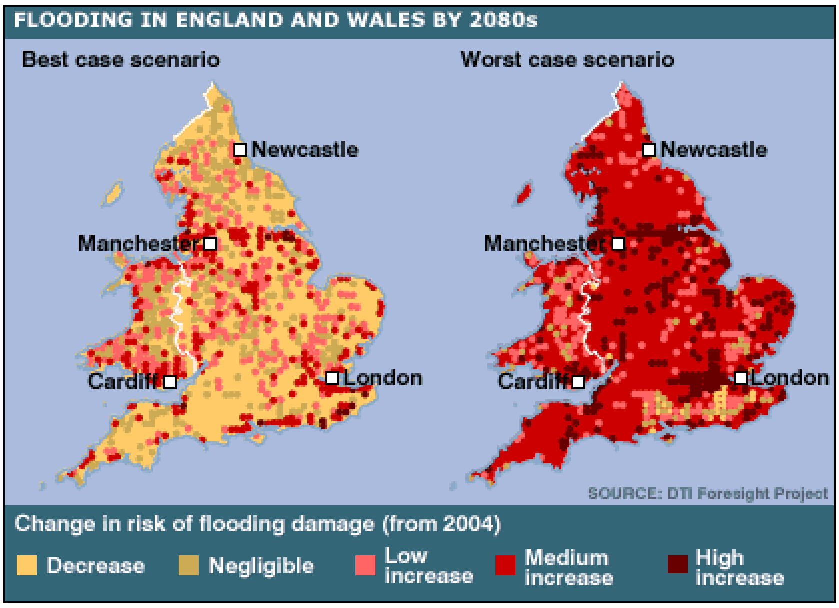

Figure 12: Flood risk in England and Wales by 2080s (Source: BBC)

3.3 Water consumption

The Environment Agency's 2008 report on the state of water resource in England and Wales identifies London and the South East as the areas where water resources are most under pressure, due to lower rainfall, high population density and relatively high rates of consumptions (see Figure 13).

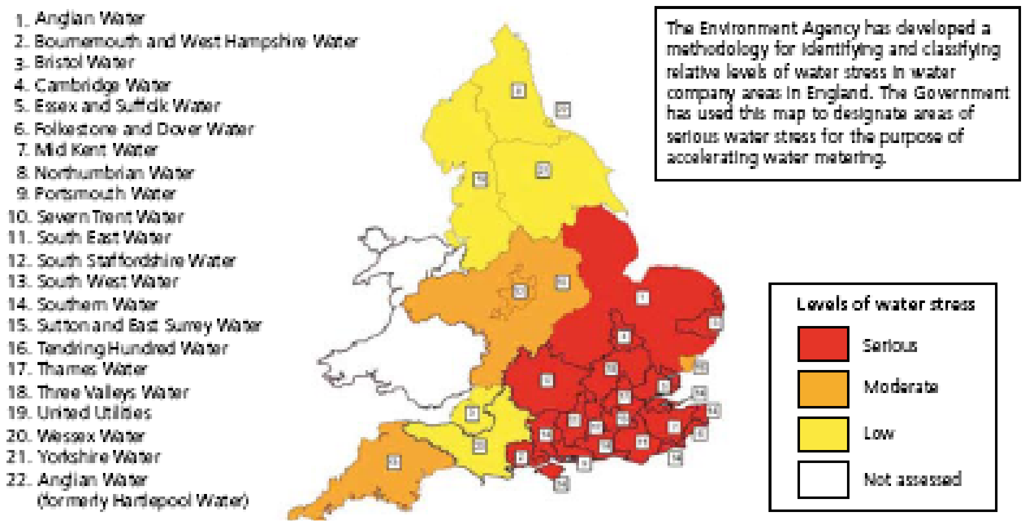

Figure 13: Areas of water stress in England and Wales (Source: Environment Agency)

London's average annual rainfall is lower than that of several cities in more arid climates and over one third below the average for England and Wales (see Figure 14). This is partly balanced by the relatively modest proportion of evapotranspiration from the Thames catchment and the fact that rainfall is fairly evenly distributed throughout the year.

City/area	Rainfall [mm/year]
London	590
Jerusalem	597
Istanbul	629
Rome	791
Manchester	809
England and Wales	897
Sydney	1,226

Figure 14: Average annual rainfall for London and selected other locations[33]

In the future, it is predicted that water stress in the region will increase as it becomes increasingly difficult to balance supply with demand. This will occur because of a predicted population increase of around 1.5 million by 2031[34] and because of the impacts of climate change. A predicted 15% increase in winter rainfall will be balanced by an 18% decrease in summer rainfall[35], which means that although the average annual rainfall will remain the same, increased variability across the seasons will affect the availability of water. Furthermore, higher summer temperatures will increase rates of evapotranspiration and more extreme rainfall events will increase runoff and reduce rates of soil and groundwater recharge, leading to lower availability of water.

Currently, the average per capita domestic water consumption stands at 156 litres per day (l/p/d). Treating wastewater and providing clean water in the UK is responsible for 5 million tonnes CO_2 equivalent each year.

Reductions in domestic water consumption could be achieved partly through requiring a particular level of the CSH or BREEAM or by setting a maximum level of per capita water consumption for new developments. However, it must be recognised that new buildings will be responsible for only a proportion of water consumption and the Council should seek opportunities to reduce consumption in existing buildings as well, through retrofit and behaviour change. This will also help reduce CO_2 emissions as less energy will be needed to heat water.

3.4 Air quality

The Government adopted the UK Air Quality Strategy (AQS) in 1997 to deal with, amongst other issues, local air quality and its impact on health. The AQS set requirements from the Environment Act 1995 for local authorities to undertake a process of Local Air Quality Management (LAQM).

As part of this process, local authorities must review air quality in their areas and assess whether or not air quality will meet their objective levels. Where the prescribed air quality objectives are unlikely to be met, local authorities

[33] Mayor of London: Draft Water Strategy 2009
[34] Ibid
[35] Ibid

must designate Air Quality Management Areas (AQMAs) and produce an Air Quality Action Plan setting out measures they intend to take to work towards objectives.

All London boroughs have declared one or more AQMAs for oxides of nitrogen (NOx) and/or particles (PM_{10}). In Croydon the entire Borough has been designated as an AQMA because of annual mean levels of NO_2 exceeding the air quality objective. At present the major cause of air pollution in London is road traffic, but by 2010 emissions of nitrogen oxides from buildings will broadly equal those from road transport.

Modelled NOx and particulate levels for Croydon in 2010 can be found in Figures 16 and 17.

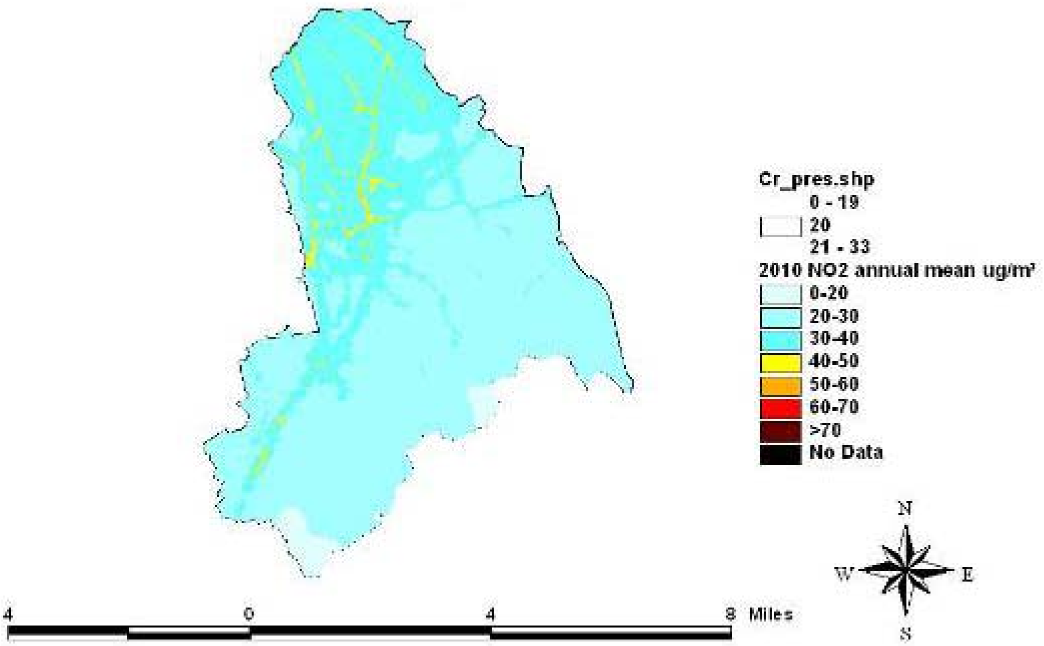

Figure 15: Modelled NOx levels in Croydon, 2010

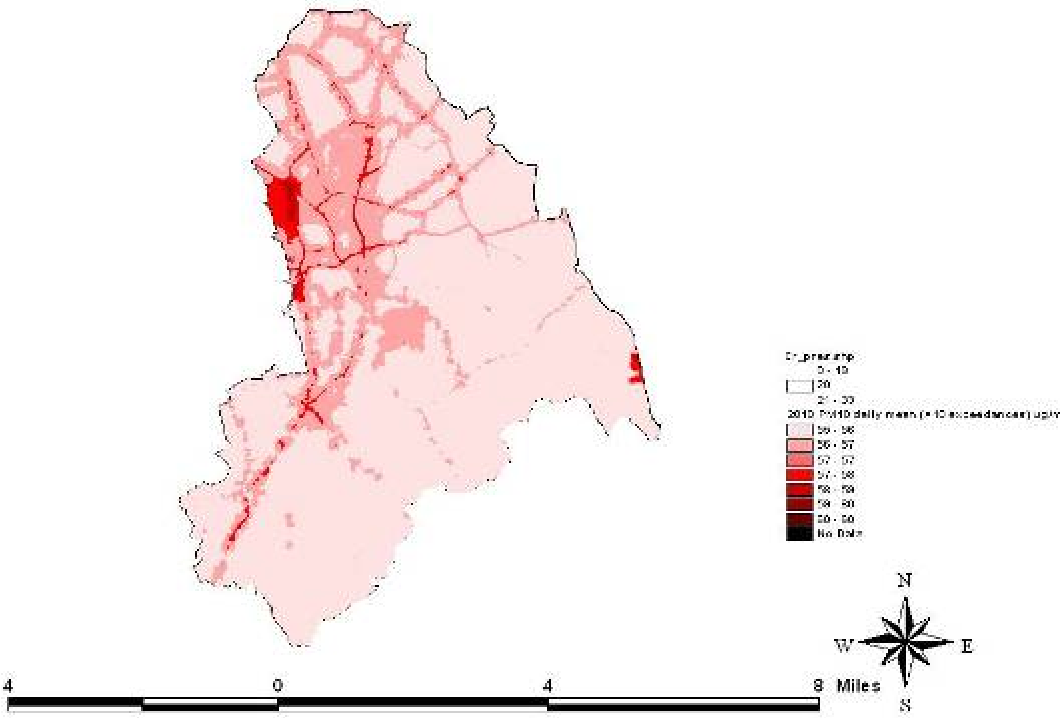

Figure 16: Modelled particulate levels in Croydon, 2010

Where development takes place in an AQMA (i.e. the whole borough of Croydon), the developer must consider the air quality impacts of the proposed development. Where a development has a marginal negative impact on air quality, developers should identify mitigation measures that will minimise or offset the emissions from the development.

These can include reducing energy consumption through improving building fabric, installing efficient heating systems and installing zero emission technologies such as solar thermal or solar PV panels. Measures that contribute to more sustainable

In recent years there has been growing concern over the impact of installations of biomass heating systems in AQMAs. Biomass is often seen by developers as the best way to meet renewables and CO_2 emission reduction targets on large, high-density sites and the proliferation of these systems has increased significantly over the past 10 years. Further discussion of biomass and air quality can be found in Section 6.

4 Development in Croydon

This section provides an overview of development in Croydon; recently completed developments, projected growth scenarios, types of development in Croydon and costs of developing sites in Croydon.

4.1 Residential Development

4.1.1 Completed development 2006-2009

In order to help define patterns of residential development across the Borough, the available data on completed residential developments in between 2006 and June 2009, including conversions, were broken down by location and size (Figure 17).

Using this data, the following trends can be identified:

- In the south and east of the Borough, the majority of residential development (60% -100%) is in small sites of 1-4 units consisting of a mixture of new builds and conversions. There is only the occasional major development and these tend to be between 10 and 25 units.
- In the north of the Borough and the fringes of the town centre, there is still a relatively high proportion of very small developments, including conversions, but also a relatively high proportion of new build housing in infill or brownfield developments of between 10 and 40 units. These tend to be clustered around major transport routes and district centres such as South Croydon, London Road, the A23 corridor and South Norwood.
- In the centre of the Borough and to an extent in Purley, the majority of new housing can be found in large new build developments of over 40 units

Ward	No. developments	Total units	Major sites[36]	Largest site	Proportion of units in Major sites[37] [%]	Proportion of total units in Borough [%]
Addiscombe	37	228	6	34	54.4	5.3
Ashburton	19	255	4	100	80.4	5.9
Bensham Manor	22	389	1	330	84.8	9.0
Broad Green	31	159	4	16	33.3	3.7
Coulsdon East	9	35	1	21	60.0	0.8
Coulsdon West	43	133	3	17	31.6	3.1
Croham	59	241	6	25	37.3	5.6
Fairfield	58	600	8	189	71.8	13.8
Fieldway						
Kenley						
Addington	8	26	1	14	53.8	0.6
Norbury	38	230	2	105		
Purley	51	318	9	76		
Selhurst	55	246	4	37	40.2	5.7
Selsdon and	13	30	1	11	40.0	0.7
Shirley						
	52	242	6	26	43.4	5.6
Thornton Heath	36	132	1	31	23.5	3.0
Upper	34	180	4	24	47.2	4.1
Waddon	28	200	5	57	65.0	4.6
West Thornton	29	172	3	51	61.0	4.0
Woodside	46	185	5	26	40.0	4.3
Croydon total	**747**	**4,341**	**81**	**330**	**58.0**	**100**

Figure 17: Residential developments in Croydon 2006-2009 by ward

The vast majority of new housing consists of flats; well over half of these are new build, although there are a significant proportion of extensions, conversions and changes of use. In terms of tenure, over two thirds of residential development is market housing (Figure 18).

[36] Defined as 10 or more units
[37] Defined as having 10 or more units

Tenure	Market	Intermediate	Social rented
Proportion of dwellings [%]	69.1	11.4	19.5
Type of dwelling	**New build house**	**New build flat**	**Flat conversion[38]**
Proportion of dwellings [%]	12.7	48.3	39.0

Figure 18: Residential development in Croydon 2006-2009 by tenure and type

4.1.2 Anticipated future growth

Three possible scenarios have been identified for growth in population and construction of new housing in the period 2010-2031. These are summarised in Figure 19.

Scenario	Housing type	Under construction	2011-2021	2021-2031
1) Growth concentrated in central Croydon and A23 corridor. Equal numbers of family and non-family housing	Family	231	6,375	3,165
	Non-family	2,202	6,674	2,959
	2031 Total completions			21,606
2) Growth concentrated in central Croydon and A23 corridor. Equal numbers of family and non-family housing	Family	231	5,467	2,246
	Non-family	2,202	8,309	4,549
	2031 Total completions			23,004
3) Dispersed growth – greater numbers of family housing with lower overall housing growth	Family	231	5,474	1,814
	Non-family	2,202	4,755	1,789
	2031 Total completions			16,265

Figure 19: Summary of housing growth scenarios for Croydon 2011-2031

The Council has commissioned an Affordable Housing Viability Study, which will take account of the various costs a developer will incur during development of a site in order to determine what level of affordable housing can be required. This will include costs for achieving CHS Levels 3 and 4. Further details of the methodology used can be found in Section 7 of this report.

[38] Includes extensions and changes of use

4.2 Non-residential development

In order to understand patterns of non-residential developments across the borough, the available data on major non-residential developments was analysed, together with the available information on future development patterns. This information was used in Section 8 to look at the costs of achieving different standards of BREEAM for relevant types of development.

4.2.1 Completed residential development 2006-2009

The available data on major non-residential developments[39] completed between 2006 and June 2009 was broken down by location and type in order to understand development patterns (Figure 20).

When analysed and mapped, a similar pattern emerges to that observed for residential development; we see a concentration of major non-residential development in and around central Croydon and the A23 corridor, with the occasional development outside this area.

A significant proportion of total area of these developments (30%) is made of the extension, refurbishment or construction of school buildings, with retail, offices and storage accounting for the majority of the remainder (57%).

[39] Defined as 1,000m^2 GIFA or more

Ward	Total floor area completed	Major sites[40]	Planning use class[41]						
			A1	B1	B2	B8	C2	D1	Sui Generis
Ashburton	3,796	2	2,520					1,276	
Bensham	5,554	1		5,554					
Broad Green	9,560	4				5,689		2,678	1,193
	9,500	1						9,500	
Coulsdon West	2,123	1		2,123					
Fairfield	1,040	1						1,040	
Kenley	2,864	1				2,864			
New Addington	3,086	2			518	1,045		1,523	
Selhurst	5,292	1		298			3,980	1,014	
South Norwood	1,612	1						1,612	
Upper Norwood	1,312	1						1,312	
Waddon	22685	6	6,340	4,252	1,203	8,059		686	2,145
Total	**68,424**	**22**	**8,860**	**12,227**	**1,721**	**17,657**	**3,980**	**20,641**	**3,338**

Figure 20: Major non-residential development in Croydon 2006-2009 by ward and use class

4.2.2 Transforming Croydon Schools

Over the next decade or so, the Borough will see the implementation of a comprehensive programme of rejuvenation for its schools. This will comprise the renewal of existing buildings and provision of new ones as well as the transformation of the education programme. Approximately 50 primary schools and 17 secondary schools will be covered by the programme. The programme, known as Transforming Croydon Schools will consist of several delivery vehicles:

- Building Schools for the Future (BSF)
- Secondary Review
- Primary Capital Programme (PCP)
- Capital Programme
- School Improvement

Achieving high standards of sustainable design and construction will be an important concern with regard to the construction and asset renewal elements of the programme. This will not only ensure that buildings are comfortable for occupants and cost less to run, but will provide a learning opportunity for pupils.

The programme will consist of a mixture of new build, major remodelling and refurbishment. For Building Schools for the Future projects, the ratio of this mix will be 50:35:15. Very few projects will be entirely new build.

[40] Defined as 1,000m^2 GIFA or more
[41] Defined as follows: A1 - Retail, B1 – Business (offices, research and light industry), B2 – General Industrial, B8 – Storage or distribution, C2 – Residential institutions, D1 – Non-residential institutions including schools and training centres.

In terms of the sustainable design and construction objectives for TCS, all projects where new buildings and major remodelling are needed will be required to meet a BREEAM Very Good standard in line with government requirements.

For BSF projects where new buildings account for 75% of the total, additional government funding is available where it can be demonstrated that a 60% reduction over 2002 Part L regulated CO_2 emissions can be achieved. Where this additional funding is available it should be possible to achieve a BREEAM Excellent rating.

For other projects where additional funding is not available, it may not be viable to achieve the BREEAM Excellent rating currently sought by the Council for all major non-residential schemes. The TCS board has provided an undertaking to achieve a minimum standard of Very Good, but to seek to achieve an Excellent rating where possible. This will be determined on a site by site basis, but further analysis and guidance on this issue is available in Section 8.

4.2.3 Other non-residential development

Three reports have been produced for Croydon Council, assessing the potential for retail[42], industrial[43] and office[44] developments in the Borough. The conclusions of these reports regarding future development in the Borough largely mirror the patter of recent development and can be summarised as follows:

- The greatest potential for new developments is in the Croydon Metropolitan Centre (CMC), A23 corridor and district centres.
- The greatest potential for additional convenience retail sites may exist in Coulsdon, Purley, New Addington and the fringe of the CMC.
- Additional comparison retail sites may be viable in the Purley Way area and the CMC
- The key industrial sites in the Borough are to be found in Marlpit Lane, Coulsdon and the Purley Way. The majority of these sites are in light industrial, distribution or warehouse use
- Office employment in the Borough is concentrated in the CMC and district centres, particularly Purley and Coulsdon, and these locations are likely to be the most suitable ones for future office sites.

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[42] "Borough-wise retail needs study update, 2008", Drivers Jonas, 2008

[43] "Croydon Industrial and Warehousing Land/Premises Market Assessment", London Borough of Croydon, South London Business, Kingston University and Stiles Harold Williams, October 2008

[44] "Croydon Office Market Review", PACEC, September 2007

5 Energy efficiency and passive design

The first step toward reducing any building's CO_2 emissions should be to reduce its energy demand through energy efficiency measures and passive design. If given careful consideration at the beginning of the project, this can be a very cost effective way of reducing CO_2 emissions and providing a comfortable, high-quality environment for building occupants.

The following principles should be followed for residential buildings:

- Buildings should be oriented south where possible to benefit from passive solar gain during the winter months.
- Suitable shading should be provided to south facing glazing so that buildings can benefit form passive lighting and heating during winter months, when the sun is low, but will not overheat during the summer
- Room layout should be designed so that rooms which are in use during the day, such as kitchens and living rooms, are located where they can benefit from passive heating and lighting
- Where possible, windows should be openable on two sides of a dwelling to allow natural cross ventilation

The following principles can be applied to all buildings

- Buildings should be designed with careful use of from, glazing and shading so that:
    - Overheating and heat loss are minimised by not using excessive glazing
    - Natural lighting is encourage through the use of light wells, atriums and the avoidance of deep-plan buildings where possible
- Building fabric elements with a high thermal mass should be used where possible to help regulate heat loss and prevent overheating and provide night time cooling
- Building fabric elements should be insulated to very high standards to help minimise heat loss
- The air tightness of buildings should be improved to high standards to minimise heat loss
- Where ventilation is required, it should incorporate efficient heat recovery units
- Energy efficient pumps and fans should be used in building services
- Energy efficient lighting including LED lighting should be used
- Sanitary fittings should be water-efficient to reduce consumption of hot water
- Heating and cooling systems should be chosen for efficiency
- Vegetation should be applied to buildings in the form of green roofs and walls to provide insulation and cooling

Currently, the highest available standard of building fabric efficiency is the German Passivhaus standard, which seeks to limit the air tightness of building fabric to 0.6 air changes per hour and energy consumption to 15 $kWh/m^2/yr$. The energy efficiency standard of 39-46 $kWh/m^2/yr$ currently proposed by DECC and the Zero Carbon Hub (February 2010) is some way short of this standard, although it is a significant improvement on current Part L fabric standards.

The large difference between current British standards and Passivhaus suggests that, even though standards are improving rapidly, the construction industry still has a long way to go to meet the exemplar standards of energy efficiency that, in a world of volatile energy markets and uncertain futures, should probably be aspired to.

For this reason, it is not considered appropriate at this time for Croydon to require a specific challenging energy efficiency standard, such as Passivhaus. Instead, the Council could seek to implement such a standard on its own stock, or, through negotiation with developers, on sites of strategic importance, where opportunities exist.

In terms of promoting energy efficiency in new buildings across the Borough, a policy which requires new buildings to meet challenging CO_2 reduction targets will ensure that developers take account of these issues. Further discussion of policy options can be found in Sections 7 and 8.

6 Opportunities for Low and Zero Carbon Energy

6.1 Introduction

Since 2004, Croydon Council has required major residential and commercial developments to offset a proportion of their CO_2 emissions through the use of renewable energy on site. This has seen a significant increase in the proliferation of renewable technologies in the Borough; at least 100 major completed sites have complied with the Council's requirement that site CO_2 emissions should be reduced by 10% through on site renewables. Some installations have also been made in schools and at community sites.

It is not known whether the number of installations of renewable technologies in existing private buildings has increased over this time as this information is currently not monitored. However, the likely number of installations is thought to be relatively small.

This section will examine the opportunities for installing low carbon as well as renewable energy technologies in the Borough, taking into account any restrictions that may exist. Given that requirements for each type of technology are different, certain technologies will only be suitable for certain areas and types of development.

When choosing the most appropriate technology of combination of technologies for a given site, developers should bear in mind site constraints, product lifecycle, likely CO_2 savings and opportunities to help grow district energy networks.

6.2 Wind

6.2.1 Technology overview

Wind turbines harness the energy in the wind to generate electricity for use in buildings or to be exported directly to the grid. They can be mounted on buildings of as stand alone turbines in open ground. Turbines are more commonly horizontal axis, such as the one at the Spa Hill allotments (Figure 5), but vertical axis wind turbines are also available (see Figure 21).

The output of wind turbines will vary according to a number of factors:

- Rating or size of turbine, measured in kilowatts
- Average local wind speed at the height of the rotor blades – the output of the turbine is proportional to the cube of the wind speed and a minimum average wind speed of 5 to 6 m/s is needed for a turbine to be feasible
- Orientation in relation to prevailing wind
- Turbulence of air flow – the presence of obstacles downwind of the turbine will disrupt the flow of the wind and inhibit its performance

Where favourable conditions do exist, consideration must also be given to other factors such as existing land use, access and management. Any stand-alone installations should be located sufficiently far[45] from buildings due to acoustic emissions and shadow flicker.

Wind turbines have a lifespan of 20-25 years and may require maintenance every two years.

[45] The distance will vary depending on the size of the turbine, but is not usually less than 100m

Figure 21: A vertical axis wind turbine (Source: Quiet Revolution)

6.2.2 Opportunities for wind in Croydon

Wind is a technology best suited to large, open areas exposed to the prevailing wind. Currently, there are a limited number of wind turbines installed in Croydon. The majority of installations, such as those of small building-mounted wind turbines on buildings in central Croydon, do not seem to have been successful.

A look at the topography of the borough (Figure 22) and existing land use suggests that the most suitable areas for installing wind turbines could be in the south where the land is higher and there are more open spaces. In the centre and north of the borough, where land is lower, there are far fewer open areas and the greater density building density is likely to restrict opportunities for wind turbines.

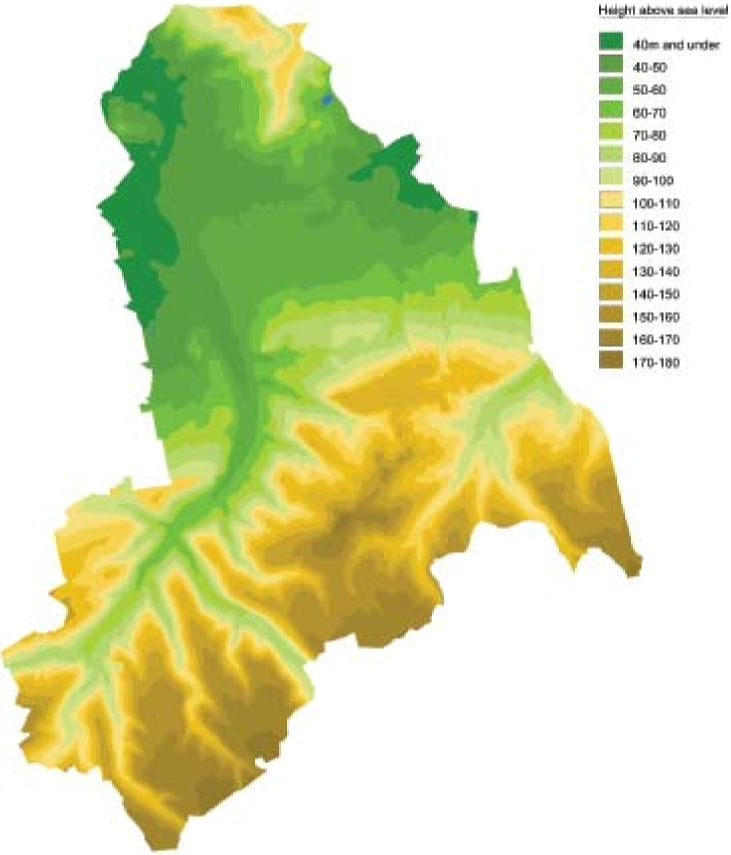

Figure 22: Croydon's topography

This is largely borne out by an analysis of wind speed at a series of locations across the borough (Figure 23), using the UK NOABL database[46]. Locations were selected according to the availability of open space or because turbines have already been installed there.

Area	Average wind speed above ground level (m/s)		
	10m	25m	45m
Purley Playing Fields			
Coombe Lane/Lloyd	5.2	6.0	6.5
Addington Village			
Addington High	5.0	5.7	6.2
Kenley - Godstone	5.5	6.2	6.7
Upper Norwood -	5.7	6.4	6.8
			6.1
Central Croydon			
Addiscombe Road	4.9	5.7	6.2

Figure 23: Estimated average wind speed at selected locations in Croydon

[46] It should be noted that this database provides only an estimate of wind speed at a given location. NOABL is considered less reliable for urban areas, where estimates of average wind speed may be significantly higher than the reality.

With the possible exception of parts of Upper Norwood, wind turbines, both stand-alone and building-mounted, are highly unlikely to be feasible in the centre and north of the Borough. Furthermore, there is very little space available for the installation of any kind of stand-alone wind turbine in these areas. There may be limited scope for turbines mounted on tall buildings in central Croydon.

In the south of the Borough, small stand-alone wind turbines are more likely to be feasible and, where there is sufficient open ground, there may be scope for installations of medium sized turbines up to around 100kW. These slightly larger installations could generate up to 213,000 kWh/yr[47] at a wind speed of 6 m/s, equivalent to the electricity requirements for approximately 60 homes.

In conclusion, there may be some opportunities for some installations of small and medium sized wind turbines in Croydon, particularly in the south of the Borough, but these are likely to be limited. Where suitable conditions for the installation of a wind turbine are thought to exist, it is recommended that extensive on-site testing is carried prior to installation to confirm this.

When assessing a planning application for the installation of a wind turbine, planning officers should consider the impact this will have on amenity and land use, as well of assessing the potential benefits of the project.

[47] www.energymechanics.co.uk

6.3 Solar Photovoltaics

6.3.1 Technology overview

Solar photovoltaic (PV) panels convert the light of the sun into electricity for use in buildings or to export to the grid. Installations of panels can be located on the ground, but the technology is also highly suited for integration into buildings. Building integrated PV can come in many different forms: as bolt-on modules; tiles, which are virtually indistinguishable from roof slates; cladding; louvres; and glass laminates (Figure 24).

Figure 24: Clockwise from top left: Solar PV tiles, cladding, glass laminate PV, solar louvres and bolt-on modules (Source: Solarcentury)

In order to achieve optimum performance, solar panels should be installed at an angle of 30-35^{o} and oriented due south. However, a good performance can be achieved from other orientations and pitches. Figure 25 shows the performance of solar panels at different orientations and pitches relative to the optimum performance (represented as 100).

Output of solar PV panels is measured in kilowatt peak (kWp). 1 kWp solar PV panels is likely to take up around 6-8m^2 on a pitched roof and 10-14m^2 on a flat roof. The output of a 1 kWp array installed in optimum conditions is approximately 900 kWh/yr.

Maintenance of a PV array is relatively low; the inverter that converts DC current to AC current for use in the home and export to the grid may need replacing during the lifetime of the installation and panels may need occasional cleaning depending on how and where they are installed. A PV array can last for up to 30 years and beyond.

		Orientation												
		West						South					East	
		90												
		56	60	64									62	58
		63												
	70	69	74		82	85	86	87	87	86	84	80		70
	60	74		84	87	90	91	93	93	92	89	86	81	
Pitch	50		84	88	92	95	96	97	97	96	93	89	85	80
	40	82	86	90	95	97	99	100	99	98	96	92	88	84
	30	86	89	93	96	98	99	100	100	98	96	94	90	86
	20	87	90	93	96	97	98	98	98	97	96	94	91	88
	10	89	91	92	94	95	95	95	95	95	94	93	91	90
	0	90	90	90	90	90	90	90	90	90	90	90	90	90

Figure 25: Relative performance of solar panels at different orientations and pitches

In order to function efficiently, PV panels require the following site conditions:

- Suitable pitched or flat roof area oriented between East and West through South. One issue that can often prevent the installation of suitably sized PV arrays is the location of dormer windows on suitable pitched roof areas. When designing roofs, architects should assess which roof area is likely to be most suitable for solar technologies and locate dormer windows appropriately with this in mind.
- A pitch between 5 and 50 degrees[48]. At any level lower than this, installations are not likely to operate efficiently enough. Panels on flat roofs can be installed on A-frames to achieve the optimal orientation
- Roof area free from shading. Panels should be located so as to avoid shading when the Sun is at it's lowest during winter (approximately 20^o). Where panels are installed in banks on A-frames on flat roofs, attention should be given to the space between banks to avoid one bank shading another (Figure 26).

[48] A pitch of 0^o is not recommended; panels with flat or very shallow pitches may need more cleaning.

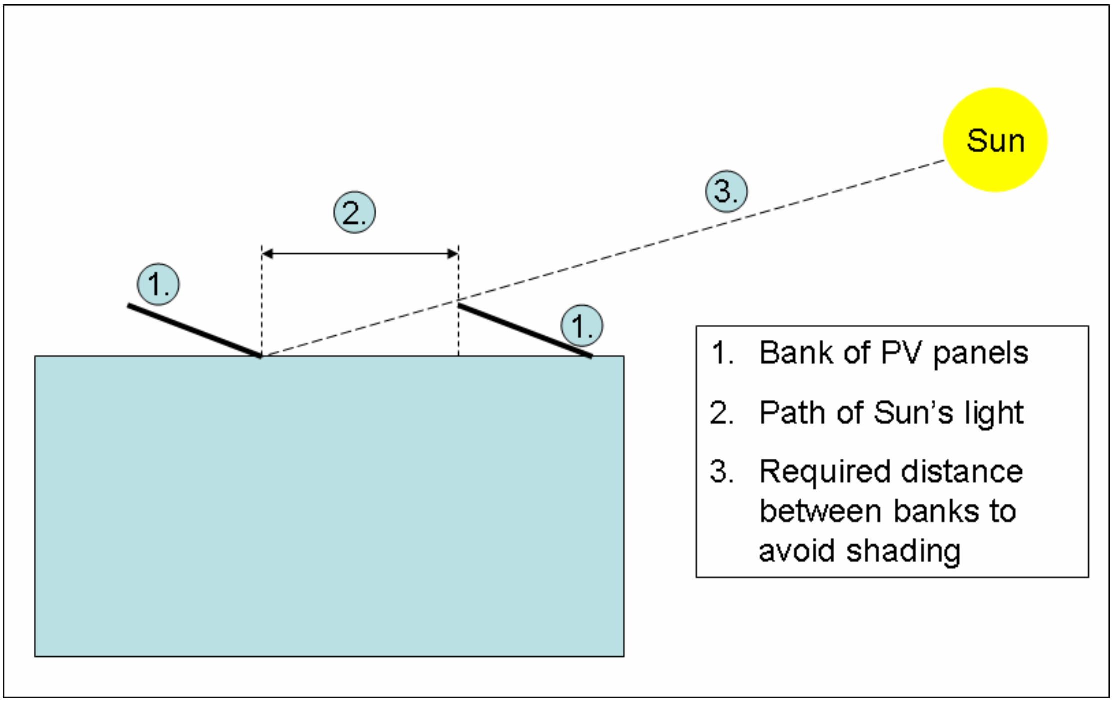

Figure 26: Installation of banks of PV on a flat roof to avoid shading

6.3.2 Opportunities for solar PV in Croydon

A large number of PV arrays have already been installed in the borough, largely due to the Council's planning requirement for renewables in major sites. Opportunities for PV in Croydon are widespread as it is an appropriate technology for any building with a suitable roof and an electricity demand. However, the opportunities for PV to make substantial CO_2 reductions to a building's emissions will be rather more limited in very high density locations where the roof area of a building is small in relation to its height and therefore its floor area and energy demand, such as in the town centre. In these locations, PV cladding may be feasible for tall buildings where the south façade is not shaded by other structures.

Due to the introduction of the feed-in tariff from 2010, it is predicted that there will be a greater number of PV installations on existing buildings. In the case of individual houses, this will be considered permitted development that does not require a planning application unless the building is a listed building, in a conservation area or other restricted area.

Figure 27 below shows the locations of listed buildings (pink) and conservation areas (grey hatching) in Croydon, which may restrict the installation of solar technologies. In assessing applications in these areas, planning officers should give attention to the benefit an installation provides as well as where the most appropriate location may be for it in order to avoid any negative impacts on the building or area.

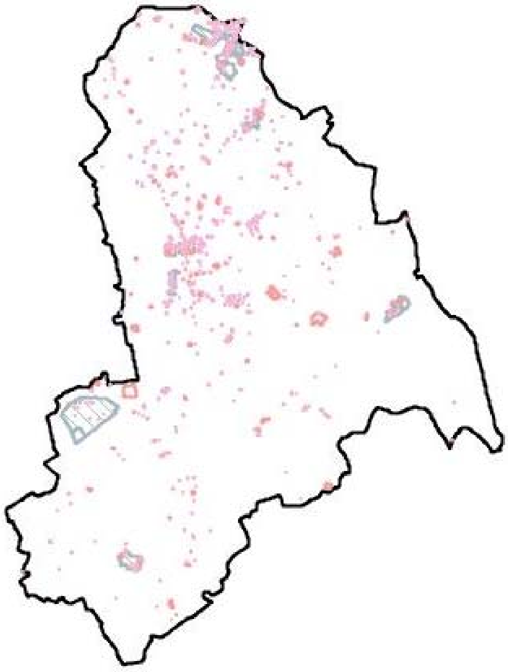

Figure 27: Listed buildings and conservation areas in Croydon

6.4 Solar thermal

6.4.1 Technology overview

Solar thermal panels use the heat of the Sun to preheat water to reduce the amount of fuel needed for hot water requirements. Heat is collected by fluid in pipes in the panels and circulated to a dual coil hot water tank (Figure 28).

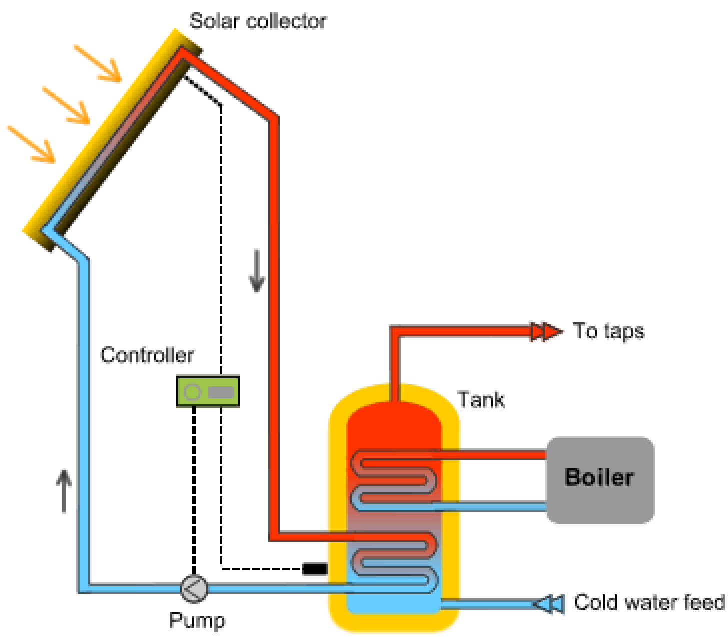

Figure 28: Diagram of a typical solar thermal system

Systems must be sized to meet a proportion of a building's hot water requirements. Oversizing of a system can overheat and damage it. In the summer, panels can produce up to 100% of a building's hot water demand if sized appropriately and over the course of a year a system can provide 50% - 70% of total hot water requirements.

There are three types of solar thermal collectors; flat plate, evacuated tube and tiles (Figure 29). Evacuated tube collectors have a higher output per m^2 but are less resilient and more expensive than flat plate collectors. Solar thermal tiles are less efficient than flat plate collectors but can be integrated well into a tiled roof and as such may be more suitable for areas where planning restrictions are present, such as conservation areas.

Figure 29: Solar collectors (l-r): Evacuated tube, flat pate and tile (Sources: Riomay, generateyourown.co.uk, Solarcentury)

In order to function well, a solar thermal system requires the following:

- Suitable pitched or flat roof (see Section 6.3.1 for further explanation)
- Sufficient internal space for a dual coil hot water cylinder – this is typically higher than a normal hot water cylinder, but with a similar footprint
- Year-round hot water demand

Solar thermal systems can be connected to individual dwellings or to a communal heating system. In the latter case, a single large cylinder is needed; this would be located in the plant room adjacent to a boiler. The distance between panels and cylinders should be minimised as far as possible to avoid heat loss and the need for a more complex system involving longer pipe runs, more powerful pumps and bypass valves. Therefore solar thermal is well-suited to serving up to three storeys of a building, but is less likely to be suitable for providing energy to all the floors in a taller building.

6.4.2 Opportunities for solar thermal in Croydon

Like solar PV, a large number of solar thermal systems have already been installed in the borough, due to the Council's planning requirement for renewables in major sites. There are likely to be significant further opportunities for installing solar thermal systems throughout the borough, particularly on existing housing. It is more likely to be suited to relatively low buildings with a medium to low density and a year-round hot water demand, particularly new-build and existing housing. The number of installations in existing buildings is likely to increase with the introduction of the renewable heat incentive in 2011.

In the case of individual houses, this is considered permitted development that does not require a planning application unless the building is in a conservation area or other restricted area.

Buildings which are not in use during the summer, such as many schools are not suitable for solar thermal. As with solar PV, solar thermal is less likely to be able to make a significant contribution to CO_2 reductions in high density areas with large numbers of tall buildings.

Furthermore, while the installation of solar thermal systems is considered permitted development for existing houses, restrictions may apply for blocks of flats, listed buildings and buildings in conservation areas (see Section 6.3.2).

6.5 Ground Source Heat Pumps (GSHPs)

6.5.1 Technology overview

Ground source heat pumps absorb heat from the ground, which is at a relatively constant temperature throughout the year (10-13^{o} C), to provide space heating and hot water for building. This cycle can be reversed to provide refrigeration and cooling where appropriate.

A ground source heat pump system (Figure 30) consists of; a ground loop (pipe containing fluid), which can be buried horizontally, in vertical boreholes or wrapped around the piles of a tall building; a heat pump which uses electricity to pump fluid through the ground loop to collect heat and a low temperature distribution system, typically underfloor heating or oversized radiators.

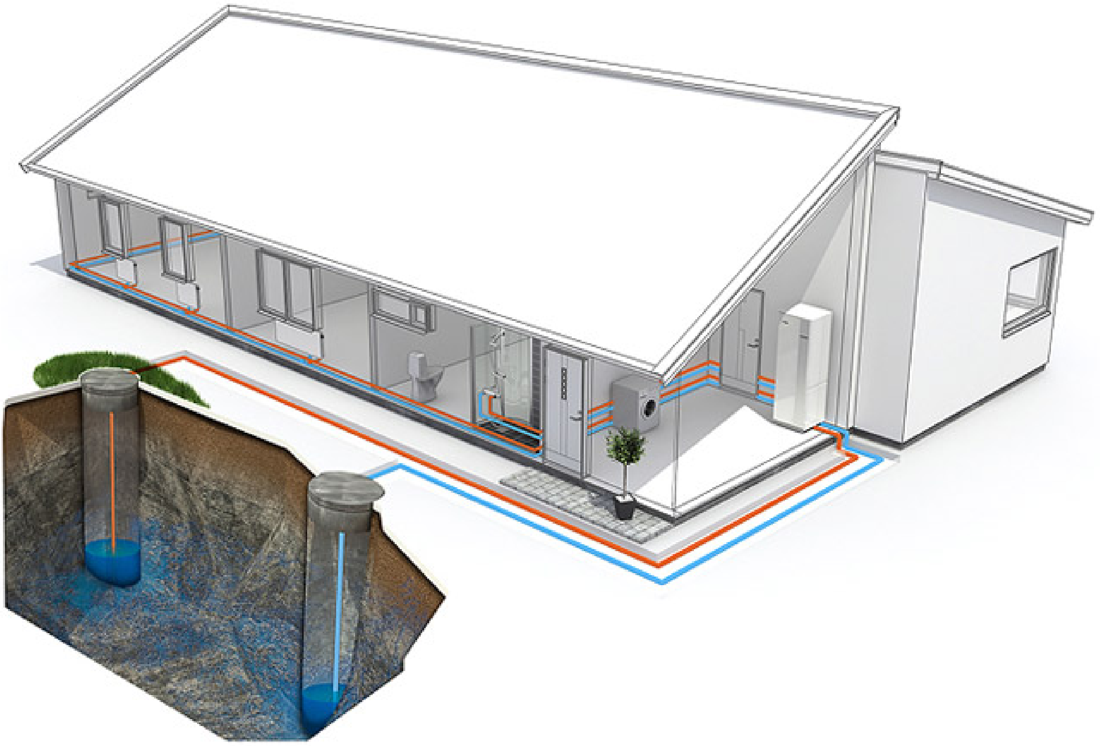

Figure 30: A domestic ground source heat pump system with vertical borehole ground loop (Source: Nibe)

The required length of the ground loop in such a system is in proportion to the size of the heat pump. Care must be taken to size the ground loop appropriately as if it is too short, too much heat can be taken from a particular area and the ground can become frozen.

A GSHP will normally operate at an efficiency of 400-500% for space heating alone and around 300-350% for space heating and hot water together (the lower efficiency is because hot water needs to be heated to a higher temperature). This is why even though GSHPs require electricity from predominantly fossil fuel sources to function, they are able to deliver a CO_2 saving.

For example a gas boiler operating at 90% efficiency will burn 10 kWh of gas to produce 9 kWh useful heat. Using a carbon factor or 0.194 $kgCO_2$/kWh for gas, this will produce 1.94 kg CO_2. In comparison, a heat pump operating at an efficiency of 300% will use only 3 kWh electricity to produce 9 kWh useful heat. Using a carbon factor of 0.422 $kgCO_2$/kWh for grid electricity, this will produce 1.266 kg CO_2, a saving of approximately 35%. As grid electricity becomes less carbon intensive in the mid- to long-term future, these savings will increase.

However, a ground source heating system may also prove to have higher running costs than a gas system. If we accept that the average gas price is approximately 3.5 p/kWh and the average electricity price is approximately 12.5 p/kWh, then even if a GSHP is 3.33 times more efficient than a gas boiler, then it will cost approximately 10% more to run.

GSHPs have a lifecycle in excess of 25 years. The ground loop can have a significantly longer lifespan.

GSHPs require the following:

- Sufficient area of open ground for the installation of a horizontal or vertical ground loop (a ground loo[p can be installed under a building where a heating and cooling system is required; the cooling cycle puts heat back into the ground to be collected when heating is required.
- Sufficient space inside the unit for the heat pump. A GSHP for a single domestic property has typically the same footprint as a gas boiler, but can be taller and is usually installed on the ground.
- Suitable ground conditions; some soil types are more suitable for ground source heating systems than others and a ground survey should be carried out during the early states of development to confirm that the installation is viable.

6.5.2 Opportunities for GSHPs in Croydon

GSHPs are well-suited to several types of development, plarticularly large commercial, retail and office sites where a sizeable heating and cooling load may exist. They are also well-suited to low and medium-density housing with sufficient open space for the installation of ground loops, particularly those which are not connected to the gas network, since in these cases CO_2 and utility bill savings will be significantly higher.

In high density residential sites, the technology is less likely to be appropriate as the likelihood of there being sufficient open ground available to install ground loops is much less. Buildings with a very high hot water demand such as leisure centres are also less likely to be suitable for GSHPs as their efficiency, and therefore resulting cost and CO_2 savings, will be reduced.

Retrofitting GSHPs to existing buildings can be difficult, particularly in urban areas; the heat distribution system may need replacing, causing disruption to building occupants, availability of land may be low and, where vertical boreholes are required, it may be difficult for a drilling rig to access the site.

6.6 Air source and exhaust air heat pumps

6.6.1 Technology overview

Air source heat pumps (ASHPs) work in the same way as GSHPs, but take heat from the air surrounding a building rather than from the ground and are located on the outside of buildings. Exhaust air heat pumps (EAHPs) work in a similar way, but use the air expelled from a building's bathrooms, kitchens or other ventilation systems as a heat source and are located internally.

Both technologies are becoming increasingly popular as a way to meet sustainable building requirements, although they are a relatively new technology to the bulk housing market and information on how they perform once installed is limited and variable.

Figure 31: Exhaust air (l) and air source (r) heat pumps (Sources: Nibe, diytrade.com)

Questions remain over the performance of both technologies and the potential to achieve meaningful emissions reductions. An ASHP/EAHP will normally operate at a lower efficiency than a GSHP; this could be as low as 250% for space heating and hot water together, which will achieve a much more modest CO_2 saving and result in significantly higher fuel bills.

ASHPs and EAHPs may be more suitable where space heating and cooling requirements are significant, but hot water requirements are relatively low, for example in office and retail buildings. This is because the efficiency of the heat pumps is significantly greater when they are not required to provide hot water.

ASHPs and EAHPs have an estimated lifespan of 20-25 years.

ASHPs require the following:

- Suitable space for mounting the heat pump on the outside of a building; this must be accessible for maintenance
- Low temperature hot water distribution system

EAHPs require the following:

- Suitable space inside the building to locate the heat pump
- Low temperature hot water system
- Good standards of building air tightness and insulation to maximise efficiency

6.6.2 Opportunities for ASHPs and EAHPs in Croydon

ASHPs and EAHPs are technically feasible for a wide range of buildings, but are perhaps most effective where hot water demand is relatively low, or where buildings are not connected to the gas network (see also Section 6.5.2).

Careful attention should be paid to the performance of these technologies relative to other technologies as it is important to avoid higher utility costs, particularly in affordable housing.

In the future, the potential for these technologies to reduce CO_2 emissions will increase as the carbon intensity of grid electricity is reduced, but running costs may remain relatively high if electricity prices increase at a similar or greater rate than gas prices.

6.7 Combined heat and power (CHP)

6.7.1 Technology overview

A CHP engine combusts fuel to produce electricity and heat, which can be used to provide heating and hot water to one site or to a number of buildings linked together in a heat network. Where a large cooling demand exists, a CHP engine can be used in tandem with absorption chillers to provide a combined cooling, heating and power (CCHP) or “trigeneration” network.

The fuel typically used in a CHP engine is natural gas, although other fuels such as biomass, liquid biofuels and hydrogen fuel cells can be used. Biomass CHP is usually only suitable for very large sites in excess of 1,000 or more units; there are currently no functioning biomass CHP systems in the UK, but in countries where large district heating networks are well established, such as Finland, town-wide biomass CHP systems can be found.

The benefits of gas CHP compared with conventional electricity generation and gas heating can be seen below in Figure 32.

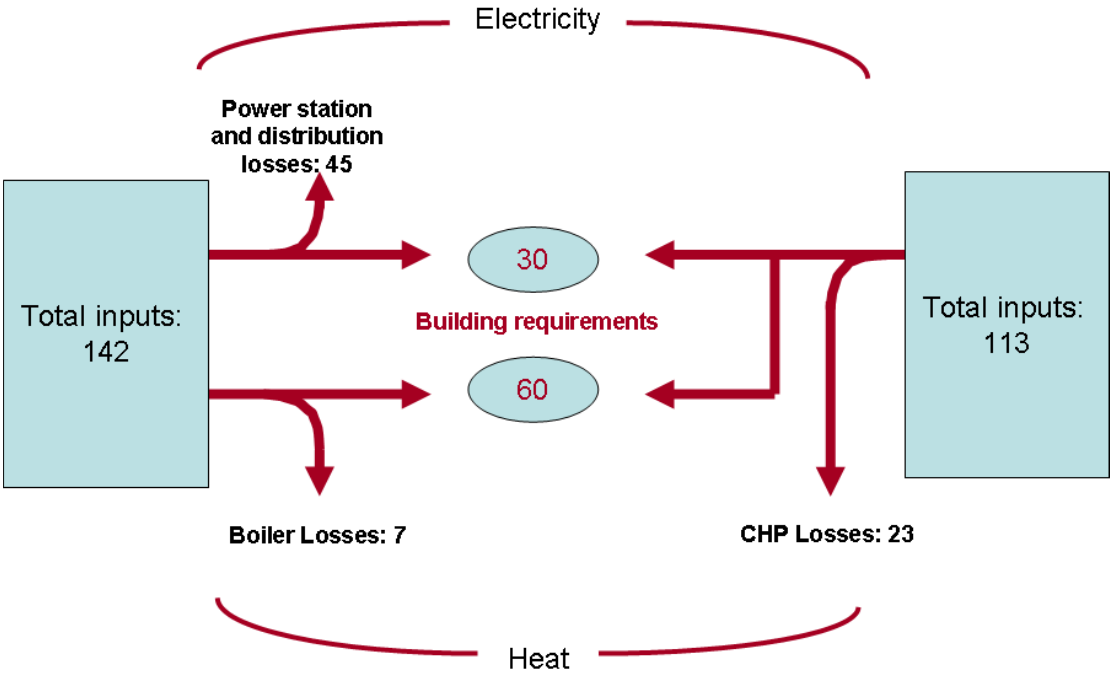

Figure 32: Benefits of CHP versus conventional heat and power generation

A CHP system requires:

- Sufficient space for a plant room containing a CHP engine, back-up boiler and a thermal store. The thermal store is required to help balance out heat demand and ensure that the system runs efficiently. The plant room should be designed to minimise noise from operation of the engine.
- Connection to a communal heat distribution system; this can serve one building or a larger network linking several sites
- Connection to a gas main, if natural gas is the fuel source
- Where electricity from the CHP is to be sold to site occupants, a private wire network may be required which can significantly increase the overall capital cost of the investment

CHP works best where there is a large, constant heat demand that enables the engine to run for longer periods of time and thereby achieve greater energy savings. Therefore, sites such as hospitals, leisure centres, large, dense residential developments (from upwards of 20 units) and large mixed-use sites can be well suited to CHP.

Where several such sites in one area can be linked together in an energy network, the savings can be even greater, although the capital costs of installing heat mains can be high. The higher the density of heat demand, the better, as this reduces the size of capital costs relative to potential revenues from selling the energy. Management and some of the capital cost of a heat network may be provided by an energy services company (ESCo).

6.7.2 Opportunities for CHP in Croydon

There are currently a number of CHP engines in operation or pending installation in the Borough, predominantly in large residential and mixed use sites in Croydon town centre.

Significant potential exists for the development of a town centre-wide energy network given current density of heat demand (Figure 33) and the strong likelihood that the area will see significant regeneration and new housing in the next 20 years which will increase this demand. This new wave of development will see the improvement of public realm, services and infrastructure and could provide an ideal opportunity to install heat mains and other utilities to serve both existing and new buildings and achieve substantial resource and CO_2 savings.

In order to confirm the feasibility of a town-centre energy network and assess the potential for CO_2 reduction, Croydon Council in partnership with the LDA commissioned a study from AECOM. This study was submitted to the Council in December 2009 and forms part of the LDF evidence base for low carbon energy technologies in the Borough. The study identifies a number of options for district energy networks in Croydon Metropolitan Centre, serving both proposed and existing buildings.

In other locations in the Borough, much smaller heat networks or stand-alone CHP systems may be viable. The areas that could be suitable for smaller district networks include district centres located in the A23 corridor that is earmarked for concentration of development in the Core Strategy Issues and Options - Initial Report, i.e. Waddon, Purley and Coulsdon / Cane Hill.

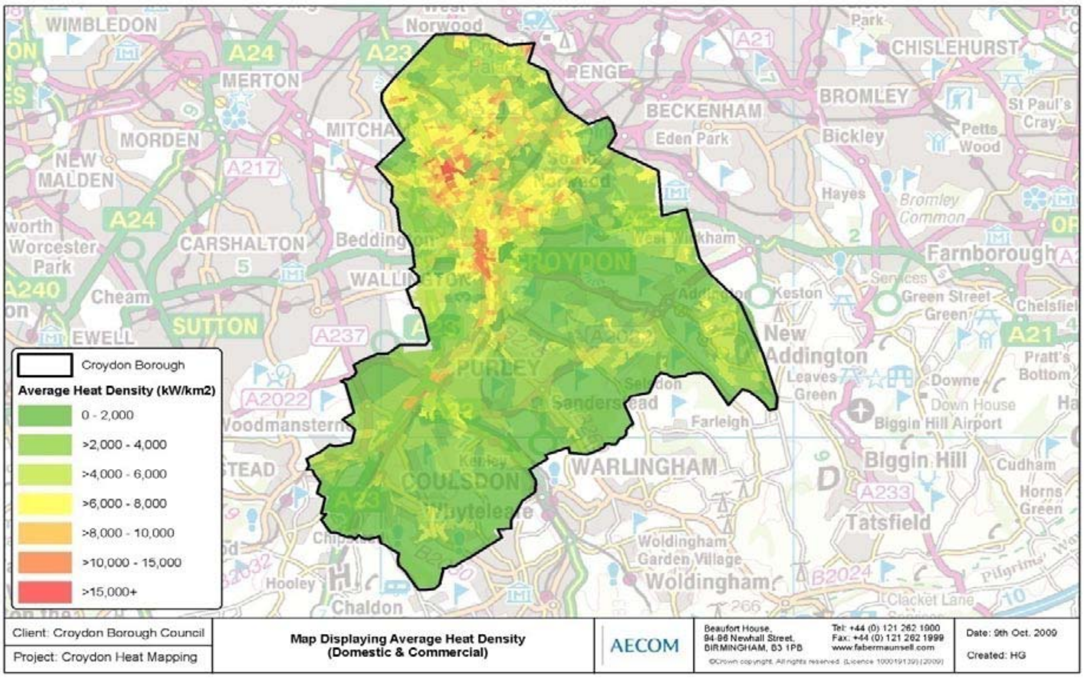

Figure 33: Estimated heat density in Croydon (Source: AECOM)

Waddon: A district energy network is already planned for the proposed leisure centre, housing development and pupil referral unit at the Waylands site (Figure 34). An opportunity may exist to extend this network to the medical centre adjacent to the site in the medium term. Where other major regeneration sites are put forward in this area, opportunities to expand district energy networks to supply both new developments and existing industrial and retail sites along the Purley Way should be considered.

Figure 34: Proposed heat network for the Waylands site (Source: Levitt Bernstein)

Purley: There is potential for the town centre to be regenerated to provide new community and leisure facilities and link the superstore to the town centre through improving cycle and pedestrian links between the two areas. This could provide a significant opportunity to develop a district energy network and any masterplan for the area should consider this. The possible extension of Purley Hospital and the likely intensification of residential development along the Brighton Road either side of the town centre may offer further opportunities for such a network.

Coulsdon / Cane Hill: The presence of several strategic development sites in and around Coulsdon town centre may provide an opportunity to like a number of locations together on a district energy network. These include the Lion Green Road Car Park, Cane Hill, Pinewood and Red Lion sites. The possible addition of more community facilities in the town centre and the improvement of links could improve the potential to grow a network. Any masterplan for the area should carefully consider the potential for district energy.

There may also be potential for small heat networks at other district centres where significant development is brought forward including Addiscombe, Broad Green and Selhurst and New Addington.

At other locations in the Borough, CHP may be suitable on a site by site basis. Where buildings are constructed in areas where district energy networks are planned, steps should be taken to ensure that they are made ready to be connected to the network in the future.

6.8 Biomass

6.8.1 Technology overview

Biomass can refer to any organic material that is combusted to produce energy, but in this instance it is used to refer to wood or woody energy crops, such as miscanthus (elephant grass) and short rotation coppice willow, that are burned in a boiler for space heating and hot water.

Biomass boilers can be used to serve individual dwellings, entire buildings or even larger district schemes. It is most suitable for large, high-density sites. Boilers are as efficient as their gas equivalents and include automatic fuel feed, de-ashing and ignition. Some boilers may also incorporate additional features such as flue gas recirculation to ensure that combustion is complete and emissions are minimised.

There are a number of different types of wood fuel. Wood pellets have a higher energy content by volume and as such require a lower amount of storage space and fewer deliveries, but they are more expensive. Wood chips and woody energy crops are significantly cheaper, but have a lower energy content and therefore require more storage space and a greater number of deliveries. For urban areas therefore, where space is limited and traffic can be a significant issue, wood pellet boilers are normally more suitable.

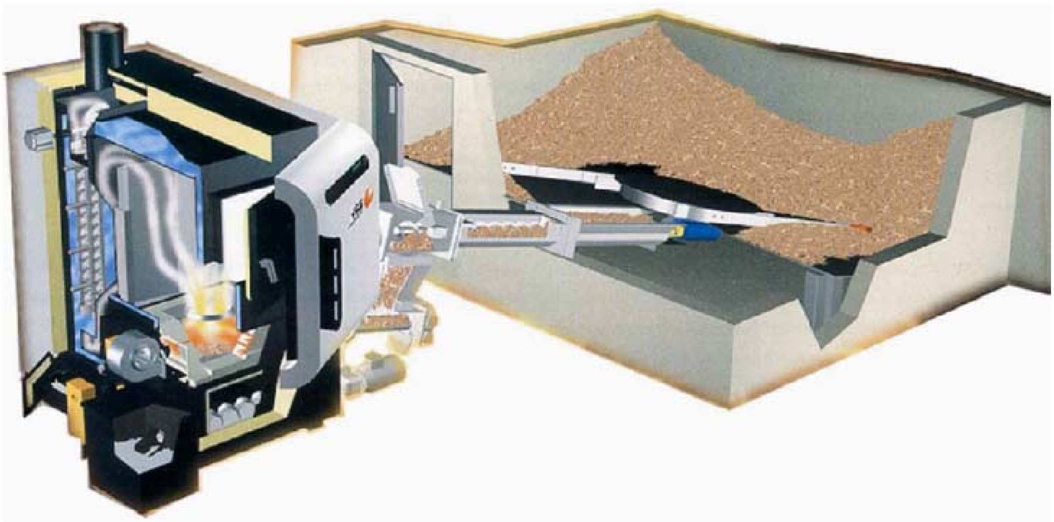

Figure 35: Diagram of a wood pellet boiler and store with automated feed (Source: Econergy)

A communal biomass system requires the following:

- Consistent heat demand. As with CHP, the installation will work more efficiently with a large and constant base head load.
- Sufficient space for plant room and adjacent fuel store. The plant room must be large enough to include a biomass boiler, backup gas boiler and thermal store.
- Suitable access for a delivery truck to the fuel store. Wood pellet will usually be blown into the store from a specialised vehicle, while chip can be blown or tipped into a store. In order to facilitate delivery, fuel stores should be located at ground or basement level.

- Access to a reliable wood-fuel supply. Wood pellet and chip is available from several companies in the South East, but much of the supply of wood pellet in particular is sourced from outside the region.

In recent years, concern has increased over the NOx and PM_{10} emissions from biomass boilers in urban locations and their impact on air quality. A report for London Councils by the AEA[49] indicated that a substantial increase in the number of small and medium biomass installations in the area would lead to an increase in levels of pollution from NOx and particulate matter. At sites near major roads, the increased concentrations would make it difficult to achieve target emissions levels.

The report states that the impact of biomass boilers could be controlled if schemes are limited to larger, more efficient schemes and sites in Outer London, where it is more cost-effective to install the measures that are needed to minimise emissions of NOx and particulates.

6.8.2 Opportunities for biomass in Croydon

A number of biomass boilers are either installed or due to be installed in locations across the Borough. However, the aforementioned concern over NOx and PM_{10} emissions from biomass boilers and the high levels of these pollutants in key development locations in the borough means that the opportunities for this technology are likely to remain relatively limited in the foreseeable future.

Guidance on biomass and air quality for local authorities[50] states that in controlled areas such as AQMAs, developers should provide an air quality assessment. It notes that, while the impacts of biomass on air quality can be controlled by requiring greater stack heights[51] or by restricting installations to larger or district schemes, this can be a material consideration to a planning decision. Whether or not it is a material consideration depends on the significance of the impact the development is likely to have; this is to be determined by the Council, which has an understanding of the key air quality issues in an area.

Croydon's Air Quality IPG report recommends that all proposals incorporating a biomass boiler should be accompanied by an air quality assessment. It also noted that biomass is not suitable in all parts of the borough. In practice, this means that any proposal which is likely to lead to even a marginal increase in NOx and PM_{10} concentrations in the centre and north of the borough will not be deemed acceptable. In these areas, biomass installations are currently unlikely to be suitable, although this may change in the future if air quality improves substantially.

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[49] "Review of the potential impact on air quality from wood fuelled biomass use in London", AEA

[50] 'Biomass and Air Quality Guidance for Local Authorities', Environmental Protection UK, 2009

[51] It should be noted that this is often not possible due to other planning requirements

Biomass installations in other areas in the borough may be more appropriate, but an air quality assessment should be provided and it is strongly recommended that developers should consult Croydon's pollution team at as early a stage in the planning process as possible.

The Council should also produce a set of guidelines for developers indicating where biomass installations might be acceptable and providing requirements. Currently, the Council requires developers to complete a checklist providing details of the installation and proposed emission abatement measures.

6.9 Renewable and low carbon energy policy options

6.9.1 Renewable energy targets

PPS1 requires that local authorities should include in their local development plans policies that require new development to include renewable energy to provide a proportion of site energy demand. Currently, both the Croydon Plan and the London Plan include policies that require major new developments to include renewable energy technologies to reduce site CO_2 emissions by a certain proportion.

In Croydon, the introduction of policy EP16 has certainly helped increase the proliferation of renewable technologies across the borough; a query run on the Environment and Sustainability Team's database reveals that over 150 major planning approvals have been subject to this policy. Where developers have not been able to meet the required standard, they have provided financial contributions under Section 106 that have been used to provide renewables for community buildings or to support installations of loft insulation.

Despite the clear benefits provided by this policy to date, recent changes in policy, the introduction of the CSH and the revision of BREEAM raise important questions over the ongoing usefulness of such a policy: Does such a policy place too great an emphasis on renewables when energy efficiency should be given equal if not greater importance? If all buildings are to be subject to increasingly challenging CO_2 reduction targets from 2010 onwards, then does it matter whether these targets are met through energy efficiency or renewables or both?

To help frame a response to these questions, we need to ask a third: What is a policy like EP16 or policy 4A.7 of the London Plan trying to achieve? The objectives of these policies can be defined as reducing reliance on fossil fuels, reducing CO_2 emissions and improving air quality by reducing pollutant emissions. A policy requiring increased energy efficiency will also help to contribute towards these goals.

Both the London Plan and the Croydon Plan emphasise the importance of energy efficiency. The Croydon Plan states that "the design and layout of new development should maximise energy efficiency”[52], while the London Plan has energy efficiency as the first plank of its energy hierarchy[53].

However, unlike with renewable energy, there is no specific target in either plan for energy efficiency standards. In theory, it is in a developer's interests to maximise energy efficiency in spite of the lack of a specific standard, as by reducing the development's CO_2 emissions, they will have to spend less to meet a 10% or 20% renewables target. In practice, this does not always happen, for a number of reasons:

- Given that there is no specific policy requirement on energy efficiency standards, securing high energy efficiency standards becomes a matter for the planning officer. This demands a high degree of technical awareness and does not promote consistency. Furthermore, it is not enforceable. Under the current London Plan, a 2% reduction in emissions through energy efficiency is, in theory, just as acceptable as a 10% reduction.
- It may be more cost-effective in some cases to install a larger renewable energy system than to consider redesigning a project to reduce energy demand, if energy efficiency has not been taken into account at an early stage. With some renewable technologies, such as biomass, it may also be cheaper to install a larger system than it is to concentrate on maximising energy efficiency.
- Many developers are less willing to seek higher standards of energy efficiency because of the perceived degree of technical difficulty in construction. Increasing the size of a bolt-on renewables system can often represent a technically simpler option.

A second issue with specific renewable energy policies is the extent to which they can be properly monitored and enforced. A high degree of technical knowledge and awareness is needed on the part of the planning authority, which may or may not be available and it may be difficult to determine whether policy requirements have been met.

Finally, renewable energy targets can vary across planning authorities, which can create uncertainty for developers, leading to difficulty in achieving compliance. A policy may be expressed in terms of energy or CO_2, take into account regulated emissions only or both regulated and unregulated emissions or require 10% or a 20% contribution from renewables.

The alternative to a specific renewables policy is to set an overall CO_2 reduction policy by requiring a certain level of the CSH or BREEAM, which can be met through any combination of energy efficiency measures and renewable technologies. This still allows the policy objectives of reducing fossil fuel consumption and CO_2 emissions to be met, but is favourable for the following reasons:

- It sets a target based on Building Regulations requirements, which is a metric that is comprehensible for all developers

[52] Policy EP16, paragraph 8.68
[53] Policy 4A.1

- In order to meet such a target, it is likely that both energy efficiency measures and low and zero carbon technologies will still be required; however, the choice of which technologies will be used is left to the developer, which allows greater flexibility and encourages innovation in order to achieve higher reductions in CO_2 per unit of expenditure.
- As both BREEAM and the CSH have post-construction phases, monitoring and enforcing policies is more straightforward as it can be done through a universally available certification system
- Due to the above, less work is generated for the planning authority, which helps streamline the planning process to the benefit of all parties.

Policy recommendations

- In light of the above, it is recommended that no specific renewable energy target should be set for new developments. Instead, a minimum level of the CSH or BREEAM should be set and the Council should expect a proportion of the required CO2 reduction to come from low or zero carbon energy technologies. This will allow developers flexibility while ensuring that the CO_2 emissions of new buildings are significantly reduced.

6.9.2 Planning permission for renewable technologies

Currently, planning permission for renewable technologies in Croydon is governed by policy EP15. This policy is compliant with the guidelines included in PPS 22: Renewable Energy, in particular:

- “Regional spatial strategies and local development documents should contain policies designed to promote and encourage, rather than restrict, the development of renewable energy resources.”
- “Planning policies that rule out or place constraints on the development of all, or specific types of, renewable energy technologies should not be included in regional spatial strategies or local development documents without sufficient reasoned justification.”
- “Regional planning bodies and local planning authorities should not make assumptions about the technical and commercial feasibility of renewable energy projects (e.g. identifying generalised locations for development based on mean wind speeds). Technological change can mean that sites currently excluded as locations for particular types of renewable energy development may in future be suitable.”[54]

These guidelines clearly stress the importance of not restricting the deployment of particular technologies to specific locations unless there is sufficient justification. Applied to Croydon, this means that although certain technologies may be more suited to particular areas (for example wind is more likely to be suitable for locations in the south of the Borough, while

[54] PPS 22: Renewable Energy, Paragraph 1 (Key principles)

biomass is not likely to be suitable for north and central Croydon for the foreseeable future), applications should be assessed on a site by site basis.

Policy recommendations

- The Core Strategy should include a policy allowing the installation of renewable technologies provided that any forthcoming benefits are not outweighed by adverse impacts.
- This policy should be accompanied by guidance identifying likely constraints and opportunities for renewables installations (for example AQMAs, conservation areas, green belts) and how these constraints can be balanced with the need to reduce the borough's CO_2 emissions. It is important that this guidance is available to the public as well as developers, as the introduction of the Feed-in Tariff and the Renewable Heat Incentive, together with proposed changes to permitted development regulations, is likely to encourage householders to install renewable technologies.

6.9.3 District energy and communal heating

There is currently no mention of district energy networks in the Croydon Plan, although both the London Plan (2008) and the draft replacement London Plan include overarching policies designed to encourage the spread of such networks.

Given that the development of a district energy network in the CMC to serve both new and existing buildings is likely to be a significant part of the borough's carbon reduction strategy over the duration of the LDF, then the LDF must provide a framework to facilitate this. Part of this process will be the development of an action plan to promote the development of such a network and ensure that masterplanning and infrastructure planning takes this into account.

A second side to this will be securing finance to help grow the network. The government's Heat and Energy Saving Strategy (HESS) envisages that obligations under the Community Infrastructure Levy (CIL) could play a role in supporting the development of heat networks.

Finally, policies should be included in the Core Strategy that ensure that developments are connected to the heat network, or made ready for connection, in order to maximise the potential number of developments served by the network and hence increase CO_2 savings.

Outside of the CMC, it may be possible to develop smaller networks (see Section 6.7.2) or to install communal heating systems in major developments, both of which will increase efficiency and reduce CO_2 emissions.

Policy Recommendations

- Major developments should select energy systems according to the following hierarchy, in line with the London Plan:
    - Connection to existing energy networks
    - Site wide CHP or CCHP
    - Communal heating and cooling
- Where a new communal heating system is proposed, opportunities to extend the system to other sites in the surrounding area should be identified
- Where a development with a communal heating system is proposed in an area of high heat density, or where a district heat network is planned, the development should be made ready for a future connection to an energy network by locating the plant room in a suitable area and installing the appropriate equipment.
- In order to facilitate the above, the Council should map areas of high heat density indicating where it will enforce:
    - connection to an existing heat network
    - future-proofing a development for a connection to a planned network
    - a contribution from each development that connects to an existing heat network against avoided capital costs that would otherwise have been spend on individual boiler plant

7 Costing the Code for Sustainable Homes (CSH)

7.1 Methodology

A typical approach to assessing the viability of a housing development[55] is based on the residual land value of the site in question. Residual land value (R) is determined by subtracting the costs of developing a site[56] from the market value of a site and can be described as the maximum value a developer would be prepared to pay for an area of land.

If this figure is greater than the amount the landowner would be prepared to accept for the land (L), then a surplus may become available. The presence of a surplus suggests that the development is viable. Any policy that produces a cost to the developer will reduce the residual land value of a site and potentially reduce its viability.

Therefore in order to calculate the viability of a policy or obligation for a given site, it should first be determined whether there is potential for a surplus. The costs of implementing the policy should then be taken into account when calculating the residual land value of the site and if this number remains potentially positive, then it may be concluded that the policy is economically viable.

Given that the introduction more than one new policy will have a cumulative impact on the viability of development, it is important that the economic impact of a particular policy is not assessed in isolation. For this reason, the Council has examined viability of sustainable design and construction standards and affordable housing requirements together through this report and the Affordable Housing Viability Study (AHVA).

The AHVA has been produced by Fordham Research, who used a similar approach to assessing viability through their “Dynamic Viability” model. This approach allows plots a range of market price values against a range of costs values to determine the most appropriate level for affordable housing at a given time. The benefit of this approach is that it allows this level to vary over time according to market circumstances and is therefore robust. The AHVA will apply this model to 28 housing sites, 10 of which are real, with the remainder notional.

This model was applied to different CSH scenarios for each site to test different policy options. The first scenario includes the additional build costs of

[55] As outlined in Oxley, Golland and Weston, “Urban residential development, economic viability and urban capacity studies”, *Journal of Housing and the built environment*, 2005, Vol 20.
[56] These include build costs, planning obligations, consultants’ fees and developer’s expected profit margin.

achieving CSH Level 4, while the second includes the additional build costs of achieving CSH Level 3.

7.2 Costing the Code

The costs for achieving CSH Levels 3 and 4 used by Fordham research as inputs to the Dynamic Viability model are outlined below.

Costs for achieving each standard have been calculated for five types of unit:

- 102 m^2 detached house
- 76 m^2 end terrace house
- 76 m^2 mid-terrace house
- 60m^2 flat – infill site
- 60 m^2 flat – city centre site

Two different kinds of flatted development have been included to account for the likely differences in the chosen mix of energy technologies needed to meet CSH targets.

These costs are based on information included in the 2008 Cyril Sweett report for DCLG, titled “Cost Analysis of the Code for Sustainable Homes”, unless specified otherwise. For each of the types of unit, a CSH assessor has produced a pre-assessment indicator to determine how the required level could be achieved, taking into account likely site constraints to determine the most suitable energy solution and the most appropriate mix of tradable credits.

Details of the pre-assessment indicators and assumptions made can be found in Appendix A.

Figure 36 below provides a summary of the additional costs required to meet Part L requirements in 2010 and to achieve CSH Levels 3 and 4. Part L base build costs for 2006 are taken from the 2008 Cyril Sweett report. It has been assumed that developers would seek to achieve the standards in the most cost-effective and practical way possible.

	Detached	End terrace	Mid-terrace	Flat – infill site	Flat – city centre
2006 Part L base build cost	80,172	56,620	56,620	80,640	80,520
Increase to meet 2010 Part L [£]	3,916	3,916	3,916	3,298	5,238
Increase to meet 2010 Part L [%]	4.9%	6.9%	6.9%	4.1%	6.5%
Increase to meet CSH 3 [£]	4,961	5,201	5,121	4,263	5,828
Increase to meet CSH 3 [%]	6.2%	9.2%	9.0%	5.3%	7.2%
Increase to meet CSH 4 [£]	10,101	10,393	9,293	7,423	8,053
Increase to meet CSH 4 [%]	12.6%	18.4%	16.4%	9.2%	10.0%

Figure 36: Increase in costs to meet CSH Levels

These costs are generally slightly higher than the cost estimates provided for each unit type in the 2008 Cyril Sweet report[57]. This can be explained by a number of factors. Firstly, assumptions have been made for the pre-assessment indicators that some credits will not be gained for certain sites, for example those relating to flood risk, daylighting and provision of outdoor space.

Secondly, the likely limits to the deployment of biomass mean that it will be more expensive in several cases to meet CO_2 reduction requirements for a higher level of the CSH. Finally, it is assumed that for large city centre developments, sites will be required to install communal CHP or to connect to a district energy network, in order to comply with other Council policies.

Details of the proposed mix of energy efficiency and low and zero carbon technologies for each unit type are provided in Figure 37, together with CO_2 savings. Please note that the energy solution for each unit type may exceed the required reduction in CO_2 emissions. This is because energy systems have been sized to meet demand, apart from in the case of solar PV, to reflect other policy requirements. For example, a large development in the town centre might be required to install a communal CHP system in readiness for connection to a district energy network at a later stage. These energy solutions represent the most likely solution for a particular type of building based on form, location and existing planning applications in Croydon. It should be noted that many other options may be feasible.

[57] Since the initial drafting of this report and the delivery of the Affordable Housing Viability Study, a further analysis of the costs of meeting the CSH has been produced by Cyril Sweett and DCLG (Code for Sustainable Homes: a cost review DCLG, 2010). As it was not possible to feed these costs into the AHVA, it was considered more appropriate to keep the first cost analysis in this report. However, these adjusted costs, obtained using the same methodology described above, can be found in Appendix C.

	Detached	End terrace	Mid-terrace	Flat – infill site	Flat – city centre
CSH 3					
Energy solution	Energy efficiency and 4m^2 solar thermal	Energy efficiency and 4m^2 solar thermal	Energy efficiency and 4m^2 solar thermal	Energy efficiency and 0.3 kWp PV	Energy efficiency and site-wide CHP
TER	22.90	22.37	19.87	22.50	22.50
DER	15.36	14.23	11.70	15.78	13.95
Total notional emissions [kgCO_2/yr]	2,336	1,700	1,510	1,350	1,350
Total actual emissions [kgCO_2/yr]	1,567	1,082	889	947	837
CO_2 reduction [kgCO_2/yr]	769	618	621	403	513
CO_2 reduction [%]	32.9	36.3	41.1	29.8	38.0
CSH 4					
Energy solution	Energy efficiency, 4m^2 solar thermal and 0.6 kWp PV	Energy efficiency and 1 kWp PV	Energy efficiency and 0.8 kWp PV	Energy efficiency and 0.7 kWp PV	Energy efficiency, site-wide CHP and 0.2 kWp PV
TER	22.90	22.37	19.87	22.50	22.50
DER	12.35	12.10	10.91	12.48	12.25
Total notional emissions	2,336	1,700	1,510	1,350	1,350
Total actual emissions	1,260	920	829	749	735
CO_2 reduction [kgCO_2/yr]	1,076	780	681	601	615
CO_2 reduction [%]	46.1	45.9	45.1	44.5	45.6

Figure 37: Details of energy solutions for CSH Levels 3 and 4

7.3 Findings of Affordable Housing Viability Assessment

The Affordable Housing Viability Assessment (AHVA) produced by Fordham Research analysed the impact of requiring different levels of the CSH on a range of developments under current market conditions, assuming that an affordable housing contribution of 30% would be required. Figure 38 provides a summary of the results. It can be seen that there is a substantial difference between current Building Regulations and CSH Level 3, but only a relatively minor difference between CSH Levels 3 and 4.

Given that the cost difference between Building Regulations Part L 2010 and CSH Level 3 is minor (See Section 7.1) , we may assume that a policy requiring Level 3 will have little impact on viability. Fordham's analysis suggests that a more substantial increase in costs to meet CSH Level 4 would also have little impact on viability.

	Viable	Marginal	Not viable
Part L 2006	12	5	5
CSH Level 3	8	1	13
CSH Level 4	7	0	15

Figure 38: Viability of sites under different CSH levels

7.4 Environmental impact of policy scenarios

The environmental impacts of new housing in Croydon in the period 2011-2031 in terms of CO_2 emissions and increased water consumption were analysed for each different housing growth scenario (see Section 4.1) and for a range of policy options.

Figures 39, 40, 41 and 42 show the impact of new housing on CO_2 emissions across the Borough. Using housing projections provided by the Council's planning policy team, emissions from new housing were calculated for three policy options:

- No specific policy for the CSH (i.e. compliance with Part L, Building Regs
- CSH 4 until 2016, compliance with Building Regulations Part L thereafter
- CSH 4 until 2013, 70% reduction over Part L 2006 until 2016 and Part 2016 thereafter

The impact of these policies in terms of CO_2 savings over the period and how this would impact on per capita CO_2 emissions was calculated[58].

[58] Assuming no other action was taken to reduce emissions

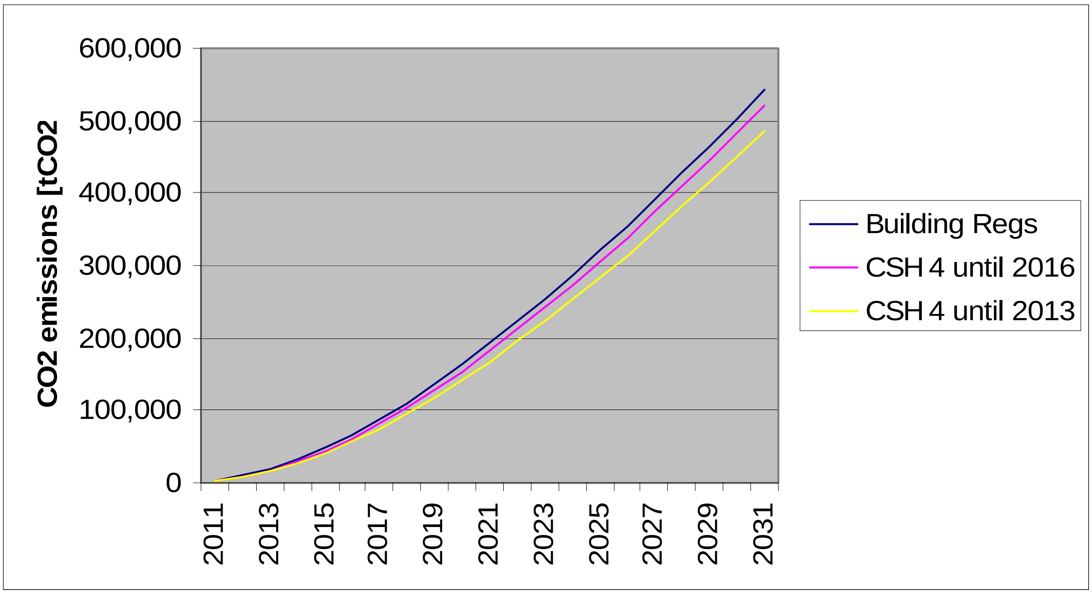

Figure 39: Impacts of different policy options on CO_2 emissions from new housing (Scenario 1)

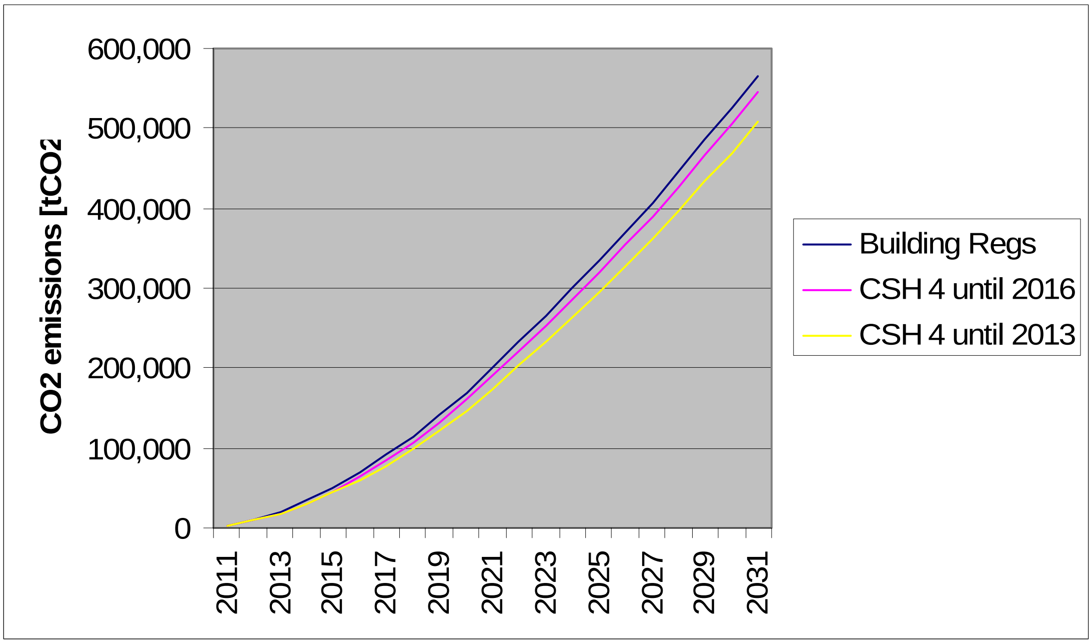

Figure 40: Impacts of different policy options on CO_2 emissions from new housing (Scenario 2)

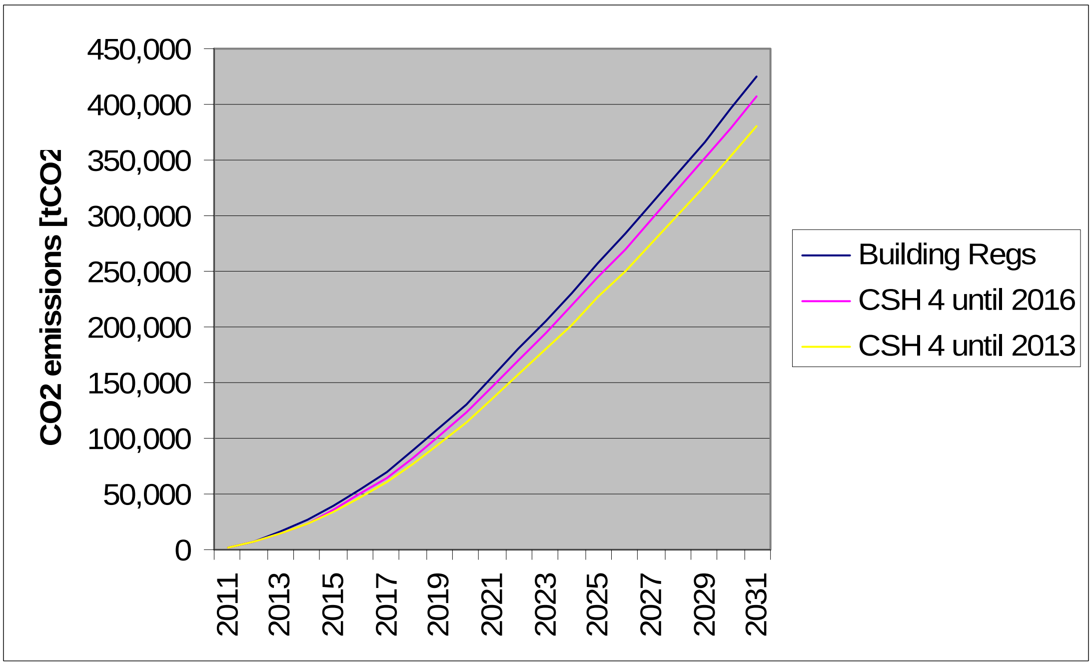

Figure 41: Impacts of different policy options on CO_2 emissions from new housing (Scenario 3)

	Cumulative emissions from new housing 2011-2031 [tCO_2]	Cumulative saving over Part L minima [tCO_2]	Annual emissions from new housing in 2031 [$tCO_{2/yr}$]	Increase above aggregate 2007 emissions [%]	Emissions per capita in 2031 [%]	Change in emissions per capita from 2007 [tCO_2]
Scenario 1						
Building Regs	542,017	0	39,264	2.4	4.49	-0.31
	521,025	20,992	38,214	2.3	4.48	-0.32
	486,057	55,960	36,157	2.2	4.48	-0.32
Building Regs	566,430	0	41,225	2.5	4.49	-0.31
CSH 4 until 2016	544,833	21,597	40,145	2.4	4.49	-0.32
CSH 4 until 2013	507,606	58,825	37,955	2.3	4.48	-0.32
Scenario 3						
Building Regs	425,178	0	29,545	1.8	4.46	-0.34
CSH 4 until 2016	407,753	17,425	28,674	1.7	4.46	-0.34
CSH 4 until 2013	380,231	44,946	27,055	1.6	4.45	-0.35

Figure 42: Impacts of different policy options on CO_2 emissions from new housing

While the impacts of different policies will be relatively small in terms of reducing CO_2 emissions per capita, the cumulative and ongoing impacts of the different options are more significant.

These impacts remain relatively insubstantial when compared to the total CO_2 emissions from existing domestic buildings. This highlights the need for the Council not only to ensure that new development is sustainable, but to play a leading role in encouraging and enabling building retrofit programmes and behaviour change.

The impact of different policy options in terms of water consumption can be found in Figure 43. Two different policy options were investigated:

- Not setting a particular policy (i.e. Building Regs 2010, though to be equivalent to maximum per capita water consumption of 120 l/p/d)
- CSH Level 3 or 4 (equivalent to maximum per capita water consumption of 105 l/p/d

Water consumption for the existing population was assumed as 150 l/p/d.

Scenario	Total estimated increase in water use [m^3/yr]	Total increase in water use [%]	Average water per capita water use in 2031 [m^3/p/yr]	Total estimated increase in water use [m^3/yr]	Total increase in water use [%]	Average water per capita water use in 2031 [m^3/p/yr]
	Building Regulations			CSH Level 3/4		
	1,573,631	8.47%	53.70	1,376,927	7.41%	53.18
	1,582,149	8.51%	53.70	1,384,380	7.45%	53.17
	1,193,987	6.42%	53.94	1,044,739	5.62%	53.53

Figure 43: Impact of different policy options on water consumption

The difference between policy options is more significantly greater than for CO_2 emissions and shows a substantial benefit in requiring at least Level 3 of the CSH for new housing. The Council might even consider a more ambitious water consumption target of 90 l/p/d from 2013 (equivalent to four CSH Wat 1 credits), depending on the cost impact of such a policy.

It is more difficult to assess the direct impacts of other elements of the CSH and therefore the impacts of different policy requirements. However, the pre-assessment indicators produced for the purposes of this report indicate that, assuming that a developer is seeking to minimise costs, a policy requirement of CSH Level 3 only would not deliver several important benefits, including:

- Greater reduction in CO_2 emissions
- Provision of cycle storage
- Reduction in potable water consumption for external use
- Reduction in surface water run-off and flood risk

Given that several areas where development is likely to take place are at risk from surface-water flooding, the last point on the above list is of particular importance.

7.5 Policy discussion – new-build housing

Section 7.4, which outlines the environmental impacts of policy options, provides a strong case for requiring new-build housing to achieve at least a CSH Level 3 rating rather than mere compliance with 2010 Building Regulations.

The Fordham Research study indicates that the jump from Level 3 to Level 4 would have a minimal impact in terms of viability. Given the significant additional environmental benefits that would be achieved by requiring CSH Level 4, it is recommended that this standard should be required as a minimum for all developments of 2 or more houses. It is not considered suitable for the requirement to be extended to single houses given that many of this type of development is likely to be undertaken by homeowners with minimal experience of commercial development who will incur substantial costs and a heft administrative burden.

This requirement should be reviewed after a 3-year period to assess the viability of requiring higher standards in terms of water consumption and CO_2 emissions.

In some cases however, it may not be feasible to achieve a Level 4 rating, because the most suitable combination of energy technologies does not achieve a 44% reduction in regulated CO_2 emissions. For example, a high density high-rise development would currently be unsuitable for biomass due to its impact on air quality, while a combination of PV and CHP would be unlikely to achieve the necessary emissions reduction due to the low proportion of available roof area.

The Council has experienced issues of this kind with several recent planning applications, where all requirements necessary to achieve a Level 4 rating an be met apart from the mandatory 44% reduction in CO_2 emissions.

Where CSH Level 4 cannot be achieved, the Council could seek a financial contribution in lieu of achieving this reduction.

The size of this contribution could be determined several different ways. Two of these, which would be applicable where a developer has failed to meet an emissions reduction requirement, are outlined below:

- The cost of installing a particular renewable technology (e.g. solar PV or solar thermal) to achieve the additional CO_2 reductions needed to meet CSH Level 4 standards
- The cost of installing energy efficiency measures (e.g. loft insulation) in existing homes to achieve additional CO_2 reductions equivalent to those needed to meet CSH Level 4 standards

The contribution could be used to retrofit housing or other buildings, or to help finance district energy networks or other infrastructure. The Council would have to identify suitable projects where this money could be used and would also have to justify requiring a contribution under the terms of Government Circular 05/05 or the Community Infrastructure Levy[59].

If the Council does implement a requirement that all new-build dwellings should meet CSH Level 4, it may wish to review this policy in 2013. The draft replacement London Plan outlines an expectation that a 55% reduction over Part L 2006 CO_2 emissions should be achieved by all new development from this date forward. The Council could consider the following alternatives:

- Require a 55% or a 70% reduction over Part L 2006 CO_2 emissions (the latter is equivalent to the minimum statutory requirement for on-site CO_2 reduction in 2016)
- Require developers to make a financial contribution equivalent to the cost of achieving the additional CO_2 reductions needed to achieve a 55% or a 70% reduction over Part L 2006 CO_2 emissions. This contribution would then be spent on achieving reducing CO_2 emissions in the local area[60].
- Require developers to make a financial contribution to cover the cost of installing energy efficiency measures (e.g. loft insulation) in existing homes to achieve additional CO_2 reductions equivalent to those needed to achieve a 55% or a 70% reduction over Part L 2006 CO_2 emissions. This contribution would then be spent on achieving reducing CO_2 emissions in the local area.

The benefit of the latter two policy approaches would be that they would provide a stream of capital for retrofit and/or energy infrastructure projects, which would help make substantial reductions in the emissions produced by buildings.

Examples of how such a policy could work are outlined below. First, the cost of retrofitting various measures to an existing house have been calculated, together with the CO_2 reductions achieved through these measures[61] (Figure 44).

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[59] Paragraph 2.24 of the CLG publication “The Community Infrastructure Levy” states that “an increasingly important component of infrastructure planning is the area of demand management – that is, measures which prevent a need for mew or more costly infrastructure from arising. Demand management measures can sometimes be the best and most cost effective solutions to delivering sustainable communities”

[60] This would be equivalent to the “allowable solutions” approach outlined in the CLG response to the Zero Carbon Homes consultation.

[61] Costs from Energy Saving Trust unless specified otherwise

Measure	Estimated installation cost [£]	Estimated annual CO_2 saving [$kgCO_2$]
Cavity wall insulation		
Draught proofing	200	130
Double glazing	n/a	
Boiler replacement		
Solar thermal system		
1 kWp PV panels		
LED lights		
Total (house with cavity wall)		
Total (house with solid wall)	16,557+	5,596

Figure 44: Costs of retrofitting existing dwellings and associated CO_2 savings

The two policy options outlined above that require a contribution for retrofit measures have been be applied to a notional infill development of 20 flats built to achieve CSH Level 4[67]. In order to achieve an additional 11% reduction in CO_2 emissions, for example (in order to meet a policy of a 55% reduction in CO_2 emissions), a developer would be required to reduce regulated emissions by a total of 2,830 $kgCO_2$ across the site.

This reduction could be achieved by installing an additional 5.5 kWp solar PV panels, which would cost £30,250[68]. This could be used to provide loft insulation for 121 houses, which would achieve a CO_2 reduction of 96,800 kg CO_2, several times greater than the required CO_2 reduction from the notional site. It could also be used to provide whole house retrofits for two houses, achieving a CO_2 reduction of 11,192 $kgCO_2$.

Alternatively, in order to achieve a 2,830 $kgCO_2$ reduction in emissions from existing housing in the borough, approximately 8 boilers would have to be replaced[69]. The cost of this would be a significantly smaller £12,000, and this could be set as the developer's contribution.

The first of these two examples (i.e. developer contribution based on cost of achieving emissions reductions on site) was applied to housing growth scenario information to determine the potential impact of such a policy. Figure

[62] Cost from government Heat and Energy Saving Strategy consultation
[63] Estimated cost of 90% efficient combi condensing boiler
[64] Based on replacing "D" rated boiler. Many boilers that would be replaced would be less efficient than this
[65] Based in an LED bulb cost of £35. Some LED lighting may be significantly cheaper
[66] Based on 16x 60W bulbs per house used for 2 hours per day. Power consumption of LED light estimated at 4.7W
[67] All costs and emissions estimates are based on the methodology used in Section 7.2 to provide costs for the CSH
[68] Equivalent to £1,513 per unit
[69] Boiler replacement is used as an example – the cost could be based on loft insulation, or any other measure.

45 shows the costs and benefits of implementing a policy based on the cost of the additional PV panels required to meet the emissions reduction targets[70].

The second example (i.e. cost of achieving emissions reductions off site) has not been developed further here, as the overall CO_2 reductions in the Borough would be the same as if a policy requiring on-site CO_2 savings was implemented.

Emissions reduction target [%]	Total additional emissions reduction to meet target [tCO_2/yr]	Total developer contribution to meet target based on PV [£/yr]	Emissions reduction if contribution spent on loft insulation [tCO_2/yr]	Emissions reduction if contribution spent on whole house retrofit [tCO_2/yr]
55%	322	3,466,116	11,092	1,171
70%	761	8,192,637	26,216	2,769
55%	339	3,648,173	11,674	1,233
70%	801	8,622,955	27,593	2,914
55%	258	2,778,388	8,891	939
70%	610	6,567,099	21,015	2,220

Figure 45: Impact of retrofit policy based on cost of achieving emissions reductions on site

This indicates quite strongly that a policy of seeking a contribution from developers to retrofit buildings in lieu of an on-site CO_2 reduction could achieve significantly greater CO_2 reductions, as well as helping to address the issue of energy efficiency in Croydon's existing housing stock.

Figure 47 shows the cumulative impact of this policy compared with a policy of requiring a 70% on-site reduction over Part L emissions from 2013-2016, if assuming that developer contributions were spent on whole house retrofits. If the contributions were spent no other more cost-effective measures, then the reduction in CO_2 emissions would be significantly greater.

This shows that a policy based on retrofit contributions will have a significantly greater impact on Croydon's CO_2 emissions than even the most ambitious of policies requiring on-site emissions reductions. By concentrating on technologies that have a high CO_2 reduction per pound spent, such as loft insulation, the CO_2 reductions achieved through implementing such a policy would be several times greater.

Such a policy could have an even greater impact if contributions were made available as a loan attached to the property receiving retrofit measures; loan repayments would be based on energy bill savings and could be reclaimed through repayments added to the council tax for the property in question,

[70] This is not necessarily the most appropriate technology to calculate a contribution and is used here for illustrative purposes only

allowing capital to be recycled. Such a scheme could be made to reach a greater number of properties by supplementing loans with available funding from other sources.

Alternatively, where microgeneration equipment is installed, the Council could seek to set up an agreement with the building user and the energy company, whereby the Council would receive any income from the Renewable Heat Incentive (RHI) or Feed-In tariff (FIT), while the building user would benefit from lower energy bills. Figure 46 shows how such an arrangement could work.

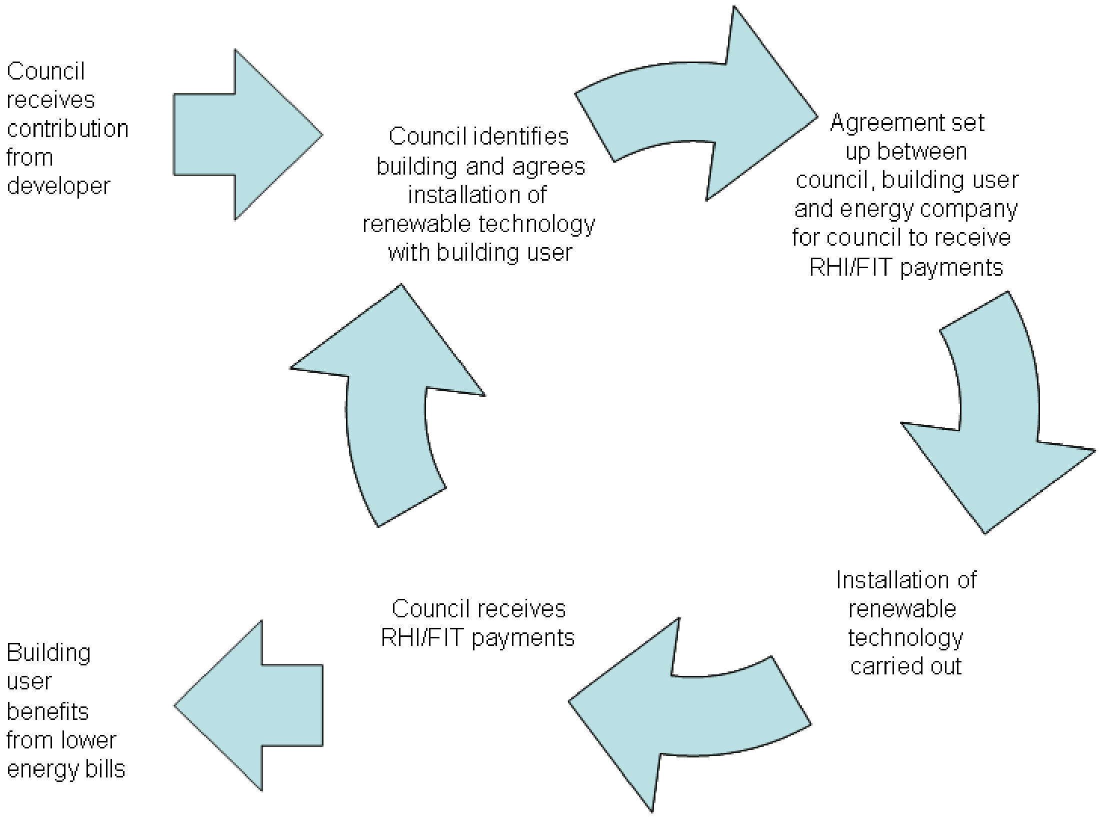

Figure 46: How the Council could recycle developer contributions by using the RHI or FIT

Policy requirement	Cumulative emissions for new housing 2011-2031 [tCO_2]	Cumulative saving over 70% reduction in on-site emissions [tCO_2]	Annual emissions from new housing in 2031 [$tCO_{2/yr}$]	Increase above aggregate 2007 emissions [%]	Emissions per capita in 2031 [%]	Change in emissions per capita from 2007 [%]
Scenario 1						
70% reduction in CO_2 emissions	486,057	n/a	36,157	2.2	4.48	-7.4
Retrofit policy – 55% reduction	461,279	24,778	34,700	2.1	4.47	-7.5
Retrofit policy – 70% reduction	379,807	106,250	29,907	1.8	4.46	-7.6
Scenario 2						
70% reduction in CO_2 emissions	507,606	n/a	37,955	2.3	4.48	-7.3
Retrofit policy – 55% reduction	481,949	25,657	36,446	2.2	4.48	-7.4
Retrofit policy – 70% reduction	396,198	111,408	31,402	1.9	4.47	-7.5
70% reduction in CO_2 emissions	380,231	n/a	27,055	1.6	4.45	-7.9
Retrofit policy – 55% reduction	359,861	20,370	25,856	1.6	4.45	-8.0
Retrofit policy – 70% reduction	294,555	85,677	22,015	1.3	4.44	-8.1

Figure 47: Impact of retrofit policies on Croydon's CO_2 emissions

If the Council were to take forward such a policy option, careful consideration would need to be given to the following:

- Whether such a policy is justifiable under the terms of Government Circular 05/05 and the Community Infrastructure Levy. An initial reading of these two documents suggests that such a policy may be justifiable, but confirmation is required.
- How contributions would be determined
- How contributions would be used. The Council would need to conduct an audit of housing stock (or other suitable buildings in the Borough such as schools) to determine what measures could be installed and where. Alternatively, the capital could be used to stimulate the growth of district energy networks.
- If contributions were to be used to finance home retrofit loans, how loans would be repaid. Is the council tax payment system able to assimilate repayments on a loan attached to a particular address?
- What staff resources would be required to administer projects funded by contributions? Would additional employees be needed for example, or could an external organisation deal manage part of the programme?
- Could contributions be used to fund project management or installations only?

Policy recommendations

- The Council should require all new-build housing developments of two or more units to achieve Level 4 of the Code for Sustainable Homes upon adoption of the Core Strategy. Where developments are unable to achieve this standard, the Council should seek a financial contribution from the developer, to be used to reduce CO_2 emissions in the Borough. The Council should identify suitable projects where these contributions could be spent, as well as how the contribution would be calculated.
- The above policy should be reviewed by 2013 to determine whether this requirement should be increased. Policy options of increasing the on-site requirement for CO_2 emissions reductions or adding a requirement for a contribution to be used to reduce CO_2 emissions

7.6 Policy discussion – existing buildings

A significant proportion of planning applications for new dwellings in Croydon are for conversions or refurbishments. The majority of these are relatively small house conversions and extensions of around 5 units, but there are a number of conversions over 10 units, such as the 319 unit conversion of City House.

These developments cannot be assessed under the CSH; EcoHomes is currently used instead. By the time the Core Strategy is adopted, the BRE will have published details of the BREEAM Domestic Refurbishment Methodology, which is currently under development. The Council could require domestic conversions and refurbishments to meet a particular level of this new standard, subject to confirmation that this would be feasible.

It is not recommended that the Council requires conversions and major refurbishment projects to achieve a particular level of EcoHomes, given the emergence of the new BREEAM standard.

For residential extensions require that a certain proportion of the estimated build cost is spent on improving the energy and water efficiency of the existing building. The applicant would be required to provide a statement demonstrating how they would meet this requirement. Examples of suitable measures to meet such a requirement and estimated costs and utility savings are can be found in Figure 48. Please note that this is not intended as a comprehensive list of potential measures.

Further research would be needed to determine: what an appropriate proportion of the estimated build cost is; what a comprehensive list of suitable measures should include; and how such a policy would be implemented. One option could be to have a Building Control officer check that the proposed measures had been installed; Uttlesford Council in Essex have adopted a similar approach to enforcing such a policy.

Such a policy would be particularly suitable for Croydon, where domestic emissions make up a particularly high proportion of the area's overall CO_2 emissions as it would provide an effective way of ensuring that the efficiency of existing buildings is improved.

Measure - Energy	Additional capital cost per unit	Estimated annual CO_2 reduction [kg/CO_2] [71]	Estimated annual energy saving [kWh]	Estimated annual energy bill saving [£][72]
Installing 0.6 kWp solar PV panels	3,600	307	540	67.50
Installing solar thermal system				40.86
Installing a gas saver to improve efficiency of boiler	800	150	773	27.84
Improving U-value of roof to 0.12 W/m^2K (	n/a	101	520	18.74
Improving U-value of floor to 0.15 W/m^2K	n/a	153	789	28.39
Improving U-value of external wall to 0.24 W/m^2K	n/a	73	376	13.55
Measure - Water	**Additional capital cost per unit [£]**	**Estimated annual water saving[73] [m^3]**		**Estimated annual water saving [£][74]**
Installing water efficient fittings to reduce daily consumption to 105 l/p[75]	125	32.8		52.15
Rainwater harvesting	n/a	20		31.8

Figure 48: Costs and savings of additional retrofit measures for conversions

<u>Policy recommendations</u>

- The Council should require all residential conversions of existing buildings to meet a high standard of BREEAM Domestic Refurbishment. The standard should be decided after publication of this methodology and further analysis.
- For domestic extensions, the Council should require a percentage of the cost of the extension to be spent on improving the energy and water efficiency of the existing building.

[71] Based on an end-terrace flat conversion of 59m^2, modelled in SAP
[72] Based on electricity price of 12.5p/kWh and gas price of 3.6p/kWh. Does not take into account additional income from renewable technologies generated through feed in tariff and renewable heat incentive
[73] Based on typical annual consumption of two people
[74] Based on a cost of £1.59 per cubic metre (Source: Thames Water)
[75] This measure will also reduce energy bills, as less hot water will be used

8 Costing BREEAM standards

8.1 Schools

This section will seek to present the additional costs of achieving BREEAM Excellent for schools in order to provide guidelines, rather than following standard viability assessment methodology.

The only available research on the costs of achieving BREEAM standards in school buildings at the time this report was written was the 2008 report by the BRE and Faithful and Gould, "Costing sustainable schools".

The report assesses the percentage uplift in costs for achieving BREEAM Very Good and BREEAM Excellent for two case study buildings, one secondary school of 3,116m^2 and one primary school of 1,367m^2. Two scenarios were run for each school, based on "good" and "poor" locations[76]; a school on a brownfield site with good transport links and a school on a greenfield site with poor transport links, respectively.

The buildings are assumed to be new and no lifecycle costs are included in the costing, i.e. capital costs only are included. The base build costs are assumed to be £1,205/m^2 for a primary school and £1,365/m^2 for a secondary school[77]. These costs have been adjusted to reflect the fact that all schools involved in the Transforming Croydon Schools programme will be required to meet BREEAM Very Good (Figure 49).

	Good location	Poor location
Primary school		
Secondary school		

Figure 49: Adjusted base school build costs[78]

The percentage and absolute increase in build cost required to achieve BREEAM Excellent was then calculated. The results are found in Figure 50.

	Good location	Poor location
	Absolute cost	
Primary school	£1,273	£1,323
Secondary school	£1,435	£1,460
	Percentage increase over base case	
Primary school	3.7	6.6
Secondary school	3.7	3.5

Figure 50: Increase in build costs to reach BREEAM Excellent

[76] This reflects the fact that several available BREEAM ecology and transport credits for a given site are based on its location
[77] For further assumptions and details, please see the study itself
[78] Costs from BRE

8.2 Other non-residential development

At the time of writing this study, there was no reliable information available on land prices and resale values for retail, office and industrial sites in the borough, therefore it was not considered appropriate to use a standard viability methodology to determine the impact of BREEAM standards.

Instead, build costs have been provided for a number of notional types of development that might be found in Croydon. Percentage estimates of the uplift in cost associated with different BREEAM standards have then been applied to provide revised build costs.

The notional development types have been developed based on recent patterns of these types of development in Croydon and the findings of reports on retail, industrial and office developments for the Council, as outlined in Section 4. Data for base build costs has been taken from building cost models contained in SPON's Architects' and Builders' price book 2009.

The only available study providing estimates for the cost of achieving BREEAM standards is the 2004 report, "Costing Sustainability", produced by Cyril Sweett. This report provides percentage cost increase estimates for achieving different BREEAM standards for a number of different buildings, or case studies. For the purposes of this study, the case study for air conditioned offices has been used (Case study 3). There are no case studies available for retail and industrial buildings; cost estimates for air conditioned offices have been used as they are at the conservative end of the scale and because, out of the four case studies provided, Case study 3 is the one that is most similar to the other building types.

The notional development types are as follows:

- 2,000m^2 supermarket
- 2,000m^2 retail shell
- 1,000m^2 light industrial units
- 5,000m^2 distribution centre and warehouse
- 5,000m^2 office development

The assumptions for the notional development types are as follows:

- All buildings are assumed to be fitted out with the exception of the retail shell and light industrial units
- Cost data has been estimated for buildings in both "good" (defined as qualifying for all BREEAM location credits) and "typical" locations (defined as qualifying for some BREEAM location credits). Cost data for buildings in "bad" locations has not been used as development in these areas of the borough will be limited.
- All sites are assumed to be brownfield development sites
- Demolition and site clearance costs are not included

The base build cost for each type of development can be found in Figure 51 below.

Development type	Base build cost [£/m^2]	Total base build cost [£]
2,000m^2 supermarket	1,692.97	3,385,940
2,000m^2 retail shell	776.02	1,552,040
1,000m^2 light industrial units	733.34	733,340
5,000m^2 distribution centre and warehouse	495.13	2,475,650
5,000m^2 office development	2,094.79	10,473,950

Figure 51: Base build costs for notional development types

Estimates for the percentage uplift in build cost to achieve BREEAM standards are found in Figure 52 below.

Location	Cost increase to achieve Very Good [%]	Cost increase to achieve Excellent [%]
Typical	0.2	7.0
Good	0.1	3.3

Figure 52: Estimated percentage increase in costs to achieve BREEAM standards

The costs of achieving BREEAM Very Good and Excellent standards for the case study developments in both typical and good locations can be found in Figure 53 below.

Development type	Very Good		Excellent	
	[£/m^2]	Total Cost [£]	[£/m^2]	Total Cost [£]
Typical location				
2,000m^2 supermarket	1,696.36	3,392,711	1,811.48	3,622,955
2,000m^2 retail shell	777.57	1,555,144	830.34	1,660,682
1,000m^2 light industrial units	734.81	734,806	784.67	784,673
5,000m^2 distribution centre and warehouse	496.12	2,480,601	529.79	2,648,945
5,000m^2 office development	2,098.98	10,494,897	2,241.43	11,207,126
Good location				
2,000m^2 supermarket	1,694.66	3,389,325	1,748.84	3,497,676
2,000m^2 retail shell	776.80	1,553,592	801.63	1,603,257
1,000m^2 light industrial units	734.07	734,073	757.54	757,540
5,000m^2 distribution centre and warehouse	495.63	2,478,125	511.47	2,557,346
5,000m^2 office development	2,096.88	10,484,423	2,163.92	10,819,590

Figure 53: Build costs for achieving BREEAM standards for notional development types

The above data indicates that the cost of achieving BREEAM Very Good is negligible in both typical and good sites. The cost of achieving BREEAM Excellent is likely to be somewhat greater, particularly for sites in typical locations. However, recent BREEAM case studies, such as the 2009 Campus M business park in Munich, suggest that an Excellent rating can be achieved at no additional cost. The key to achieving this was to ensure that sustainability was made an integral part of the design process and that all relevant parties were brought together at an early stage of the process[79]. In addition, the building was thought likely to benefit from reduced running costs for users and an increase in value.

Given that the majority of large non-residential buildings that will be built in Croydon are likely to be sited in good or typical locations and assuming that developers take sustainability into account at an early stage of the project, it seems likely that most of these sites would be able to achieve a BREEAM Excellent rating at a relatively low additional cost. There may be some situations where site constraints mean that it will not be more difficult to achieve an Excellent rating; these sites are likely to include major refurbishments, where it is more difficult to design improvements into the existing buildings.

Examples of how a developer could realistically achieve an Excellent rating for office, retail and industrial sites in either a typical or a good location can be found in Appendix B. These have been based on BREEAM pre-assessments produced for sites in Croydon.

8.3 Non-residential development policy options

The Croydon Plan does not currently contain a policy requiring a particular environmental performance standard for new buildings; instead, a number of disparate policies govern the issue of sustainable design and construction in non-residential buildings. In practice, the Council has sought to implement these policies by requiring that a particular BREEAM standard is met, since this methodology covers all of the relevant issues.

Given the ongoing relevance and significance of the environmental issues facing the Borough, the question is not then whether the Council should continue to seek high environmental performance from new buildings, but what such a policy should look like.

In order to define policy options, the following questions must be addressed:

1. What standard is most appropriate for new development in Croydon?
2. Should this standard be raised over time?
3. Should major refurbishments be included in the policy? If so, should the same standard be applied?
4. Should there be a size threshold for the policy? If so, what threshold should be set?

These questions are discussed below:

1. Given that the cost analysis of BREEAM above indicates that the costs of achieving Very Good are likely to be minimal, then the policy should

[79] http://www.worldarchitecturenews.com

be set at this level at least. The costs of reaching an Excellent rating are somewhat higher, but Croydon's experience and other evidence suggests that this is achievable if targeted at an early stage in the design process and could even result in only a negligible increase in costs for some developments. The Council can point to several key developments where this has been achieved, including the BREEAM Industrial building of the year and the only BREEAM Excellent car show room in the country.

2. There are currently no BREEAM Outstanding buildings in Croydon and, at the time of writing, none is planned. Furthermore, there is no cost data available on achieving this standard for new buildings, although it is anticipated that it would currently be significantly greater than the cost of achieving Excellent. The Council should not set a future requirement for BREEAM Outstanding at this time, but may seek to explore this possibility in the future as technology improves, costs are reduced and Building Regulations standards increase.

3. Refurbishments can account for a significant proportion of major non-residential planning applications, therefore requiring these projects to meet high standards of sustainable design and construction can have significant environmental benefits. There is currently no cost data on achieving BREEAM standards for refurbishments. Judging from recent planning submissions for major refurbishments, it is believed that a Very Good standard is achievable. It is not consider that an Excellent rating will be achieved on the many refurbishments, as it can be difficult for such sites to achieve several of the credits that are available to new-build sites (in particular in the Land use and ecology and Transport categories).

4. The Council currently applies its sustainability requirement to non-residential developments of over 1,000m^2 and to residential developments of 10 units. For non-residential buildings, it makes sense to maintain a threshold, as it would not be proportionate or viable to require BREEAM assessments for small extensions, for example. The Cyril Sweett report, "Costing Sustainability" indicates that BREEAM Excellent is achievable on developments of just under 500m^2. Policy options of setting a 1,000m^2 or a 500m^2 threshold could be explored. If we re-examine statistics for non-residential planning applications for 2006-2009 to see how much development would be affected by lowering the threshold to 500m^2, we find that an additional 5,154 m^2 floor space would have been subject to the policy, representing 7% of the total eligible floor space. These developments are located exclusively in the north and centre of the Borough in areas which would be defined as Good or Intermediate in terms of BREEAM location-based credits and therefore more likely to be able to achieve a higher standard.

Policy Recommendations

- All non-residential development greater than 500 m^2 floor space should be required to achieve a BREEAM Excellent standard or equivalent if BREEAM is replaced by a Code for Sustainable Buildings.
- This policy should be subject to review before 2016 to determine whether this requirement should be changed
- All non-residential major refurbishments or conversions greater than 500 m^2 floor space should be required to achieve a BREEAM Very Good standard or equivalent is BREEAM is replaced by a Code for Sustainable Buildings.

9 Green roofs and SUDs

The installation of green roofs[80] can have several benefits in terms of reducing surface water run-off, increasing biodiversity, reducing the likelihood of a building overheating and providing a limited amount of insulation. This section gives special consideration to green roofs for the following reasons:

- Much of the area earmarked for development is designated as a high flood risk zone, therefore development must be implemented in such a way so as to reduce the risk of flooding. The likelihood of flooding is thought to increase in the future due to climate change and adaptation is likely to become an increasingly important issue for the Council.
- Development may take place in a built-up area, where open space is limited and the opportunities for integrating other SuDS techniques such as soakaways and swales may be restricted.
- Due to the geology of the borough, certain areas may be unsuitable for several types of SuDs techniques, such as soakaways and swales.
- Green roofs may provide up to 75% attenuation of peak storm run-off from roofs

Despite these benefits, they are often overlooked by policy makers:

> *"Green roofs are therefore part of designers' armoury of solutions to combat some of the implications of PPG3-driven in-town development.*
>
> *However, living roofs have no specific place in the urban design policy framework and therefore can be treated as another item on the "nice to have" list. With energy efficiency and on-site renewables dominating the agenda, they could end up being way down the list of options.*
>
> *By contrast, in Germany and Switzerland, green roofs have been promoted as a key element of flood mitigation strategies and there is a flourishing market for them."*[81]

Green roofs may offer an effective way to reduce flood risk in the borough, as well as provide other benefits. For this reason, estimates of the cost of installing green roofs on new buildings have been provided, along with a discussion of possible policy options.

The costs of a green roof (including sedum mat, drainage layer and filter fleece) can range from £40-£65/m^2.

These costs have been applied to two notional buildings to provide an estimate of the cost per square metre and per unit.

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[80] There are many different types of green roof. For the purposes of this study, a green roof is taken to mean a lwo-maintenance extensive sedum roof.

[81] Source: http://www.building.co.uk/story.asp?storycode=3069718

Building type	Size of roof [m^2]	Per unit cost of green roof [£]	Total cost of green roof [£][82]	Increase in base build cost [%][83]
Residential block: • 12 units • 60 m^2 per unit • Four units per floor • 20 m^2 communal space per floor	260	65	16,900	1.7
Commercial/office building • 2,400m^2 • Three floors of equal size	800	65	52,000	1.0

Figure 54: Costs of green roofs for notional buildings

These costs are only intended as guidelines; clearly the costs per unit will vary dramatically with different types and shapes of building. The benefits that come with having a green roof will also vary; buildings where there is likely to be a high cooling demand with benefit from substantially lower energy bills by incorporating a green roof for example.

This information does suggest that for medium-scale medium rise residential sites of the type that could be developed in the A23 corridor, the costs of installing a green roof will be relatively high. Given that a policy requirement for CSH Level 4 would encourage developers to address flood risk and surface water run-off, the benefits of having a policy specifically requiring a green roof could be unjustifiable and ineffective.

The Council could however adopt a policy requiring all new residential developments, or perhaps only those in high flood risk areas, to achieve compliance with CSH Sur 1 credits relating to management of site surface water run-off. Such a policy would be easy to implement through the CSH framework and would allow developers flexibility in achieving the requirements. No additional costs would be required beyond the estimated costs of achieving CSH Level 4 as stated in Section 7.

The costs of installing a green roof on a major non residential development will depend on the layout and form of the buildings. The benefits however are likely to be greater in terms of reducing the energy requirement for cooling, although this is currently difficult to quantify for new buildings. Given the greater benefits for non-residential buildings, the Council may seek to require major non-residential developments in high flood-risk areas, or perhaps the whole of the Borough, to incorporate green roofs unless there is a strong technical or financial justification why this should not be done.

[82] Assuming £65/m^2
[83] Based on estimated build costs for flats and office buildings contained elsewhere in this report

Policy Recommendations

- All new residential development should be required to achieve two Sur 1 credits under the CSH, in order to ensure that surface water run-off is managed on site and flood risk reduced.
- All major non-residential developments in the borough should consider the installation of green roofs to reduce site surface water run-off and the need for summer cooling, unless it can be demonstrated that this is:
    - Technically unfeasible
    - Financially unviable (more likely for low-rise developments)

Appendix A – Example CSH pre-assessments for types of development in Croydon

This section draws together the CSH pre-assessments that were carried out for notional housing types in the Borough to determine the technical feasibility and costs of achieving CSH Levels 3 and 4.

A list of the assumptions used for each building type to help determine the likelihood of achieving certain credits can be found below.

Criteria	Detached	End	Mid terrace	Flat (Infill	Flat (high
Council recycling collection					
High flood risk					
All rooms receive direct light from sky					
Private outdoor space					
Low Ecological value					

CSH Level 3

Detached House

Credit	Description	Points gained	Notes/assumptions	Cost [£]
		Energy		
Ene 1	Dwelling emission rate	7.56	Achieved through improved controls, air tightness and insulation and $4m^2$ flat plate	3,916
Ene 2	parameter	0.00	Not assumed	0
	Internal lighting		70% low energy light fittings	
Ene 4	Drying Space	1.26	Washing line or pull out dryer installed	20

[84] Output of solar thermal collectors = 450 $W/m^2/yr$

Credit	Description	Points gained	Notes/assumptions	Cost [£]
	White goods		EU information provided	
	External Lighting		Compliance achieved	
Ene 7	technologies	0.00	Feasibility study required to confirm if any credits can be	0
	Cycle Storage			
Wat 1	Internal water use	4.50	Mandatory requirements met	125
Wat 2	External Water use	0	Credit not needed	0
Mat 1	impact of	3.00		0
Mat 2	Responsible sourcing - major building elements	0.60	2 credits achieved	0
Mat 3	Responsible sourcing - finishing elements	0.30	1 credit achieved	0
Sur 1		0.00		0
Sur 2	Flood risk	0.00	Assumed site is in a high	0
Was 1	storage	3.64	Internal storage plus local authority collection	160
Was 2	management plan	1.82	Compliance achieved	100
	Composting		Compliance achieved	
			Compliance achieved	
Pol 2	heating system	2.10	Compliance achieved	0
		Health and Wellbeing		
Hea 1	Daylighting	1.17	Credit for kitchen, living room and home office having view of sky	0
Hea 2	Sound insulation	4.68	Four credits achieved by	0
Hea 3	space	1.17	House has garden	0
Hea 4	Lifetime homes	4.68	Credits achieved. Although other credits will be cheaper to achieve, it has been assumed that compliance with Lifetime Homes will be required by the London Plan.	550
	Home user guide			

Credit	Description	Points gained	Notes/assumptions	Cost [£]
Man 2	Considerate constructors	2.22	Best practice score of over 32 achieved	0
Man 3	Site construction impacts	1.11	Second credit not needed	0
Man 4	Secured by design	2.22	Compliance achieved	0
Ecology				
Eco 1	Ecological value of site	1.33	Site is of low ecological value	0
Eco 2	Site ecological enhancement	0.00	Ecologist not employed	0
Eco 3	Protection of ecologically valuable features	1.33	Credit awarded by default	0
Eco 4	Change in site ecological value	2.66	Two credits awarded – site is of low ecological value so no change assumed	0
Eco 5	Building footprint	0.00	Credits not achieved	0
Total		**57.44**		4,961

End terrace house

Credit	Description	Points gained	Notes/assumptions	Cost [£]
Ene 1	Dwelling emission rate	7.56	Achieved through improved controls, air tightness and insulation and 4m^2 flat plate solar thermal collectors	3,916
Ene 2	Heat loss parameter	0.00	Not assumed	0
	Internal lighting		70% low energy light fittings	
Ene 4	Drying Space	1.26	Washing line or pull out dryer installed	20
	White goods		EU information provided	
	External Lighting		Compliance achieved	
Ene 7	technologies	0.00	Feasibility study required to confirm if any credits can be	0
	Cycle Storage			
			Mandatory requirements met	
Wat 2		0	Credit not needed	0
Materials				
Mat 1	impact of	3.00		0
Mat 2	Responsible sourcing - major	0.60	2 credits achieved	0

Credit	Description	Points gained		
	building elements			
Mat 3	Responsible sourcing - finishing elements	0.30		
Sur 1		0.00		0
Sur 2	Flood risk	0.00	Assumed site is in a high	0
Was 1	storage	3.64	Internal storage plus local authority collection	160
Was 2	management plan	1.82	Compliance achieved	100
	Composting		Compliance achieved	
			Compliance achieved	
Pol 2	heating system	2.10	Compliance achieved	0
Hea 1	Daylighting	1.17	Credit for kitchen, living room and home office having view of sky	0
Hea 2	Sound insulation	3.51	Costs incurred through testing	160
Hea 3	space	1.17	House has garden	0
Hea 4	Lifetime homes	4.68	Credits achieved. Although other credits will be cheaper assumed that compliance required by the London Plan.	550
Man 1	Home user guide	3.33	Compliance achieved	100
Man 2	Considerate constructors	2.22	Best practice score of over 32 achieved	0
Man 3	Site construction impacts	1.11	One credit achieved	0
Man 4	Secured by design	2.22	Compliance achieved	0
Eco 1	Ecological value of site	1.33	Site is of low ecological value	0
Eco 2	Site ecological enhancement	0.00	Ecologist not employed	0
Eco 3	Protection of ecologically valuable features	1.33	Credit awarded by default	0
Eco 4	Change in site ecological value	2.66	Two credits awarded – site is of low ecological value so no	0

Credit	Description	Points gained	Notes/assumptions	Cost [£]
			change assumed	
	Building footprint			

Mid-terrace house

Credit	Description	Points gained	Notes/assumptions	Cost [£]
Ene 1	Dwelling emission rate	8.82	Achieved through improved controls, air tightness and insulation and 4m^2 flat plate	3,916
Ene 2	parameter	0.00	Not assumed	0
Ene 3	Internal lighting	2.52	70% low energy light fittings	40
Ene 4	Drying Space	1.26	Washing line or pull out dryer installed	20
	White goods		EU information provided	
	External Lighting		Compliance achieved	
Ene 7	technologies	0.00	Feasibility study required to confirm if any credits can be	0
	Cycle Storage			
			Mandatory requirements met	
Wat 2		0	Credit not needed	0
Mat 1	impact of	3.00		0
Mat 2	Responsible sourcing - major building elements	0.60	2 credits achieved	0
Mat 3	Responsible sourcing - finishing elements	0.30	1 credit achieved	0
Sur 1		0.00		0
Sur 2	Flood risk	0.00	Assumed site is in a high	0
Was 1	storage	3.64	Internal storage plus local authority collection	160
Was 2	management plan	1.82	Compliance achieved	100
	Composting		Compliance achieved	
			Compliance achieved	
Pol 2	heating system	2.10	Compliance achieved	0
Health and Wellbeing				
Hea 1	Daylighting	1.17	Credit for kitchen, living room and home office having view of sky	0

Credit	Description	Points gained	Notes/assumptions	Cost [£]
Hea 2	Sound insulation	3.51	Three credits achieved. Costs incurred through testing	160
Hea 3	Private outdoor space	1.17	House has garden	0
Hea 4	Lifetime homes	4.68	Credits achieved. Although other credits will be cheaper to achieve, it has been assumed that compliance with Lifetime Homes will be required by the London Plan.	550
Management				
Man 1	Home user guide	2.22	Compliance achieved	20
Man 2	Considerate constructors	2.22	Best practice score of over 32 achieved	0
Man 3	Site construction impacts	1.11	Second credit not required	0
Man 4	Secured by design	2.22	Compliance achieved	0
Ecology				
Eco 1	Ecological value of site	1.33	Site is of low ecological value	0
Eco 2	Site ecological enhancement	0.00	Ecologist not employed	0
Eco 3	Protection of ecologically valuable features	1.33	Credit awarded by default	0
Eco 4	Change in site ecological value	2.66	Two credits awarded – site is of low ecological value so no change assumed	0
	Building footprint	0.00	Credits not achieved	
		57.52		

Flat – infill site

Credit	Description	Points gained	Notes/assumptions	Cost [£]
Ene 1	Dwelling emission rate	6.30	Achieved through improved controls, air tightness and insulation and 0.3 kWp solar	3,298[86]
Ene 2	parameter	1.26		0
Ene 3	Internal lighting	2.52	70% low energy light fittings	30
Ene 4	Drying Space	1.26	Washing line or pull out dryer installed	20
	White goods		EU information provided	
	External Lighting		Compliance achieved	
Ene 7	technologies	0.00	Feasibility study required to confirm if any credits can be	0
	Cycle Storage			
			Mandatory requirements met	
Wat 2		1.50	Credit achieved by default as not landscaped area	0
Mat 1	impact of	3.00		0
Mat 2	Responsible sourcing - major building elements	0.60	2 credits achieved	0
Mat 3	Responsible sourcing - finishing elements	0.30	1 credit achieved	0
Sur 1		0.00		0
Sur 2	Flood risk	0.00	Assumed site is in a high	0
Was 1	storage	3.64	Internal storage plus local authority collection	160
Was 2	management plan	1.82	Compliance achieved	100
	Composting			
			Compliance achieved	
Pol 2	heating system	2.10	Compliance achieved	0

[85] Output of PV panels = 900 kWh/kWp/yr. Assumed that a communal array would be provided, with output shared between flats
[86] Cost of PV panels = £5,500/kWp

Credit	Description	Points gained	Notes/assumptions	Cost [£]
Health and Wellbeing				
Hea 1	Daylighting	1.17	Credit for kitchen, living room and home office having view of sky	0
Hea 2	Sound insulation	3.51	Three credits achieved. Costs incurred through testing	330
Hea 3	Private outdoor space	0.00	No shared space available	0
Hea 4	Lifetime homes	4.68	Credits achieved. Although other credits will be cheaper to achieve, it has been assumed that compliance with Lifetime Homes will be required by the London Plan.	75
Management				
Man 1	Home user guide	3.33	Compliance achieved	50
Man 2	Considerate constructors	2.22	Best practice score of over 32 achieved	0
Man 3	Site construction impacts	2.22	Two credits achieved	75
Man 4	Secured by design	2.22	Compliance achieved	0
Ecology				
Eco 1	Ecological value of site	1.33	Site is of low ecological value	0
Eco 2	Site ecological enhancement	0.00	Ecologist not employed	0
Eco 3	Protection of ecologically valuable features	1.33	Credit awarded by default	0
Eco 4	Change in site ecological value	2.66	Two credits awarded – site is of low ecological value so no change assumed	0
Eco 5	Building footprint	0.00	Credits not achieved	0
		57.91		

Flat – city centre site

Credit	Description	Points gained	Notes/assumptions	Cost [£]
Ene 1	Dwelling emission rate	8.82	Achieved through improved controls, air tightness and	5,238[88]
Ene 2	parameter	1.26		0
Ene 3	Internal lighting	2.52	70% low energy light fittings	30
Ene 4	Drying Space	1.26	Washing line or pull out dryer installed	20
	White goods		EU information provided	
	External Lighting		Compliance achieved	
Ene 7	technologies	0.00	Feasibility study required to confirm if any credits can be	0
	Cycle Storage			
			Mandatory requirements met	
Wat 2		1.50	Credit achieved by default as not landscaped area	0
Mat 1	impact of	3.00		0
Mat 2	Responsible sourcing - major building elements	0.60	2 credits achieved	0
Mat 3	Responsible sourcing - finishing elements	0.30	1 credit achieved	0
Sur 1		0.00		0
Sur 2	Flood risk	0.00	Assumed site is in a high	0
Was 1	storage	3.64	Internal storage plus local authority collection	160
Was 2	management plan	1.82	Compliance achieved	100
	Composting			
			Compliance achieved	
Pol 2	heating system	1.40	Compliance for two credits	0

87 20% reduction from CHP in regulated emissions, based on “A Cost Review of the Code for Sustainable Homes” , Cyril Sweett, 2007

88 Cost based on Ibid.

Credit	Description	Points gained	Notes/assumptions	Cost [£]
			achieved as assumed CHP will not comply	
Health and Wellbeing				
Hea 1	Daylighting	1.17	Credit for kitchen, living room and home office having view of sky	0
Hea 2	Sound insulation	0.00	Credits not needed	0
Hea 3	Private outdoor space	0.00	No shared space available	0
Hea 4	Lifetime homes	4.68	Credits achieved. Although other credits will be cheaper to achieve, it has been assumed that compliance with Lifetime Homes will be required by the London Plan.	75
Management				
Man 1	Home user guide	3.33	Compliance achieved	50
Man 2	Considerate constructors	2.22	Best practice score of over 32 achieved	0
Man 3	Site construction impacts	1.11	Two credits achieved	0
Man 4	Secured by design	2.22	Compliance achieved	0
Ecology				
Eco 1	Ecological value of site	1.33	Site is of low ecological value	0
Eco 2	Site ecological enhancement	0.00	Ecologist not employed	0
Eco 3	Protection of ecologically valuable features	1.33	Credit awarded by default	0
Eco 4	Change in site ecological value	2.66	Two credits awarded – site is of low ecological value so no change assumed	0
	Building footprint	2.66	Two credits achieved	
		57.76		

CSH Level 4

Detached House

Credit	Description	Points gained	Notes/assumptions	Cost [£]
Ene 1	Dwelling emission rate	10.08	Achieved through improved controls, air tightness and insulation, $4m^2$ flat plate 0.6 kWp PV	7,216
Ene 2	parameter	0.00	Not assumed	0
Ene 3	Internal lighting	2.52	70% low energy light fittings	40
Ene 4	Drying Space	1.26	Washing line or pull out dryer installed	20
	White goods		EU information provided	
	External Lighting		Compliance achieved	
Ene 7	technologies	1.26	Assumed one credit gained	0
Ene 8	Cycle Storage	2.52	2 credits achieved	1,000
			Compliance achieved	
			Mandatory requirements met	
Wat 2		0	Water butt installed	0
Mat 1	impact of	3.00		0
Mat 2	Responsible sourcing - major building elements	0.60	2 credits achieved	0
Mat 3	Responsible sourcing - finishing elements	0.30	1 credit achieved	0
Surface water run-off				
Sur 1	Surface water run off	1.10	Requirements met for 2 credits	450
Sur 2	Flood risk	0.00	Assumed site is in a high flood risk area	0
Was 1	storage	3.64	Internal storage plus local authority collection	160
Was 2	management plan	1.82	Compliance achieved	100
	Composting		Compliance achieved	
			Compliance achieved	
			Compliance achieved	

Credit	Description	Points gained	Notes/assumptions	Cost [£]
	heating system			
Health and Wellbeing				
Hea 1	Daylighting	1.17	Credit for kitchen, living room and home office having view of sky	0
Hea 2	Sound insulation	4.68	Four credits achieved by default	0
Hea 3	Private outdoor space	1.17	House has garden	0
Hea 4	Lifetime homes	4.68	Credits achieved. Although other credits will be cheaper to achieve, it has been assumed that compliance with Lifetime Homes will be required by the London Plan.	550
Management				
Man 1	Home user guide	3.33	Compliance achieved	100
Man 2	Considerate constructors	2.22	Best practice score of over 32 achieved	0
Man 3	Site construction impacts	2.22	2 credits acheived	100
Man 4	Secured by design	2.22	Compliance achieved	0
Ecology				
Eco 1	Ecological value of site	1.33	Site is of low ecological value	0
Eco 2	Site ecological enhancement	0.00	Ecologist not employed	0
Eco 3	Protection of ecologically valuable features	1.33	Credit awarded by default	0
Eco 4	Change in site ecological value	2.66	Two credits awarded – site is of low ecological value so no change assumed	0
	Building footprint	0.00	Credits not achieved	
		68.30		

End terrace house

Credit	Description	Points gained	Notes/assumptions	Cost [£]
Ene 1	Dwelling emission rate	10.08	Achieved through improved controls, air tightness and insulation and 1 kWp PV[89]	7,148
Ene 2	Heat loss parameter	0.00	Not assumed	0
	Internal lighting		70% low energy light fittings	
Ene 4	Drying Space	1.26	Washing line or pull out dryer installed	20
	White goods		EU information provided	
	External Lighting		Compliance achieved	
Ene 7	technologies	1.26	Assumed one credit gained	0
	Cycle Storage			
			Compliance achieved	
			Mandatory requirements met	
Wat 2		1.50	Water butt installed	200
Materials				
Mat 1	impact of	3.00		0
Mat 2	Responsible sourcing - major building elements	0.60	2 credits achieved	0
Mat 3	Responsible sourcing - finishing elements	0.30	1 credit achieved	0
Sur 1		1.10		0
Sur 2	Flood risk	0.00	Assumed site is in a high	0
Was 1	storage	3.64	Internal storage plus local authority collection	160
Was 2	management plan	1.82	Compliance achieved	100
	Composting		Compliance achieved	
Pol 1	GWP of insulants	0.70	Compliance achieved	0
Pol 2	Nox emissions of heating system	2.10	Compliance achieved	0

[89] It would be more cost-effective to install solar thermal and a smaller amount of PV. However, given that technical difficulties can arise with PV arrays of less than 0.5 kWp, this solution was not considered suitable

Credit	Description	Points gained	Notes/assumptions	Cost [£]
Hea 1	Daylighting	1.17	Credit for kitchen, living room and home office having view of sky	0
Hea 2	Sound insulation	3.51	Three credits achieved. Costs incurred through testing	160
Hea 3	Private outdoor space	1.17	House has garden	0
Hea 4	Lifetime homes	4.68	Credits achieved. Although other credits will be cheaper to achieve, it has been assumed that compliance with Lifetime Homes will be required by the London Plan.	550
Management				
Man 1	Home user guide	3.33	Compliance achieved	100
Man 2	Considerate constructors	2.22	Best practice score of over 32 achieved	0
Man 3	Site construction impacts	2.22	Two credits achieved	100
Man 4	Secured by design	2.22	Compliance achieved	0
Ecology				
Eco 1	Ecological value of site	1.33	Site is of low ecological value	0
Eco 2	Site ecological enhancement	0.00	Ecologist not employed	0
Eco 3	Protection of ecologically valuable features	1.33	Credit awarded by default	0
Eco 4	Change in site ecological value	2.66	Two credits awarded – site is of low ecological value so no change assumed	0
	Building footprint	0.00	Credits not achieved	
Total		**68.63**		10,393

Mid-terrace house

Credit	Description	Points gained	Notes/assumptions	Cost [£]
Ene 1	Dwelling emission rate	10.08	Achieved through improved controls, air tightness and insulation and 0.8 kWp PV[90]	6,048
Ene 2	Heat loss parameter	0.00	Not assumed	0
	Internal lighting		70% low energy light fittings	
Ene 4	Drying Space	1.26	Washing line or pull out dryer installed	20
	White goods		EU information provided	
	External Lighting		Compliance achieved	
Ene 7	technologies	1.26	Assumed one credit gained	0
	Cycle Storage			
			Compliance achieved	
			Mandatory requirements met	
Wat 2		1.50	Water butt installed	200
Materials				
Mat 1	impact of	3.00		0
Mat 2	Responsible sourcing - major building elements	0.60	2 credits achieved	0
Mat 3	Responsible sourcing - finishing elements	0.30	1 credit achieved	0
Sur 1		1.10		450
Sur 2	Flood risk	0.00	Assumed site is in a high	0
Was 1	storage	3.64	Internal storage plus local authority collection	160
Was 2	management plan	1.82	Compliance achieved	100
	Composting		Compliance achieved	
Pol 1	GWP of insulants	0.70	Compliance achieved	0
Pol 2	NOx emissions of heating system	2.10	Compliance achieved	0

[90] It would be more cost-effective to install solar thermal and a smaller amount of PV. However, given that technical difficulties can arise with PV arrays of less than 0.5 kWp, this solution was not considered suitable

Credit	Description	Points gained	Notes/assumptions	Cost [£]
Hea 1	Daylighting	1.17	Credit for kitchen, living room and home office having view of sky	0
Hea 2	Sound insulation	3.51	Three credits achieved. Costs incurred through testing	160
Hea 3	Private outdoor space	1.17	House has garden	0
Hea 4	Lifetime homes	4.68	Credits achieved. Although other credits will be cheaper to achieve, it has been assumed that compliance with Lifetime Homes will be required by the London Plan.	550
Management				
Man 1	Home user guide	3.33	Compliance achieved	100
Man 2	Considerate constructors	2.22	Best practice score of over 32 achieved	0
Man 3	Site construction impacts	2.22	Two credits achieved	100
Man 4	Secured by design	2.22	Compliance achieved	0
Ecology				
Eco 1	Ecological value of site	1.33	Site is of low ecological value	0
Eco 2	Site ecological enhancement	0.00	Ecologist not employed	0
Eco 3	Protection of ecologically valuable features	1.33	Credit awarded by default	0
Eco 4	Change in site ecological value	2.66	Two credits awarded – site is of low ecological value so no change assumed	0
	Building footprint	0.00	Credits not achieved	
Total		**68.63**		9,293

Flat – infill site

Credit	Description	Points gained	Notes/assumptions	Cost [£]
Ene 1	Dwelling emission rate	10.08	Achieved through improved controls, air tightness and insulation and 0.7 kWp PV[91]	5,498
Ene 2	Heat loss parameter	1.26	One credit assumed	0
	Internal lighting		70% low energy light fittings	
Ene 4	Drying Space	1.26	Washing line or pull out dryer installed	20
	White goods		EU information provided	
	External Lighting		Compliance achieved	
Ene 7	technologies	1.26	Assumed one credit gained	0
	Cycle Storage			
			Compliance achieved	
			Mandatory requirements met	
Wat 2		1.50	Credit achieved by default as no landscaped area	0
		Materials		
Mat 1	impact of	3.00		0
Mat 2	Responsible sourcing - major building elements	0.90	3 credits achieved	0
Mat 3	Responsible sourcing - finishing elements	0.30	1 credit achieved	0
Sur 1		1.10		450
Sur 2	Flood risk	0.00	Assumed site is in a high	0
Was 1	storage	3.64	Internal storage plus local authority collection	160
Was 2	management plan	1.82	Compliance achieved	100
	Composting			
Pol 1	GWP of insulants	0.70	Compliance achieved	0
Pol 2	Nox emissions of heating system	2.10	Compliance achieved	0

[91] It would be more cost-effective to install solar thermal and a smaller amount of PV. However, given that technical difficulties can arise with PV arrays of less than 0.5 kWp, this solution was not considered suitable

Credit	Description	Points gained	Notes/assumptions	Cost [£]
Hea 1	Daylighting	1.17	Credit for kitchen, living room and home office having view of sky	0
Hea 2	Sound insulation	3.51	Three credits achieved. Costs incurred through testing	330
Hea 3	Private outdoor space	1.17	House has garden	0
Hea 4	Lifetime homes	4.68	Credits achieved. Although other credits will be cheaper to achieve, it has been assumed that compliance with Lifetime Homes will be required by the London Plan.	75
Management				
Man 1	Home user guide	3.33	Compliance achieved	50
Man 2	Considerate constructors	2.22	Best practice score of over 32 achieved	0
Man 3	Site construction impacts	2.22	Two credits achieved	75
Man 4	Secured by design	2.22	Compliance achieved	0
Ecology				
Eco 1	Ecological value of site	1.33	Site is of low ecological value	0
Eco 2	Site ecological enhancement	0.00	Ecologist not employed	0
Eco 3	Protection of ecologically valuable features	1.33	Credit awarded by default	0
Eco 4	Change in site ecological value	2.66	Two credits awarded – site is of low ecological value so no change assumed	0
	Building footprint	0.00	Credits not achieved	
Total		**68.10**		7,423

Flat – city centre

Credit	Description	Points gained	Notes/assumptions	Cost [£]
Ene 1	Dwelling emission rate	10.08	Achieved through improved controls, air tightness and insulation, CHP and 0.2 kWp	6,338
Ene 2	parameter	1.26	One credit assumed	0
Ene 3	Internal lighting	2.52	70% low energy light fittings	30
Ene 4	Drying Space	1.26	Washing line or pull out dryer installed	20
Ene 5	White goods	1.26	EU product information provided	0
	External Lighting		Compliance achieved	
Ene 7	Low and zero carbon technologies	1.26	Assumed one credit gained	0
	Cycle Storage			
			Mandatory requirements met	
Wat 2		1.50	Credit achieved by default as no landscaped area	0
Mat 1	impact of	3.00		0
Mat 2	Responsible sourcing - major building elements	0.60	2 credits achieved	0
Mat 3	Responsible sourcing - finishing elements	0.30	1 credit achieved	0
Sur 1		1.10		450
Sur 2	Flood risk	0.00	Assumed site is in a high	0
Was 1	storage	3.64	Internal storage plus local authority collection	160
Was 2	Site waste management plan	1.82	Compliance achieved	100
	Composting			
			Compliance achieved	

[92] It would be more cost-effective to install solar thermal and a smaller amount of PV. However, given that technical difficulties can arise with PV arrays of less than 0.5 kWp, this solution was not considered suitable

Credit	Description	Points gained	Notes/assumptions	Cost [£]
	heating system		achieved with CHP system	
Hea 1	Daylighting	1.17	Credit for kitchen, living room and home office having view of sky	0
Hea 2	Sound insulation	3.51	Three credits achieved. Costs incurred through testing	330
Hea 3	Private outdoor space	1.17	House has garden	0
Hea 4	Lifetime homes	4.68	Credits achieved. Although other credits will be cheaper assumed that compliance required by the London Plan.	75
	Home user guide		Compliance achieved	
Man 2		2.22	Best practice score of over	0
Man 3	impacts	2.22	Two credits achieved	75
Man 4	Secured by design	2.22	Compliance achieved	0
Eco 1	Ecological value	1.33	Site is of low ecological	0
Eco 2	Site ecological	0.00	Ecologist not employed	0
Eco 3	ecologically	1.33	Credit awarded by default	0
Eco 4	Change in site ecological value	2.66	Two credits awarded – site is of low ecological value so no change assumed	0
	Building footprint			

Appendix B – Example specifications for BREEAM Excellent

An example BREEAM pre-assessment has been prepared for each of the three building types examined in Chapter 8. Please note that the credits that could be achieved will vary from site to site. These assessments have been based on assessments for previous planning applications in Croydon and are intended as an example of how an Excellent rating could realistically be achieved be achieved and not as design guidance. In each case, it has been assumed that the development is in an intermediate location and will not benefit from all location credits.

Cost data for credits is not available. Instead, the 2004 Cyril Sweett report titled "Costing Sustainability" was used to determine average percentage increases in build costs. This information can be found in Section 8.

BREEAM Industrial

Assumptions for the BREEAM industrial buildings are as follows:

- New build
- Operational area is heated
- Lifts are provided
- Delivery bays included in scheme
- Office space is less than 500m^2

Credit	Description	Credits available	Credits achieved	Section total
	Management			
Man 1	Commissioning	2	2	
	Construction site impacts			
	Building user guide			
Man 8	Security	1	1	9.60%
	Health and wellbeing			
Hea 1	Daylighting	1	0	
	High frequency lighting			
	external lighting levels			
	Volatile organic compounds			
Hea 14	Office space	2	2	12.86%
	Energy			
Ene 1	Reduction of CO2 emissions	15	6	10.29%
Ene 2	Sub-metering of substantial energy	1	1	
Ene 3	Sub-metering of high energy load Areas and Tenancy	1	1	
Ene 4	external lighting	1	1	

Credit	Description	Credits available	Credits achieved	Section total
Ene 5	Low and zero carbon technologies	3	2	
Ene 6	Building fabric performance &	1	1	
Ene 8		2	1	
	Transport			
Tra 1	Provision of public transport	3	1	
	Proximity to amenities			
	Cyclist facilities			
	Pedestrian and cycle safety			
	Travel plan			
Tra 6	Maximum car parking capacity	2	1	
Tra 8	Deliveries and manoeuvring	1	1	5.82%
	Water consumption			
	Major leak detection			
	Sanitary supply shut off			
	Materials specifications			
Mat 2	Hard landscaping and boundary protection	1	1	
	Re-use of building façade			
	Re-use of building structure			
	Responsible sourcing of materials			
	Designing for robustness			
Wst 1	management	4	2	
	Recycling facilities			
	Recyclable waste storage			
	Compactor/baler			4.29%
	Land use and ecology			
LE 3	Ecological value of site and protection of ecological features	1	1	
	Mitigating ecological impacts			
	Enhancing site ecology			
	Long term impact on biodiversity			6.00%
	Refrigerant GWP - building services			
	Preventing refrigerant leaks			
	NOx emissions from heating source			
	Minimising watercourse pollution			
Pol 7	Reduction of night time light pollution	1	1	
				9.00%

Figure 55: Example BREEAM Industrial specification

BREEAM Office

Assumptions for the BREEAM office buildings are as follows:

- New build
- Lifts are provided, but not escalators

Credit	Description	Credits available	Credits achieved	Section total
	Commissioning			
	Construction site impacts			
	Building user guide			
	Security			8.40%
	Daylighting			
	High frequency lighting			
	High frequency lighting			
	external lighting levels			
	Lighting zones and controls			
	Indoor air quality			
	Volatile organic compounds			
	Thermal zoning			
	Acoustic performance			13.85%
Ene 2	Sub-metering of substantial energy	1	1	
Ene 3	Sub-metering of high energy load Areas and Tenancy	1	1	
	external lighting			
	Low and zero carbon technologies			
Ene 8	Lifts	2	2	10.74%
	Provision of public transport			
	Proximity to amenities			
	Cyclist facilities			
	Pedestrian and cycle safety			
Tra 5	Travel plan	1	1	
Tra 6	Maximum car parking capacity	2	1	6.40%
	Water consumption			
	Major leak detection			
	Sanitary supply shut off			5.00%

Credit	Description	Credits available	Credits achieved	Section total
Mat 1	Materials specifications	4	2	
Mat 2	Hard landscaping and boundary protection	1	1	
Mat 3	Re-use of building façade	1	0	
Mat 4	Re-use of building structure	1	0	
Mat 5	Responsible sourcing of materials	3	2	
Mat 6	Insulation	2	2	
Mat 7	Designing for robustness	1	1	7.69%
Waste				
Wst 1	Construction site waste management	4	2	
	Recycling facilities	1	1	
	Recyclable waste storage	1	1	
	Floor finishes	1	0	4.29%
Land use and ecology				
LE 3	Ecological value of site and protection of ecological features	1	1	
	Mitigating ecological impacts	2	1	
	Enhancing site ecology	3	2	
	Long term impact on biodiversity	2	1	7.00%
Pollution				
Pol 1	Refrigerant GWP - building services	1	1	
Pol 2	Preventing refrigerant leaks	2	1	
Pol 4	NOx emissions from heating source	2	1	
Pol 5	Flood risk	3	2	
Pol 6	Minimising watercourse pollution	1	1	
Pol 7	Reduction of night time light pollution	1	1	
Pol 8	Noise attenuation	1	1	6.67%
Total				**70.03%**

Figure 56: Example BREEAM Offices specification

BREEAM Retail

Assumptions for the BREEAM retail buildings are as follows:

- New build
- Building is larger than 500m^2
- Use of building is food retail
- Cold storage plant included in scheme
- No lifts or escalators provided
- Internal goods storage included in scheme
- Waste management area included in scheme
- Office space is less than 500m^2
- No landscaping/soft planting

Credit	Description	Credits available	Credits achieved	Section total
	Management			
Man 1	Commissioning	2	2	
	Construction site impacts			
	Building user guide			
Man 8	Security	1	1	
	Health and wellbeing			
Hea 1	Daylighting	1	0	
	High frequency lighting			
	external lighting levels			
	Indoor air quality			
	Volatile organic compounds			
Hea 14	Office space	2	2	
	Energy			
Ene 1	Reduction of CO_2 emissions	15	6	
Ene 2	Sub-metering of substantial energy uses	1	1	
Ene 3	Sub-metering of high energy load Areas and Tenancy	1	1	
	external lighting			
Ene 5	technologies	3	2	
Ene 6	Building fabric performance & avoidance of air infiltration	1	1	
Ene 7	Cold storage equipment	3	3	11.40%
	Transport			
Tra 1	Provision of public transport	5	3	
Tra 2	Proximity to amenities	1	1	
Tra 3	Cyclist facilities	2	2	
Tra 4	Pedestrian and cycle safety	2	1	
Tra 5	Travel plan	1	1	
Tra 7	Travel information point	1	1	6.15%
	Water			
Wat 1	Water consumption	3	2	5.00%
Wat 2	Water meter	1	1	
Wat 3	Major leak detection	1	1	

Credit	Description	Credits available	Credits achieved	Section total
Wat 4	Sanitary supply shut off	1	1	
	Materials			
Mat 1	Materials specifications	2	1	
Mat 2	Hard landscaping and boundary protection	1	1	
	Re-use of building façade			
	Re-use of building structure			
	Responsible sourcing of materials			
	Designing for robustness			7.95%
Wst 1	management	4	2	
	Recycling facilities			
	Recyclable waste storage			
	Compactor/baler			4.29%
	Land use and ecology			
LE 3	Ecological value of site and protection of ecological features	1	1	
	Mitigating ecological impacts			
	Enhancing site ecology			
	Long term impact on biodiversity			6.00%
Pol 1	Refrigerant GWP - building services	1	1	
Pol 2	Preventing refrigerant leaks	1	1	
Pol 4	NOx emissions from heating	2	2	
	Minimising watercourse pollution			
Pol 7	Reduction of night time light pollution	1	1	
				9.00%

Figure 57: Example BREEAM Retail specification

Appendix C – March 2010 updated Code costs

These costs are based on the CSH cost analysis published by CLG in March 2010. These costs have not been included in the Affordable Housing Viability Study used to assess the viability of affordable housing contributions and CSH Level 4, but are included here for information. The main finding of this reduced analysis is that estimated costs are substantially lower than in the initial analysis, which would give greater support to a policy requirement for Level 4 of the CSH.

The analysis also looks at the cost difference between requiring 2 Sur 1 credits as part of the CSH compliance or not in order to look at the impact of this policy. Even with the Sur 1 requirement, the updated costs remain lower than for the initial costing exercise.

Assumptions can be found in Figure 58, while Figure 59 provides updated information on compliance with Ene 1 requirements and Figure 60 provides updated cost information for meeting CSH 4 with and without a requirement to achieve 2 Sur 1 credits.

Costs for achieving each standard have been calculated for five types of unit:

- 118 m^2 detached house
- 73 m^2 end terrace house
- 73 m^2 mid-terrace house
- 61m^2 flat – infill site
- 61 m^2 flat – city centre site

Criteria	Detached house	End terrace	Mid terrace	Flat (Infill site)	Flat (high rise)
Council recycling collection	✔	✔	✔	✔	✔
High flood risk	✔	✔	✔	✔	✔
direct light from sky	✔	✔	✔	✔	✔
space	✔	✔	✔	✘	✘
Ecological value	✔	✔	✔	✔	✔

Figure 58: Assumptions for updated CSH costs

	Detached	**End terrace**	**Mid-terrace**	**Flat – infill site**	**Flat – city centre**
			CSH 3		
Energy solution	Good energy efficiency	energy efficiency, 0.3 kWp	energy efficiency, 0.5 kWp	energy efficiency, 0.3 kWp	
CO_2 reduction [%]	27	28	27	26	45
			CSH 4		
Energy solution	energy efficiency, 4m^2 solar 0.25 kWp	Good energy efficiency, 0.9 kWp PV	Better energy efficiency, 0.8 kWp PV	Better energy efficiency, 0.6 kWp PV	Good energy efficiency, Communal gas CHP
[%]	45	47	46	47	45

Figure 59: Compliance information for Ene 1 requirements

	Detached	End terrace	Mid-terrace	Flat – infill site	Flat – city centre
2006 Part L base build cost	100,300	78,110	82,950	59,780	59,780
Increase to meet 2010 Part L [£]	1,358	1,686	2,542	1,715	3,637
Increase to L [%]	1.4%	2.2%	3.1%	2.9%	6.1%
Increase to meet CSH 3 [£]	2,073	3,016	3,872	2,590	4,065
Increase to meet CSH 3 [%]	2.1%	3.9%	4.7%	4.3%	6.8%
Increase to meet CSH 4 [£]	6,955	6,205	7,547	5,863	6,198
Increase to meet CSH 4 [%]	6.9%	7.9%	9.1%	9.8%	10.4%
With SuDS requirement					
Increase to meet CSH 3 [£]	3,960	4,116	4,972	3,690	5,165
Increase to meet CSH 3 [%]	3.9%	5.3%	6.0%	6.2%	8.6%
Increase to meet CSH 4 [£]	7,955	7,391	8,547	6,863	7,198
Increase to meet CSH 4 [%]	7.9%	9.5%	10.3%	11.5%	12.0%

Figure 60: Updated CSH 4 costs