MAYOR OF LONDON

Energy Monitoring Report

Monitoring the implementation of London Plan energy policies in 2016

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CONTENTS

Executive summary

The Mayor has set a target for London to be a zero carbon city by 2050. As London grows in population, new buildings will be needed to meet the increasing demand for housing and associated facilities such as schools and places of work. This means that new build development has an important role to play in achieving the Mayor's zero carbon ambition.

All new developments and major refurbishments in London will need to deliver low carbon, efficient buildings that are high quality and are good places in which to work or live. All major developments in London need to be comply with the Mayor's London Plan and are assessed against a range of targets and policies, including those covering carbon and energy. Over time the London Plan has set increasingly stringent carbon reduction targets, exemplified by the target for zero carbon homes that came into force in October 2016.

This report

This report presents the outcomes secured in calendar year 2016 as a result of implementing the London Plan energy policies for new development, covering all strategic planning applications approved by the Mayor in that year (known as Stage II applications). It focuses on the reduction in carbon emissions[1] achieved and low carbon energy infrastructure commitments secured. It also provides details of the uptake of measures that have led to those carbon savings, including energy efficiency, installation of heat networks and Combined Heat and Power (CHP) systems and renewable energy sources such as photovoltaic solar panels (PV) and heat pumps. It is primarily aimed at developers and their consultants, planning case officers, and local planning authorities.

A summary of the outcomes secured in 2016 is shown in Box 1.

Box 1 – energy outcomes secured in 2016 across strategic developments
Key outcomes secured in 2016 as a result of implementation of London Plan energy policies include: • Regulated[2] CO_2 emission reductions of 35.7 per cent more than required by Part L of the 2013 Building Regulations across applications considered by the Mayor, exceeding the London Plan target of a 35 per cent reduction. • Cumulative regulated CO_2 emission reductions of over 48,000 tonnes per annum against the relevant Part L baseline. This is broadly equivalent to the savings achieved from retrofitting loft insulation in approximately 80,000 existing houses.

[1] Carbon dioxide (CO_2) is by far the most common greenhouse gas (GHG) emitted in London, both in terms of quantity released and total impact on global warming. As such carbon and CO_2 have become the common shorthand terms used when accounting for harmful greenhouse gases.

[2] The CO_2 emissions arising from energy used by fixed building services, as defined in Approved Document Part L of the Building Regulations. These include fixed systems for lighting, heating, hot water, air conditioning and mechanical ventilation. Unregulated emissions are those not covered by Building Regulations, e.g. those relating to electrical appliances.

- Carbon emission reductions exceeded 66,000 tonnes per annum, an increase in carbon savings from 2015 of nearly 16 per cent when normalised to the earlier Part L 2010 target.
- Significant investment (and with it associated employment opportunities) at each stage of the energy hierarchy including:

  - Be Lean - Investment in energy efficiency resulted in a 7.4 per cent reduction in CO_2 emissions compared with relevant Building Regulations
  - Be Clean – well over £150 million invested in heat network infrastructure and associated Combined Heat and Power generation (exceeding 38 MWe CHP capacity)
  - Be Green - £7.6 million in solar photovoltaic (PV) panels enabling approximately 6 MW of new electricity capacity and additional investment in other renewable energy technologies, most notably heat pumps (42 installations)

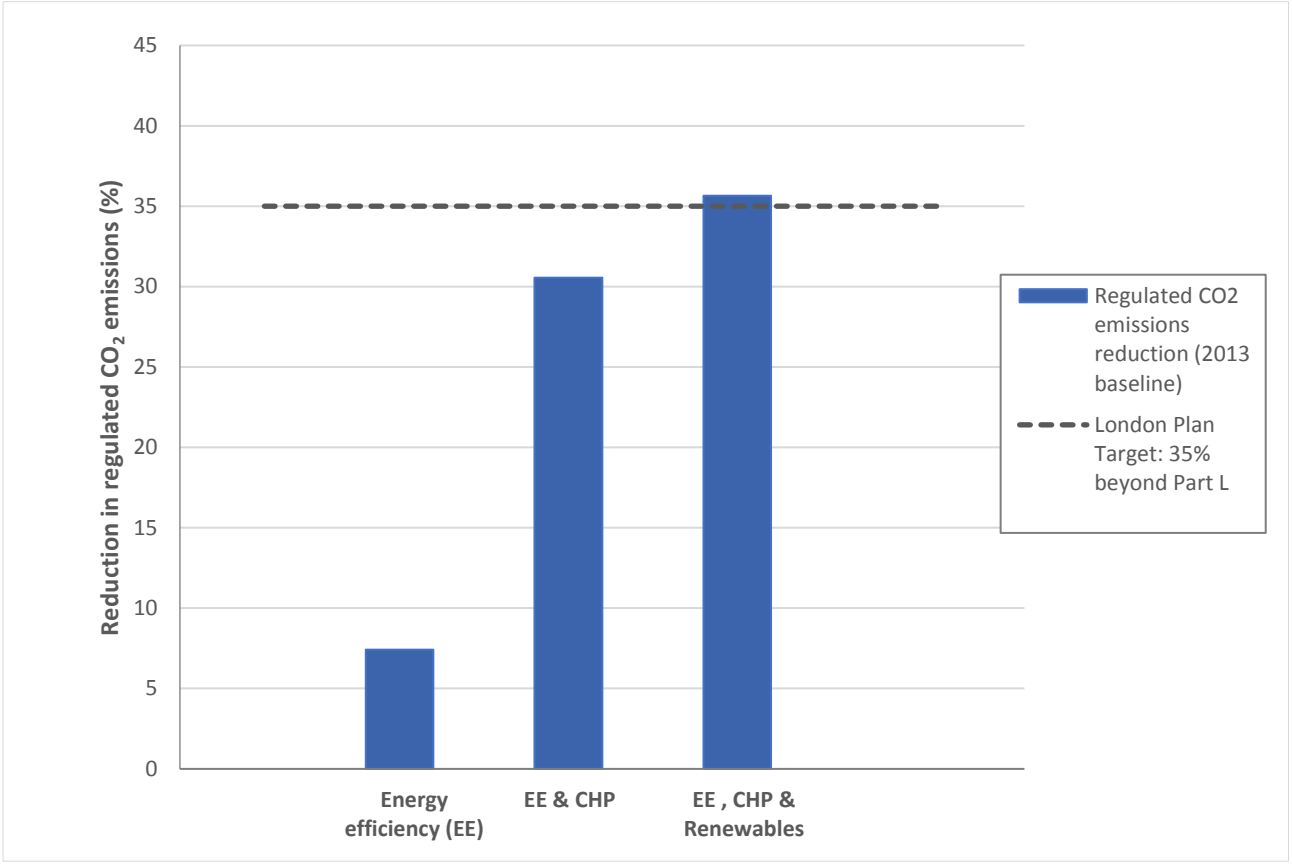
Overview of findings

In 2016, 142 applications granted provisional permission by the local planning authority were considered by the Mayor and approved. All of these applications were assessed against the most recent national building regulations (specifically Part L 2013 of Building Regulations) except for one which was submitted under previous building regulations but was not approved until 2016.

Cumulatively the overall reduction in CO_2 emissions from these applications is estimated to be 35.7 per cent more than required by Part L 2013 Building Regulations. This exceeds the Mayor's target of 35 per cent carbon reduction against Building Regulations. None of the applications approved by the Mayor in 2016 were subject to the zero carbon homes target, because they were submitted before the policy took effect on 1 October 2016.

The Mayor's energy hierarchy, set out in the London Plan, gives developers flexibility in how they meet the carbon reduction target. Many applicants demonstrated it is possible to exceed the on-site 35 per cent carbon reduction comfortably, with the majority of applications achieving a 35-45 per cent reduction. The average regulated CO_2 emissions after each stage of the energy hierarchy for all 2016 referable applications are shown in Figure 1.

Figure 1: Cumulative reductions secured in CO_2 emissions at each stage of the London Plan hierarchy for developments assessed against Part L of Building Regulations in 2016



By following the energy hierarchy, applications submitted in 2016 have continued to demonstrate a range of energy solutions based on combinations of energy efficiency and low and zero carbon technologies.

Proposed energy efficiency measures included enhanced insulation and air tightness to reduce heating demand, mechanical ventilation with heat recovery, low energy LED lights, and design features that minimise associated cooling demand. Many development proposals include heat networks, frequently supplied by Combined Heat and Power (CHP), either through on-site energy centres or by connecting to an existing network in the vicinity.

CHP remained the biggest contributor to CO_2 emission reductions in 2016. The importance of the other parts of the hierarchy remains clear however. Almost 94 per cent of the applications referred to the Mayor in 2016 met or exceeded the Building Regulations through energy efficiency alone, and 80 per cent of applications proposed renewable technologies to reach the Mayor's carbon reduction target. Approximately one third of

applications deploying renewable resources would have missed the target had they not included renewable energy. Indeed, many applications make significant use of all three parts of the energy hierarchy. These differing approaches are demonstrated through the case studies in Appendix 2.

The total shortfall from developments not meeting the 35 per cent carbon reduction target in 2016 accrued to approximately 2,298 tonnes of regulated CO_2 emissions per annum, a significant drop from the 2015 figure of 3,071 tonnes. The 2016 shortfall equates to approximately a £4.13 million contribution to offset funds and investment in off-site measures, assuming an indicative CO_2 price of £60 per tonne[3] and a 30 year lifetime.

Conclusions

The continued implementation of the London Plan energy policies in 2016 has resulted in the following:

- Total carbon reduction commitments by developers exceeded the target of a 35 per cent reduction in carbon emissions beyond Building Regulations.
- Overall, developers committed to greater carbon reductions from energy efficiency alone than required by Building Regulations, achieving on average a 7.4 per cent improvement. This is driving investment in energy efficiency. London Plan policies are estimated to result in annual resident energy cost savings of £270,000 per annum.[4]
- It is estimated that London Plan energy policies resulted in £160 million of investment in low carbon and renewable energy generation and infrastructure in 2016.
- 51,736 dwellings (95 per cent of the total dwellings receiving approval) committed to a heat network connection. This is critical for facilitating larger, area wide heat networks.
- The dominant renewable energy technologies remained solar PV and heat pumps. The number of applicants pursuing solutions with these technologies over the past few years appears to be broadly stable, reflecting the acceptance of these technologies.
- Offsetting remains necessary and will continue to play a role in planning applications going forwards following the introduction of the zero carbon homes policy.[5]

Overall, current targets are being comfortably met by developers for most types of development. As more homes are assessed against the zero carbon homes policy, we will expect developers to continue to build on performance to date and to seek innovative solutions to meeting these targets thereby contributing to the Mayor's aim for London to be zero carbon by 2050.

[3] £60 per tonne of CO2 was the central price assumption used in government's consultation on Allowable Solutions.
[4] This figure is not as high as for the previous year; total savings are likely to be equivalent but a portion of these is due to the tightening of the Building Regulations in 2014, which means less of the savings can be attributed to the London Plan.
[5] The GLA will be issuing further guidance for boroughs on offsetting funds in due course.

Introduction

The London Plan

The London Plan is the Mayor's Spatial Development Strategy. It considers how the Mayor's various relevant strategies, such as those dealing with housing, transport, economic development and environment can be coordinated to complement one another through new development. It also provides London's planning authorities with an overarching framework for their local plans. It ensures, for example, that boroughs identify enough land to meet local as well as strategic housing needs, and provides guidance on issues such as tackling climate change and improving air quality. Legally, all local plans must be in 'general conformity' with the London Plan.

New developments across London range from plans for thousands of new homes and mixed use developments that will be delivered over several years and through a series of phases, to individual buildings. Developers have continued to respond to the challenging targets set by London Plan energy policies, which substantially exceed those required by national Building Regulations. Planning applications are referred to the Mayor if they meet the criteria set out in the Mayor of London Order (2008),[6] e.g. developments of 150 residential units or more.

The flexibility built into the London Plan means developers can pursue a variety of approaches, ensuring that the technologies chosen are the most appropriate to each development. The common theme is for high standards of energy efficiency together with the integration of low carbon and renewable technologies.

These approaches also require capacity building both for the construction of new buildings and homes, and also to deliver energy efficiency measures, new infrastructure and low and zero carbon technologies, so there is a consequent positive effect on employment and a range of job opportunities.

The contribution of new-build developments to CO_2 emissions is relatively modest compared to the existing building stock since we expect around 80 per cent of London's current buildings to still be in use by 2050. However, new development has an important role to play in demonstrating best practice in building design, ensuring we don't lock in high carbon emissions through inefficient buildings, ensuring resilience to future climate and energy supply changes, building supply chains for energy efficiency and low carbon technologies and catalysing new, area-wide decentralised energy schemes.

An energy assessment is required for each planning application referable to the Mayor. In preparing these, applicants are required to follow the Greater London Authority (GLA) guidance on preparing energy assessments.[7] Each energy assessment is then evaluated on a case by case basis by a dedicated energy planning team to ensure compliance with

[6] https://www.london.gov.uk/what-we-do/planning/planning-applications-and-decisions/what-powers-does-mayor-have-planning
[7] http://www.london.gov.uk/priorities/planning/strategic-planning-applications/preplanning-application-meeting-service/energy-planning-gla-guidance-on-preparing-energy-assessments

London Plan policies and ensure each development (where appropriate) contributes to the long term plans for decentralised energy in London. The evaluation recognises the particular circumstances of individual developments and the constraints that apply in each case.

The Mayor has a duty to keep the London Plan under review so that it addresses changing trends and issues for example around population increase. The next draft London Plan was published for public consultation in November 2017 and is currently due to be finalised in 2019.

Energy and carbon policies in the London Plan

Carbon targets

Policy 5.2 of the London Plan sets CO_2 emission reduction targets for new buildings, with the zero carbon homes target introduced in October 2016.[8] The targets support the development of energy efficient new buildings and investment in infrastructure to supply energy to the remaining building stock efficiently. These policies may also enable additional benefits for building occupants through provision of affordable energy and increased security of energy supply, while also minimising the impact on the existing energy network.

The carbon reduction targets are expressed as minimum improvements over the carbon targets[9] set for buildings in 2010 National Building Regulations, which serves as a baseline. When revised Building Regulations came into effect on 6 April 2014, the London Plan target was recalibrated to take account into account the changes to the baseline. A percentage target of 35 per cent beyond the new national standards across both residential and non-domestic buildings was then applied by the Mayor.

From 1 October 2016 the target for new major residential developments[10] was raised to zero carbon, with details set out within the Housing Supplementary Planning Guidance document.[11]

If developments have proven that they are unable to reach the carbon reduction target on-site due to site-specific constraints, the London Plan requires the developer to install carbon saving measures off-site in agreement with the local borough, or make a cash-in-lieu contribution to the borough's carbon offset fund to account for the shortfall in CO_2 emission reductions (as in London Plan Policy 5.2E). This contribution is ring fenced by the borough to secure delivery of carbon dioxide savings elsewhere.

[8] Although zero carbon homes was introduced as a target for Stage I applications received after 1 October 2016, no such developments reached Stage II in 2016.
[9] Target Emission Rates outlined in Part L of Building Regulations.
[10] Developments comprising of ≥10 units.
[11] Housing Supplementary Planning Guidance (SPG) is available at https://www.london.gov.uk/what-we-do/planning/implementing-london-plan/supplementary-planning-guidance

Energy policies

Policy 5.2D of the London Plan requires every planning application referable to the Mayor to be accompanied by an energy assessment, setting out how the development will comply with London Plan energy policies. Applicants are required to set out how they have applied the following energy hierarchy:

1. Be lean: use less energy
2. Be clean: supply energy efficiently
3. Be green: use renewable energy.

A specialist team evaluates the energy assessments of strategic development to ensure compliance with London Plan energy policies and, where necessary, negotiates improvements. The case studies in Appendix 2 demonstrate how targets can be applied to, and met, by very different types and sizes of developments, applying the energy hierarchy.

Be Lean

New developments are required to incorporate passive and active energy efficiency measures in order to minimise the demand for energy. In addition to enhancing the design of the building, developments are required to include active measures such as energy efficient lighting, heat recovery systems and advanced controls. They should also include measures to avoid internal overheating and contributing to the urban heat island effect.

As energy efficiency is the first element of the energy hierarchy, developers are required to commit to improving energy efficiency before deciding on the most appropriate low or zero carbon energy supply system. This approach is reinforced by requiring developments to reduce regulated CO_2 emissions below those of a Building Regulations compliant development through energy efficiency alone.

Energy efficiency measures tend to focus mainly on reducing heating demand but energy consumption should also be minimised to meet cooling demands. Policy 5.3 sets out the aspiration for the highest standards of sustainable design and construction. As well as the intention to ensure that buildings minimise carbon dioxide emissions, policy 5.3C sets out a range of sustainable design principles such as the need to avoid internal overheating and contributing to the urban heat island effect. Energy consumption due to cooling demands is growing rapidly globally, in temperate as well as hot climates; consequently policy 5.9 sets out a cooling hierarchy for major development proposals to reduce potential overheating and reliance on air conditioning.

Developers are required to undertake dynamic overheating modelling against extreme weather scenarios and report how identified risks can be mitigated in line with existing CIBSE guidance, notably TM52 and TM49. They are also required to provide the GLA’s overheating checklist alongside their planning applications to ensure the risk of

overheating is considered early on in the detailed design and is mitigated against appropriately.

Measures to reduce overheating included use of low temperature LED lighting and optimisation of solar transmittance of glass, together with passive features including balconies and windows set back in recesses for shading, and architectural design to promote natural cross and stack ventilation.

Be Clean

New developments present an opportunity to supply low carbon energy. In London in particular new developments have an important role to play in catalysing the emergence of area wide low carbon heat networks. Larger developments may form the focal point of a new area wide initiative, but even if they are smaller, they will often be important heat loads to support wider connections of multiple existing and new buildings that can also grow to area wide size. This growth extends efficiencies and economies of scale. For example, installing a single larger CHP rather than multiple smaller CHP installations of equivalent capacity typically provides a higher electrical efficiency, helping to reduce CO_2 emissions as well as reducing maintenance and operating costs.

Policy 5.5 of the London Plan prioritises the development of heat networks at the development and area wide levels accordingly. The delivery of decentralised energy in London is supported through the planning process by prioritising connection to existing decentralised energy networks and requiring the implementation of site wide heat networks, where appropriate, in new developments which are the subject of strategic planning applications.

Be Green

Renewable energy also plays an important role for developments meeting the requirements of the London Plan. Policy 5.7 of the London Plan requires that, after considering the first two elements of the energy hierarchy, major development proposals should provide CO_2 emissions reductions through the use of on-site renewable energy generation.

Implementation

Overall 2016 results

A total of 149 applications which had been granted provisional permission by the local planning authority were considered by the Mayor at Stage II in 2016 and were approved. Of these, seven applications had no regulated energy uses (these include, for example, a bus depot); and so these are excluded from the analysis in this report leaving a total of 142 applications (Table 1). There were also 18 additional applications that were refused by the local planning authority but not taken over by the Mayor in 2016, or that were approved by the local planning authority but refused by the Mayor, so are not included in this analysis.

Table 1: Total number of developments (including dwellings and floor area) approved by the Mayor in 2016

Type of development	Number of developments	Number of dwellings	Non-domestic floor area (millions m^2)
Mixed use[12]	98	51,325	1.4
Domestic	10	2,874	N/A
Non-domestic	34	N/A	0.7
Total	**142**	**54,199**	**2.1**

Overall regulated CO_2 reductions

The application of London Plan energy policies in these new developments resulted in cumulative regulated CO_2 emission reductions for applications reaching Stage II during 2016 of 48,011 tonnes per annum. This is broadly equivalent to the savings achieved from retrofitting loft insulation in approximately 80,000 existing houses.[13]

Table 2 shows the emissions after each stage of the energy hierarchy for new developments that were referred to the GLA and obtained planning approval in 2016.

[12] All these developments have a residential and commercial component.

[13] Assumes average saving per dwelling of 0.6 tonnes of CO_2 per annum for virgin loft insulation, based on Energy Savings Trust calculations.

Table 2: On-site CO_2 emission reductions from applications reaching Stage II in 2016 assessed against Part L[14] Building Regulations where a 35 per cent target was applied			
	Regulated CO_2 emissions	Cumulative regulated CO_2 emissions reductions relative to Part L 2013 Building Regulations	
	(tCO_2/year)	(tCO_2/year)	(per cent)
Baseline	134,637	-	-
After energy efficiency	124,655	9,982	7.4
After energy efficiency & heat networks / CHP	93,495	41,142	30.6
After energy efficiency, heat networks / CHP & renewables	86,626	48,011	35.7

With the majority of applicants succeeding against this target to reach an average of 35.7 per cent beyond Part L 2013, it is clear that applicants have succeeded in devising energy strategies which meet the target with the majority of applications achieving a 35-45 per cent reduction. Figure 2 shows the range and distribution of the total savings.

[14] This table also includes the CO_2 emission reductions for one application assessed against Part L 2010

Figure 2: Total carbon savings for developments reaching Stage II in 2016 (bars represent the number of cases within each percentage saving group)

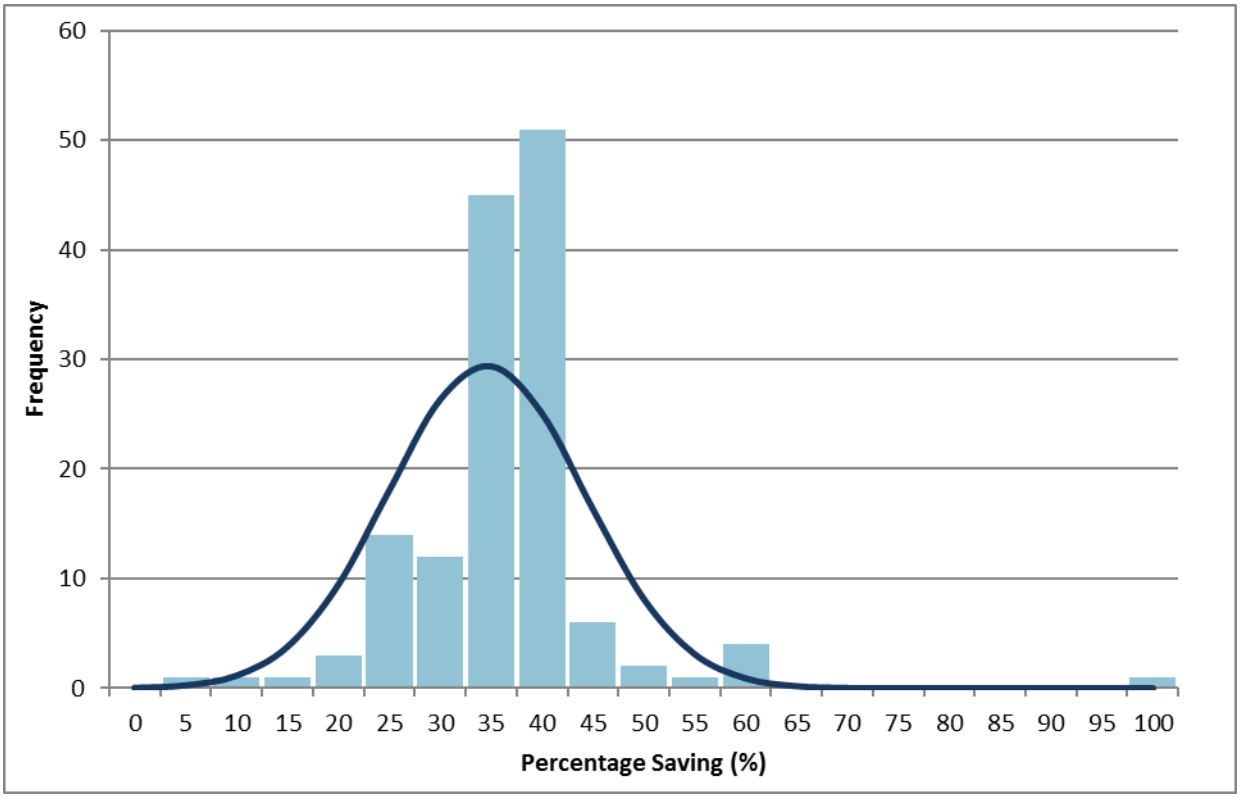
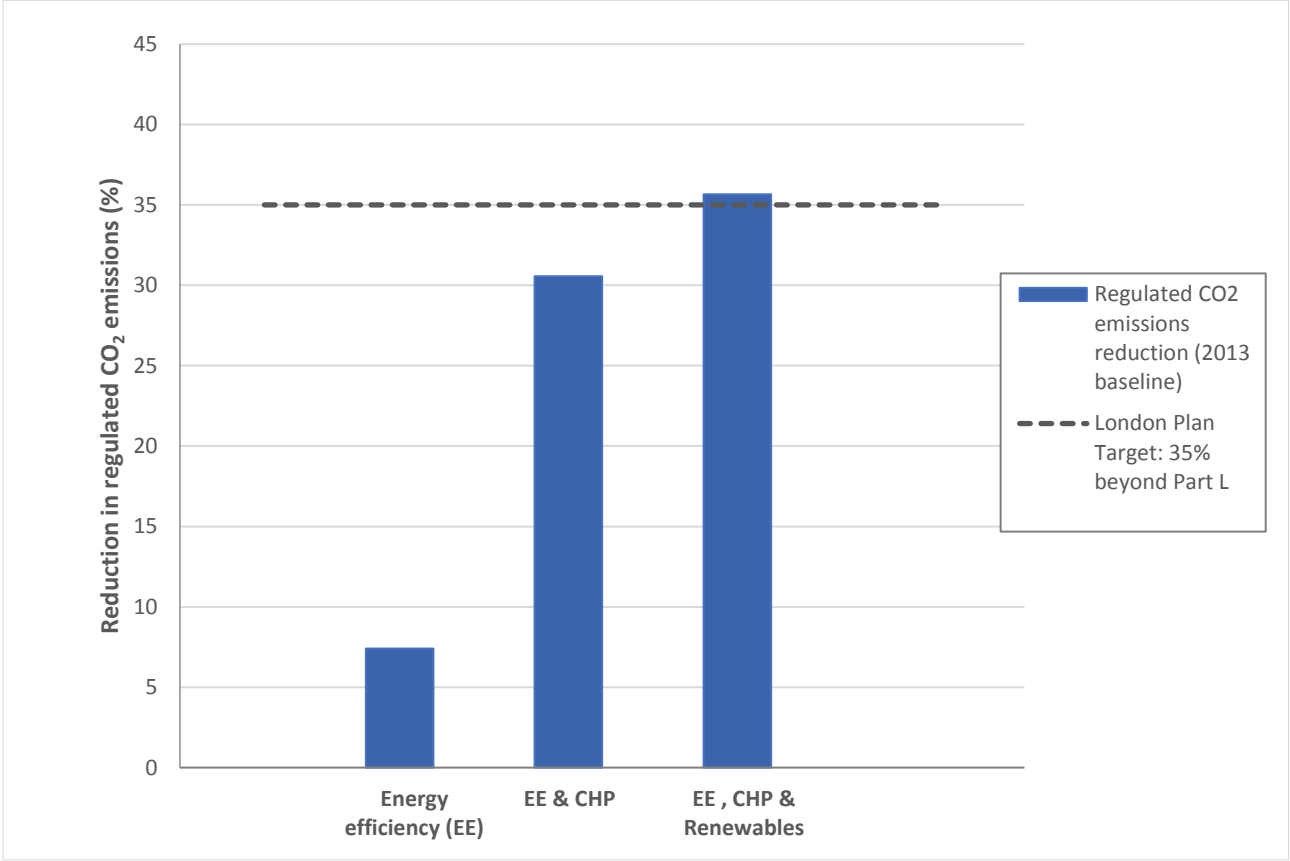


Figure 3 illustrates the cumulative percentage savings at each step of the hierarchy for applications reaching Stage II during 2016.

Figure 3: Cumulative reductions secured in CO_2 emissions at each stage of the London Plan hierarchy assessed against Part L for developments reaching Stage II during 2016



Additional CO_2 reductions from refurbishment projects

Where significant refurbishments are being carried out, it is expected that an estimate of the CO_2 savings from the refurbishment of the building is provided and best practice should be demonstrated in improving the elements to be refurbished and reducing on-site carbon emissions as far as possible. During 2016 there were no Stage II applications which comprised solely of buildings to be refurbished. GLA Energy Planning guidance provides further information on producing an energy strategy for major refurbishment projects.[15]

Baselines

Table 3 sets out the time periods over which each London Plan target has been applied and the number of developments under each target considered by the Mayor at Stage II in 2016. Although the zero carbon target for major residential developments was introduced for applications reaching Stage I on or after 1 October 2016, none of these applications reached Stage II during 2016.

[15] https://www.london.gov.uk/sites/default/files/gla_energy_planning_guidance_-_march_2016_for_web.pdf]

Table 3: Targets and their periods of applicability (for applications received by the GLA at Stage II)			
Target	Applicable from	Applicable until	Number of developments in 2016
25 per cent beyond Part L 2010	2010	30th Sept 2013	0
40 per cent beyond Part L 2010	1st Oct 2013	5th July 2014	1
35 per cent beyond Part L 2013[16]	6th April 2014	30th Sept 2016	141

Be Lean

Be Lean reductions

Almost 94 per cent of the applications reaching Stage II in 2016 achieved the level required by the Building Regulations through the first step of the energy hierarchy alone – be lean (energy efficiency measures). All but one of the 2016 Stage II applications were assessed against Part L 2013 of the Building Regulations.[17] They achieved, through energy efficiency measures alone, an average of 7.4 per cent reduction in regulated CO_2 emissions against the relevant Part L baseline – approximately 21 per cent of the overall reduction. This is lower than the equivalent figure for 2015. However, when the tightening of the Building Regulations is taken into account, by normalising CO_2 emission reductions to Part L 2010, the contribution from energy efficiency measures alone is, at 19 per cent, a 5 per cent increase on 2015. The contribution from energy efficiency remains fundamental and indeed underpins why the target was raised.

Overheating and cooling demand

A total of 6.5 GWh/yr of cooling demand is expected from the 71 developments which provided data. 98.5 per cent of this demand is attributed to non-domestic buildings. 62 of the 110 cases providing non-domestic floor area are proposing active cooling. Three of the 101 cases providing residential units are proposing active cooling within some or all of the dwellings. All three cases proposing residential active cooling are mixed-use developments. No cases with active cooling proposed were recorded for exclusively

[16] The 35 percent beyond Part L 2013 was devised to be equivalent to the existing 40 percent beyond Part L 2010 target. A transition period applied between 6/04/2014 and 5/07/2014 when applicants were able to present their CO_2 reductions relative to either a 2010 or 2013 baseline.

[17] This particular application was submitted under the previous Building Regulations.

residential developments. Cooling demand data will be required from all developments in future to build up an evidence base of performance.

Be Clean

Large new developments
Table 4 shows large new developments with more than 1,000 homes that obtained planning approval in 2016, all of which were mixed use. These dwellings are ready for connection to an existing or prosed district heat network or have developed a site heat network that may later connect to a district heating network. There are a total of 27,430 dwellings in this category, which is just over half of the total number of residential units considered though Stage II in 2016.

The energy infrastructure (e.g. site-wide heat network) planned for these developments can be a key element in realising the plans for area wide district heating networks. Due to the scale of these developments they are inevitably multi-phase and often envisaged to take over a decade to complete.

When developments with more than 500 dwellings are also considered, this number increases to almost 37,000 homes, which is more than two-thirds of the total number of new dwellings for the year. Such developments are also at a scale that would normally justify implementation of CHP.

The largest of these is the Barking Riverside development which has specified CHP supply of capacity of 7MWe, and features in Appendix 3 as a case study.

Table 4: New developments with > 1000 dwellings obtaining planning permission in 2016

Development Name	Borough	Number of dwellings	Non-domestic floor area (m^2)	Total emission reduction (%)
Barking Riverside	Barking & Dagenham	10,800	147,200	35%
Abbey Wood & South Thamesmead	Bexley	1,622	11,191	35%
Wembley Masterplan	Brent	4,000	74,802	36%
Southall Gasworks	Ealing	3,750	25,000	35%

Deptford Wharves	Lewisham	1,132	10,413	38%
Millharbour Village	Tower Hamlets	1,500	19,345	33%
Nine Elms Parkside	Wandsworth	1,870	27,000	59%
Battersea Power Station	Wandsworth	3,853	334,584	37%

Site heat networks

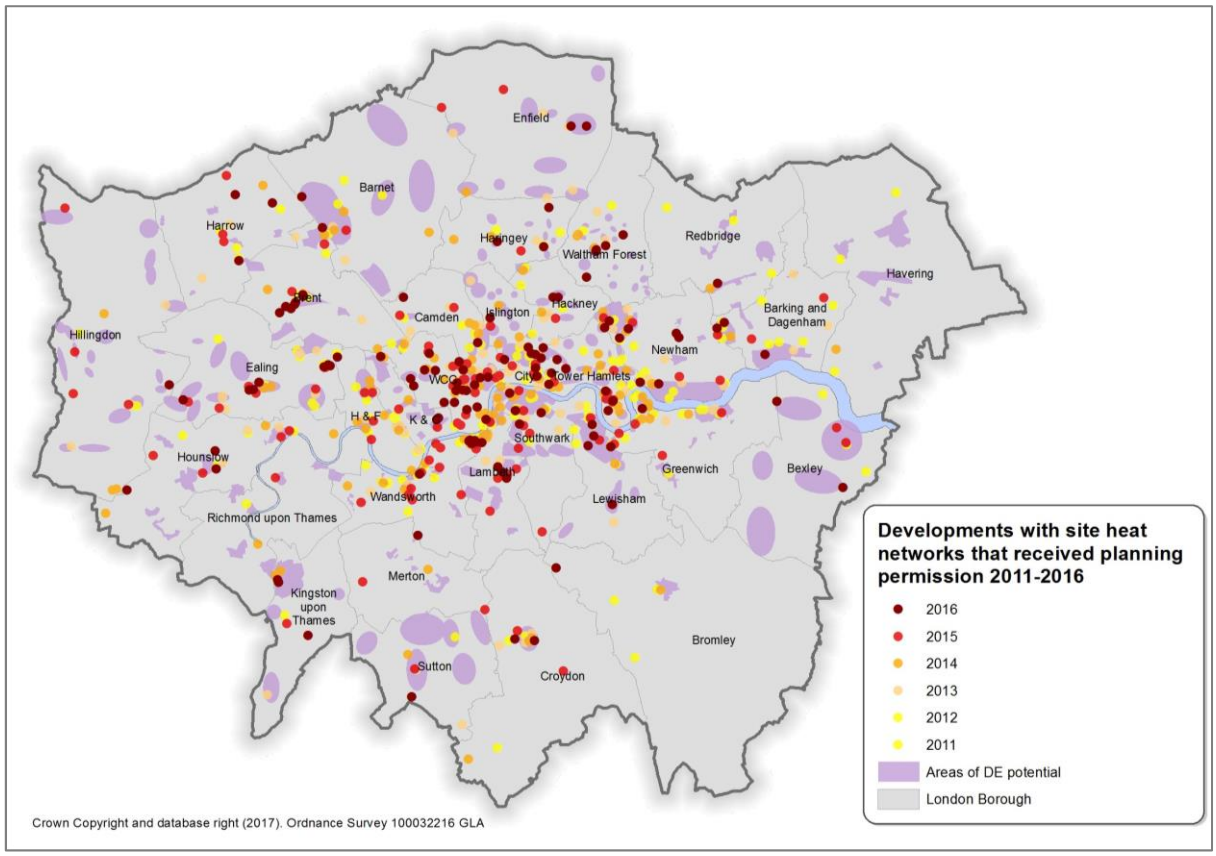
Out of 87 developments of less than 1,000 homes which reached the on-site reduction target, 76 proposed a new site heat network. This ensures future flexibility in energy supply including connection to a wider heat network when this becomes possible.

This approach for developments of less than 1,000 homes resulted in commitments to 24,306 residential units being supplied by a site heat network. Including the 27,430 dwellings connecting to heat networks in the very large developments, this amounts to total commitments to 51,736 dwellings (95 per cent of the total dwellings receiving approval) connecting to heat networks.

Figure 4 illustrates the distribution of the developments which committed to the provision of site wide heat networks between 2010 and 2016, mapped against identified areas of decentralised energy potential.[18] This shows that site heat networks feature in boroughs across London, not surprisingly with greater concentration in the Inner London boroughs, where the heat demand density will usually be higher and therefore more suitable for heat networks.

[18] Data on areas of decentralised energy potential sourced from the London Heat Map - www.londonheatmap.org.uk/

Figure 4: Distribution of developments committed to providing site heat networks



Ensuring smaller developments in dense areas are future proofed

While the majority of residential units receiving planning approval from the Mayor in 2016 were located in larger developments, the remaining residential units were distributed among a large number of smaller developments. Smaller developments typically install small on-site heat networks which can potentially be connected up to larger area wide networks in the future.

Energy sources

A total of 104 developments proposed to meet a proportion of their energy requirements through CHP. Of these, 36 of the applications are committing to connect to an existing district heating network in the vicinity. This resulted in commitments to provision of circa 38MW of new CHP electrical capacity[19], a significant increase from 2015.

[19] There were 6 developments that did not provide a value for the size of their proposed CHP installation. Recursion analysis on the other 86 developments incorporating CHP was used to derive a relationship between the size of CHP and the emissions savings from the 'Be Clean' aspect of the energy hierarchy. This was then used to estimate the size of CHP in the 6 developments that did not provide a value, these estimated values total 2.8MW and are included in the value for total CHP electricity capacity.

As the carbon emissions incurred through grid electricity generation decrease, the savings achieved by gas-fired CHP are expected to decrease. Consequently, it will become progressively more important when specifying CHP to ensure it is deployed in an efficient way and for developers to consider whether other forms of heat generation are lower carbon. Opportunities to transition to solutions such as heat pumps will correspondingly improve, and the integration of thermal storage can help to secure an effective and efficient system.

Table 5 sets out the profile of CHP capacity secured through planning in 2016. Well over 90 per cent of the aggregated capacity arises from the middle and largest CHP size categories, with the largest single installation proposed being 7MWe. Almost half of proposed CHP installations are estimated to be less than 100kWe.

Table 5: Size distribution of CHP installations secured through planning in 2016

	Number of installations	Total electrical capacity (MWe)	Average size of installation (MWe)	Number of dwellings	Non-domestic floor area (m^2)
Less than 100kWe	51	2.29	0.05	6,847	272,297
100kWe to 999kWe	45	13.00	0.29	17,523	822,171
1MWe and above	8	23.05	2.88	23,670	625,848
Total	**104**	**38.34**	**-**	**48,040**	**1,720,316**

Be clean reductions

The 2016 Stage II applications achieved, through the ‘be clean’ part of the energy hierarchy, an average of 23.2 per cent reduction in regulated CO_2 emissions against the relevant Part L baseline. This is slightly higher than the equivalent figure for 2015 (20.7 per cent), indicating the importance in 2016 of CHP and heat network connections in meeting the carbon reduction targets.

As in previous years, the largest contribution was due to connection to heat networks and on-site CHP, which amounted to 31,160 tonnes of CO_2 per annum – approximately 65 per cent of the overall reduction.

Be green

During 2016 more than 85 per cent of developments reaching Stage II have included renewable energy. Furthermore, renewable energy was needed by 80 per cent of applications to reach the on-site carbon reduction target. Without their renewable energy component, 30 applications that successfully met or exceeded their target would have failed to meet that target.

Renewable energy, the final element of the hierarchy, was responsible for 14 per cent of the overall reduction. Despite being responsible for the smallest reduction of the three elements, it remains an important additional enabling element for applicants reaching the target.

In 2016 the dominant renewable energy technologies remained solar PV and heat pumps. The number of applicants pursuing solutions with these technologies over the past few years appears to be broadly stable. Table 6 gives a breakdown of renewable technologies proposed by applicants over the past few years.

Table 6: Number of installations of different types of renewable energy systems

	2013	2014	2015	2016
Solar PV	123	98	111	104
Biomass boilers	8	2	4	1
Heat pumps	27	43	25	42
Solar thermal	12	9	4	3

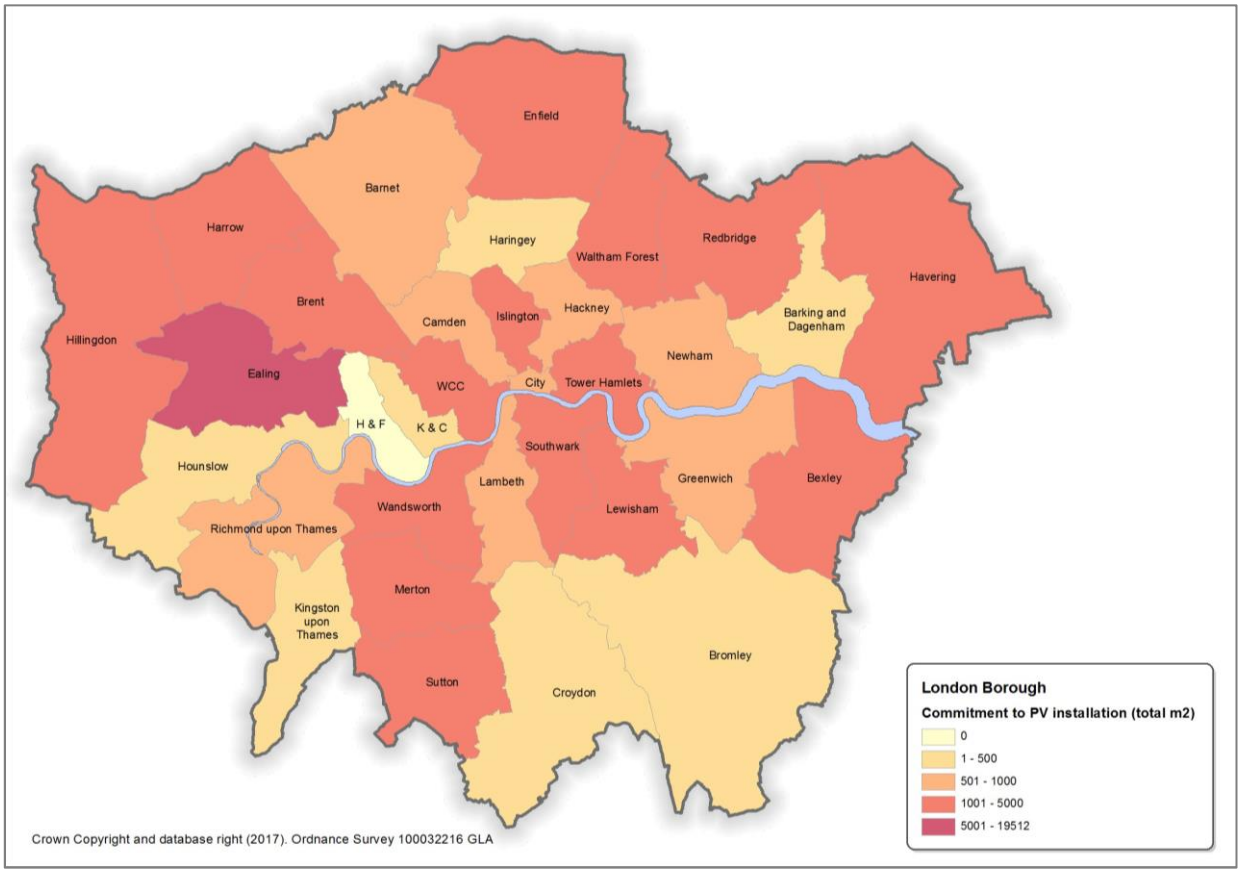
Figure 5 shows by borough the total area of PV commitments in developments approved in 2016. Although high aggregate PV commitments have been made in both inner and outer boroughs, the average commitment per application in inner London boroughs is about half that of the outer boroughs. This is exemplified by Ealing where an aggregate area of PV of nearly 19,000m^2 is shared across only eight applications, at an average of nearly 4,000m^2 per installation, compared with a total of 6,654m^2 spread across six commitments in Southwark at an average 450m^2 per installation.

For 2016, of the 42 applications specifying heat pumps, 37 proposed air source heat pumps with five ground source heat pumps accounting for the remainder. However, the latter are much larger and account for a significantly higher heat output.

During 2016 there was only one application involving the use of a biomass boiler. Use of biomass is discouraged in many parts of London due to the air quality implications. There were an additional two applications citing the use of liquid biofuel for CHP.

There were only 3 applications featuring solar thermal, indicating that priority is given to PV for suitable available roofspace given the higher value of electricity production.

Figure 5: Commitments to PV by borough



Be green reductions

The 2016 Stage II applications achieved, through the 'be green' part of the energy hierarchy, an average of 5.1 per cent reduction in regulated CO_2 emissions against the relevant Part L baseline. This is slightly lower than the equivalent figure for 2015 (5.7 per cent) which aligns with the slight reduction in the number of PV installations compared to 2015. The contribution of renewables to the carbon reduction targets has been broadly stable over the past few years.

Shortfalls and carbon offsetting

Major development proposals[20] are required to include a detailed energy assessment to demonstrate how the targets for CO_2 emission reductions are to be met within the framework of the energy hierarchy, including any shortfall in emissions. Boroughs across London have been preparing their mechanisms for collection of carbon offset payments and determining how these funds, which are ring-fenced for projects with demonstrable carbon savings, will be spent. Assistance has been made available from the Mayor's RE:NEW programme to help boroughs identify suitable (primarily energy efficiency) projects.

Proportion of developments meeting the target through on-site measures
For applications reaching Stage II in 2016, just over half met or exceeded their carbon reduction target. The average savings figure achieved in 2016 was 35.7 per cent, thereby meeting the target of 35 per cent beyond Part L 2013 of the Building Regulations and increasing marginally from the 2015 figure.

The cumulative shortfall in CO_2 reductions
The total shortfall from developments not meeting the target in 2016 accrued to approximately 2,298 tonnes of regulated CO_2 emissions per annum, a significant drop from the 2015 figure of 3,071 tonnes. The 2016 shortfall equates to approximately a £4.13 million contribution to offset funds and investment in off-site measures, assuming an indicative CO_2 price of £60 per tonne[21] and a 30 year lifetime.

[20] For dwellings, major developments are defined as having 10 or more units. For any other use they are defined as having floor space of 1000 sq metres or more (or the site area is 1 hectare or more).
[21] £60 per tonne of CO_2 was the central price assumption used in government's consultation on Allowable Solutions.

Results over time

The figures in Table 7 refer to on-site commitments since 2013. 87 developments in total reached the on-site reduction target.

Table 7 Comparison of applications 2013 - 2016 by type and CO_2 emissions reductions				
	2013	2014	2015	2016
Stage II applications	174	142	147	**142**
Number of dwellings in development	43,178	43,814	52,014	**54,199**
Estimated domestic floor area[22] (million m^2)	3.0	3.1	3.6	**3.8**
Non-domestic floor area (million m^2)	2.3	2.0	2.7	**2.1**
Regulated CO_2 emissions reductions compared to appropriate Part L (2010 or 2013) Building Regulations (percentage)	36%	39%	35%	**36%**
Regulated CO_2 emissions reductions compared to appropriate Part L (2010 or 2013) Building Regulations (tonnes per annum)	49,474	53,423	49,147	**48,011**

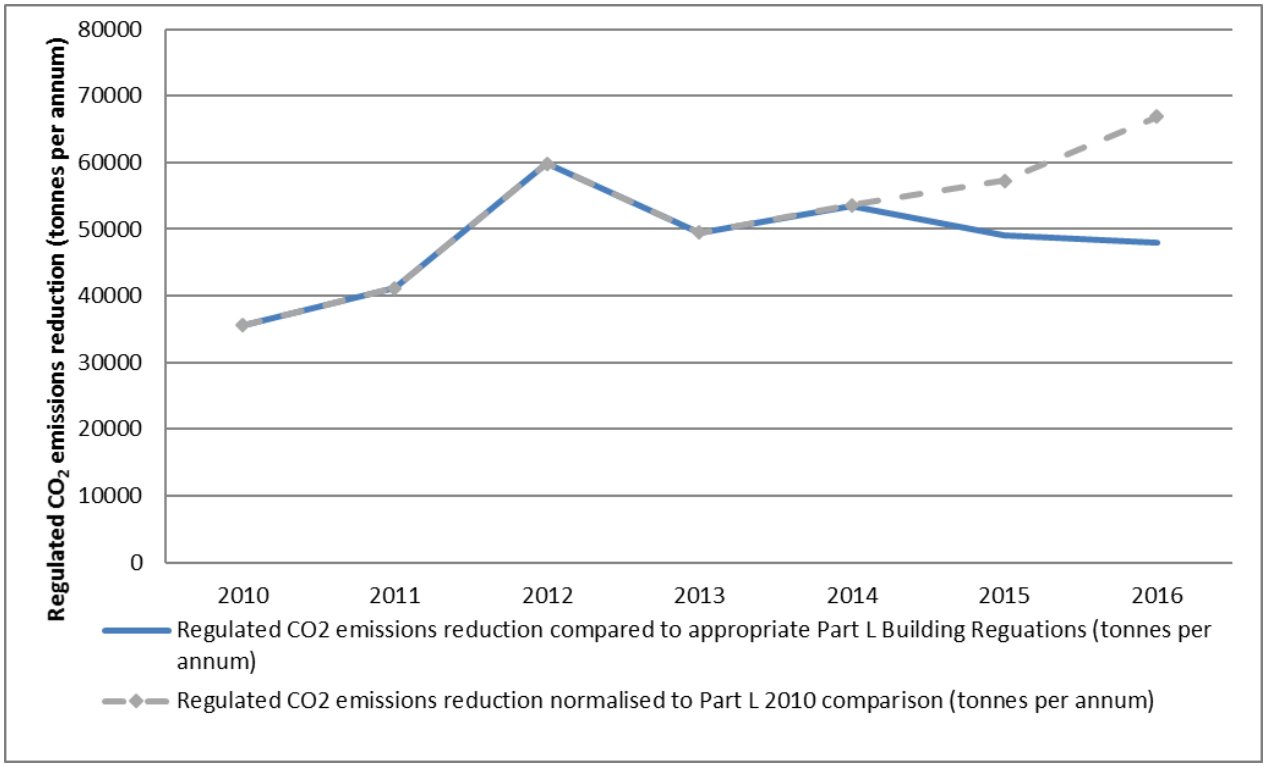
The application of London Plan energy policies in these new developments resulted in cumulative regulated CO_2 emission reductions for applications reaching Stage II during 2016 of 48,011 tonnes per annum.

This carbon reduction figure is lower than for 2015, which was in turn lower than for 2014. This is not surprising because the number of applications assessed against the less stringent Part L 2010 has progressively reduced and the number of application assessed against the stricter Part L 2013 has increased. However, it should be noted that when CO_2 reductions are normalised to a comparison against Part L 2010, the resultant figure for savings in 2016 reveals savings in excess of 66,000 tonnes per annum, a substantial increase, which is broadly equivalent to the savings achieved from retrofitting loft insulation in approximately 110,000 existing homes.

[22] Assumes that the average dwelling receiving planning approval has an internal area of $70m^2$.

Figure 6 shows the trajectory in carbon emission reductions referenced to the applicable Part L (2010 or 2013) and (dotted line) referenced to a common baseline of Part L 2010.

Figure 6: Annual reduction in regulated CO_2 emissions referenced to applicable Part L (2010 or 2013) and normalised to Part L 2010



The relative contribution from energy efficiency has also diminished over the last three years as the number of applications assessed against the former and less stringent Part L 2010 has declined, which explains this trend. Specifically, in 2014 the reduction from energy efficiency was estimated at 21,562 tonnes of CO_2, compared with 11,734 tonnes of CO_2 in 2015 and now 9,982 tonnes of CO_2 in 2016. Again, this is not surprising as the Building Regulations applicable to developments have been significantly tightened.

Investment due to London Plan energy policies

The London Plan energy policies are driving investment in low carbon and renewable energy generation and infrastructure, with the overall investment in 2016 expected to be more than £160 million:

- **£27 million investment in CHP capacity**

  Assuming an installed capital cost of £700 per kilowatt of electrical capacity, the 38MW of CHP electrical capacity committed to in 2016 is estimated to require investment of nearly £27million.[23]

- **£129 million to fund heat network infrastructure**

  The site heat network infrastructure into which CHP will supply heat energy requires significant investment. It is estimated that an outlay of circa £129 million[24] will be required to fund the heat network infrastructure for the 52,036 dwellings with communal heating. The non-domestic buildings will require additional further investment for the associated heat network infrastructure.

  A workforce will be required to operate and maintain the heat network infrastructure and associated energy generation equipment serving the new developments. It is estimated that the developer commitments obtained in 2016 will result in approximately 60 permanent jobs,[25] the majority of them being in energy services companies (ESCOs).

- **£7.6 million investment in solar PV**

  Investment in renewable energy systems was also proposed to help achieve the CO_2 reduction commitments. Using an installed capital cost estimate of £1,220[26] per kilowatt, providing circa 6MW[27] of PV panel electrical capacity will require an investment of approximately £7.6 million. Further investment will also be required to implement heat pumps, both at individual sites and in heat networks.

By requiring higher energy efficiency standards than national building regulations, London Plan energy policies are also increasing investment in energy efficiency. They are estimated to result in annual energy cost savings for domestic occupants of £270,000 per annum, with additional energy cost savings for non-domestic building occupants. This figure is not as high as for the previous year; total savings are likely to be equivalent but a portion of these is due to the tightening of the Building Regulations, and cannot be attributed to the London Plan.

[23] i.e. 700 x 38.3 x 1000 = £26,600,000.
[24] Assumes a heat distribution cost of £2,500 per flat for district heating, taken from Table 51 of Code for Sustainable Homes: A cost review (CLG March 2010).
[25] Assumes 0.5 jobs per mixed use/residential development for maintaining a site network and 120 networks
[26] Figure calculated based on PV costs sourced from the Microgeneration Certification Scheme - MCS Installation Database and cover schemes installed during 2015/16.
[27] Based on 1 kWp to each 10 m^2.

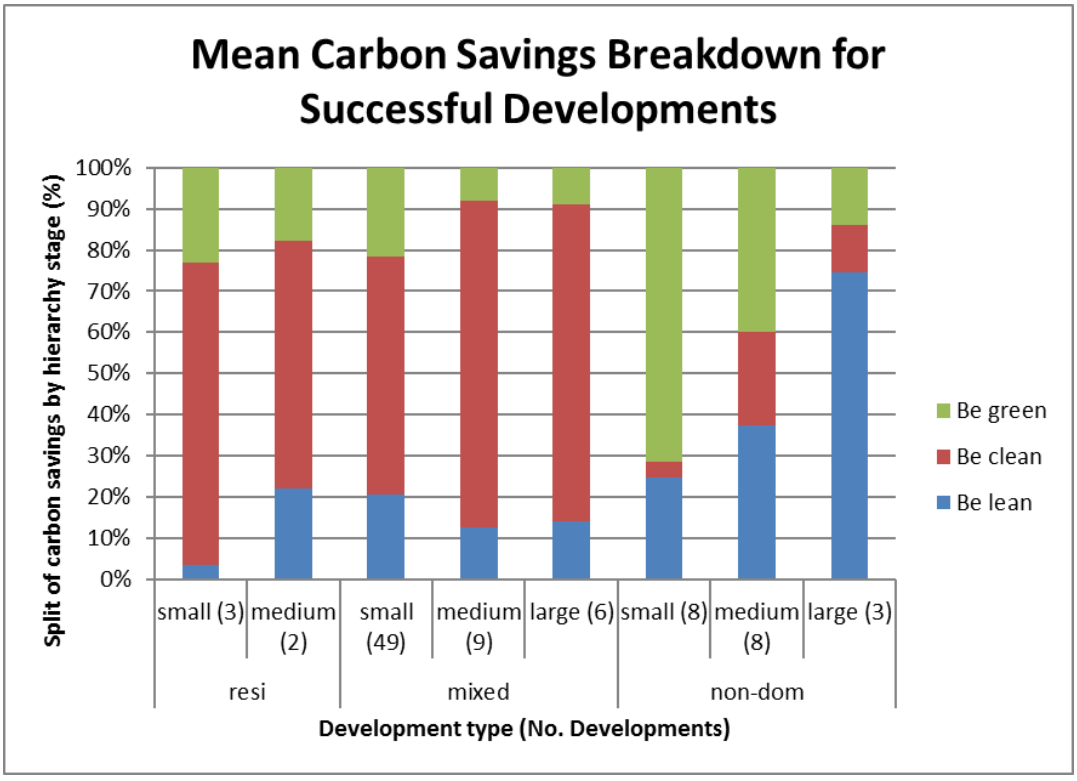
Conclusions

How different development types met the carbon target

While every development has its own individual characteristics and circumstances, there are some general trends that can be observed among different categories of application. Figure 7 shows the proportion of the total savings achieved with each stage of the energy hierarchy for developments that were successful in meeting their on-site target for carbon emission reductions. It suggests that:

- Residential and mixed developments have relied on CHP for the major part of their required carbon emissions reduction. This is appropriate for medium and large developments because there is likely to be a stable aggregate heat demand profile; the CHP will have high running-hours to satisfy this heat demand.
- Non-domestic developments have, by contrast, made much more use of energy efficiency and renewables, in particular photovoltaics, and there is a much smaller contribution from CHP as there tends to be less stable heat demand profile, making CHP less attractive.
- The non-domestic category includes a range of different building types with different characteristic demand profiles: ‘small’ (very high use of renewables to meet targets) includes a lot of schools; ‘medium’ (renewable and energy efficiency) is a mix including hotels; ‘large’ (predominance of energy efficiency) has a high proportion of offices.

Figure 7: Proportion of savings at each stage in the hierarchy for successful developments



Bibliography

The London Plan, Mayor of London, March 2015

Energy Planning: Greater London Authority guidance on preparing energy assessments, Greater London Authority, March 2016

London Heat Map - www.londonheatmap.org.uk/

Supplementary Planning Guidance (SPG) on Sustainable Design and Construction, Mayor of London, April 2014

District Heating Manual for London, Mayor of London supported by Intelligent Energy Europe, February 2013[28]

London's Zero Carbon Energy Resource – secondary heat, Mayor of London, July 2013

Homes for London: The London Housing Strategy – Draft for consultation, Mayor of London, November 2013

International Energy Agency District Heating and Cooling programme: www.iea-dhc.org

[28] Available at: www.londonheatmap.org.uk

Appendix 1

Glossary

Building Emissions Rate (BER) or Dwelling Emission Rate (DER) is the actual building/dwelling CO_2 emission rate. In order to comply with Part L of the Building Regulations, the BER/DER must be less than the TER (see below).

Combined Heat and Power (CHP) is defined as the simultaneous generation of heat and power in a single process. The power output is usually electricity, but may include mechanical power. Heat outputs include hot water for space heating or domestic hot water production.

CHP Electrical Capacity (CHPe) is the maximum power generation capacity of CHP.

Communal heating is a general term for a shared heating system where heat is supplied to multiple dwellings and/or non-domestic buildings using pipes containing hot water.

kilowatt (kW) – One thousand watts. A watt is a measure of power.

Megawatt (MW) – One million watts. A watt is a measure of power.

Part L of the Building Regulations – Approved documents L1A and L2A of the Building Regulations relate to the conservation of fuel and power in new dwellings and new buildings other than dwellings respectively.

Regulated CO_2 emissions – The CO_2 emissions arising from energy used by fixed building services, as defined in Approved Document Part L of the Building Regulations. These include fixed systems for lighting, heating, hot water, air conditioning and mechanical ventilation.

Simplified Building Energy Model (SBEM) is a computer program that provides an analysis of a building's energy consumption. The purpose of the software is to produce consistent and reliable evaluations of energy use in non-domestic buildings for Building Regulations compliance.

Site heat network – a set of flow and return pipes circulating hot water to the apartment blocks (and apartments contained therein) and non-domestic buildings on a development.

Standard Assessment Procedure (SAP) is a methodology for assessing and comparing the energy and environmental performance of dwellings. Its purpose is to provide accurate and reliable assessments of a dwelling's energy performance that are needed to underpin building regulations and other policy initiatives.

Target CO_2 Emission Rate (TER) is the minimum energy performance requirement for a new dwelling/building. It is expressed in terms of the mass of CO_2 emitted per year per square metre of the total useful floor area of the building (kg/m^2/year).

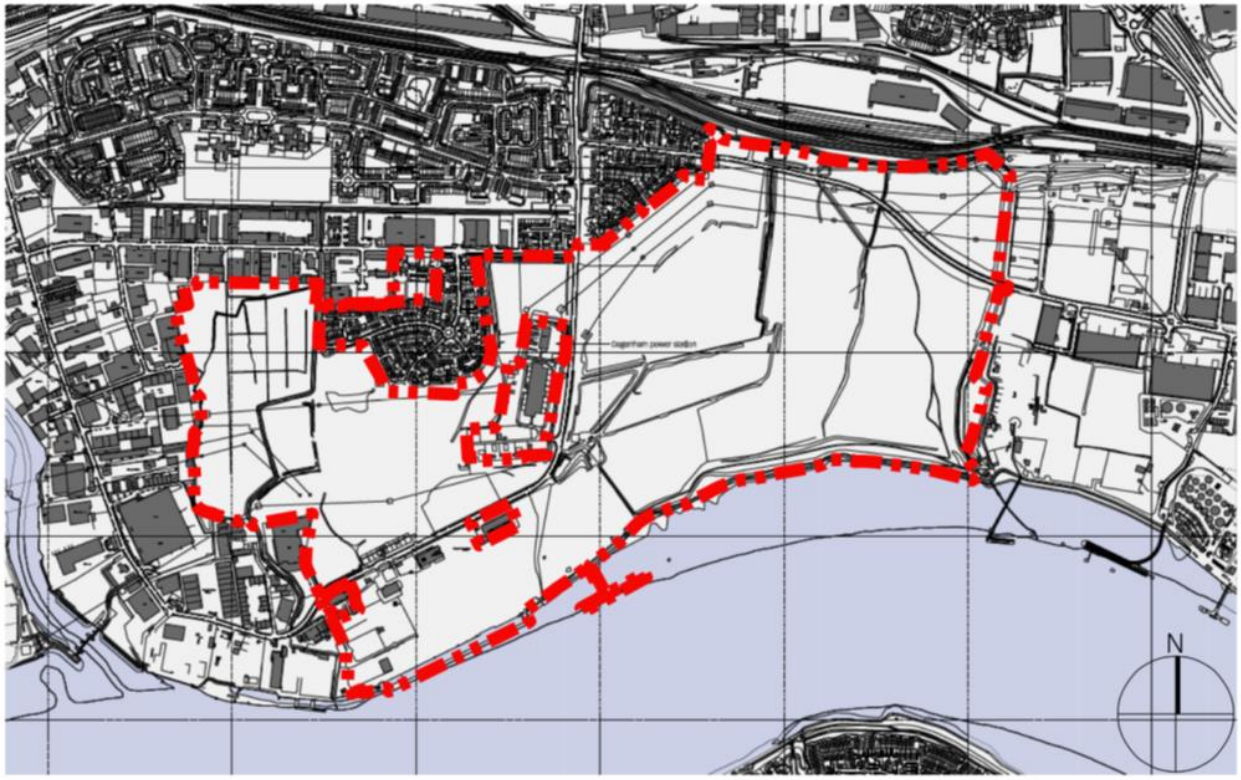
Appendix 2

Case Study 1: Barking Riverside, Barking & Dagenham

The Barking Riverside site is a large development area where up to 10,800 homes and floorspace for non-domestic buildings substantially exceeding 140,000m^2 are envisaged, all supplied by a heat network with CHP that could potentially also connect other buildings and join another proposed heat network in the vicinity.

The Barking Riverside site occupies 179.3 hectares and extends along the Thames for approximately 2km. It occupies the site of a former landfill site and power station foundations. The principle of the development is for the creation of a sustainable mixed-use community, in line with strategic priorities set out in the London Riverside Opportunity Area Planning Framework, the London Plan and local policies. A reduction of 5400 tonnes of CO_2 per year in regulated emissions compared to a 2013 Building Regulations compliant development is expected, equivalent to an overall saving of 35 per cent.

Figure 8: Plan of Barking Riverside development area



The full development of this site will be rolled out over a period of over fifteen years. By then, it is expected to comprise a mix of up to 10,800 residential dwellings, up to 65,600 m^2 of non-domestic floorspace for commercial and community buildings, including retail, community buildings, and sui-generis live work units, and additional built floorspace for an

8-form entry secondary school, and two 2-form entry primary schools. Requiring ongoing remediation, the site will also host an ecology centre and improved ecological reserves, including the retention of a city farm.

Dwellings will feature a range of passive design features and demand reduction measures, with both air permeability and heat loss parameters to be improved beyond the minimum backstop values required by the building regulations.

The risk of overheating in the dwellings will be minimised through overhangs, shading from balconies and designing for cross ventilation. The development is estimated to achieve through energy efficiency measures alone a reduction of 1200 tonnes per annum (8 per cent) in regulated CO_2 emissions compared to a 2013 Building Regulations compliant development.

The development is to be served by a site heat network, and an indicative route has been set out linking all buildings. A heat network is an ideal energy solution for such an extensive development, and it could become a catalyst for an area wide district heating network that also provides heat to external developments. The site is situated within a district heating opportunity area, and could eventually be connected to the proposed Barking Town Centre heat network.

Figure 9: Aerial model of Barking Riverside development area

The site heat network will be supplied from a single large energy centre, 620m^2 in size, accommodating a 7 MWe gas-fired CHP unit as the lead heat source for the site heat network. The CHP is sized to provide the domestic hot water load, as well as a proportion of the space heating. A reduction in regulated CO_2 emissions of 4200 tonnes per annum (27 per cent) will be achieved through this second part of the energy hierarchy.

This development reaches its overall target of 35 per cent beyond Part L 2013, through the combination of energy efficiency measures and the installation of a site heat network with CHP.

Case Study 2: Hackbridge School, Sutton

Hackbridge School is adjacent to the ground breaking BedZed development. In aspiring to be zero carbon and Passivhaus certified it exceeds the existing target of 35 per cent beyond Part L 2013, and reaches the zero carbon target that is currently in place only for new residential developments, and which will be extended to non-residential developments in 2019 without offsetting emissions. While the site uses some gas for hot water, it is net carbon positive as a result of exporting its solar electricity generation.

Hackbridge School is the only development assessed as part of this report achieving a 100 per cent reduction in carbon emissions. The opportunity will be taken to integrate principles of sustainability into their curriculum, with active travel, growing food, and reducing waste featuring alongside minimising energy consumption.

The proposed development is for a new two-storey primary school for 420 pupils that will also have out-of-hours community use. Permitted to proceed due to very special circumstances, the site for the school is on Metropolitan Open Land (MOL) that is part of the Wandle Valley Regional Park. The site is also recognised as a site of importance for nature conservation (SINC) with safeguarded minerals beneath part of it.

The site will be constructed of materials that have low embodied energy and are easy to maintain. Together with design principles to maximise daylighting and fresh air, this approach also provides a healthy internal environment.

The risk of overheating will be minimised through external shading (brise-soleil and vertical fins), blinds and mixed mode ventilation. Additional measures to minimise the risk of overheating include incorporating lower g-values (a measure of how much solar heat is allowed in through the windows) and increased air flow rates into the design of the school.

Having minimised their energy needs, their use of renewable energy technologies enables them to achieve a zero carbon development. The school plans to integrate a 900m^2 PV array (102 kWp) and also install a ground source heat pump (GSHP). The latter will be a closed loop system using a borehole field, with a nominal peak heating capacity of 65 kW for space heating. The GSHP system will provide 100 per cent of the space heating demand and 25 per cent of the Domestic Hot Water (DHW) demand.

Figure 10: Plan of the proposed development of Hackbridge School

Figure 11: BedZed is next door to the proposed Hackbridge School

Figure 12: Southern elevation of the proposed Hackbridge School

Case Study 3: Westferry Printworks, Tower Hamlets

This case study is an example of a mixed use development achieving the required carbon emission reductions beyond Part L 2013 through all three steps in the energy hierarchy.

The planned redevelopment at the Westferry Printworks involves the demolition of the existing printworks and associated buildings, and the construction of nine buildings of up to thirty storeys. These will accommodate 737 residential units and a six-form entry secondary school, together with ground-floor commercial floorspace and flexible office and business use.

Located within a 6 hectare area on the Isle of Dogs, the site faces south onto the Millwall Outer Dock, within a number of strategic views and river prospects as identified in the Mayor's London View Management Framework, and is within the wider setting of the Maritime Greenwich World Heritage Site. It is also close to a strategically significant part of London's world city offer for financial, media and business services.

The site lies within the Isle of Dogs and South Poplar Opportunity Area, as identified in the London Plan. Such areas have been identified as having significant capacity to accommodate new residential and non-domestic developments linked to potential improvements in public transport accessibility. At the local level, the site is allocated for mixed-use housing-led redevelopment.

Significant contributions from each step of the London plan hierarchy lead to the development substantially exceeding the target for carbon emissions reduction of 35 per cent beyond Part L 2013 of the Building Regulations. The development is therefore a good example of a successful approach for large mixed use developments involving all three steps of the hierarchy.

The development meets a carbon reduction of 43 per cent beyond Part L, with energy efficiency measures contributing16 per cent. All parts of the development are designed with high specification walls and windows with high U and G-values, together with mechanical ventilation with heat recovery (MVHR) serving both the commercial areas and the school, and also fitted within each of the apartments. Lighting systems will be based primarily on LED luminaires fitted with controls for automatic dimming.

The use of MHVR minimises cooling as well as heating loads. A further measure to reduce the risk of overheating is the inclusion of facades to the residential buildings and towers, designed to minimise penetration of solar radiation in summer while allowing transmittance at low sun angles. This is achieved by using full height windows to maximise daylight and balconies to provide summer shading.

Two-thirds of the residential units will have dual aspect to encourage cross-ventilation; ground floor apartments will be equipped with metal grilles for security while allowing for natural ventilation. Additionally there will be a mix of brown and green roofs; as well as increasing biodiversity and assisting water management, this will also help to moderate the building temperature.

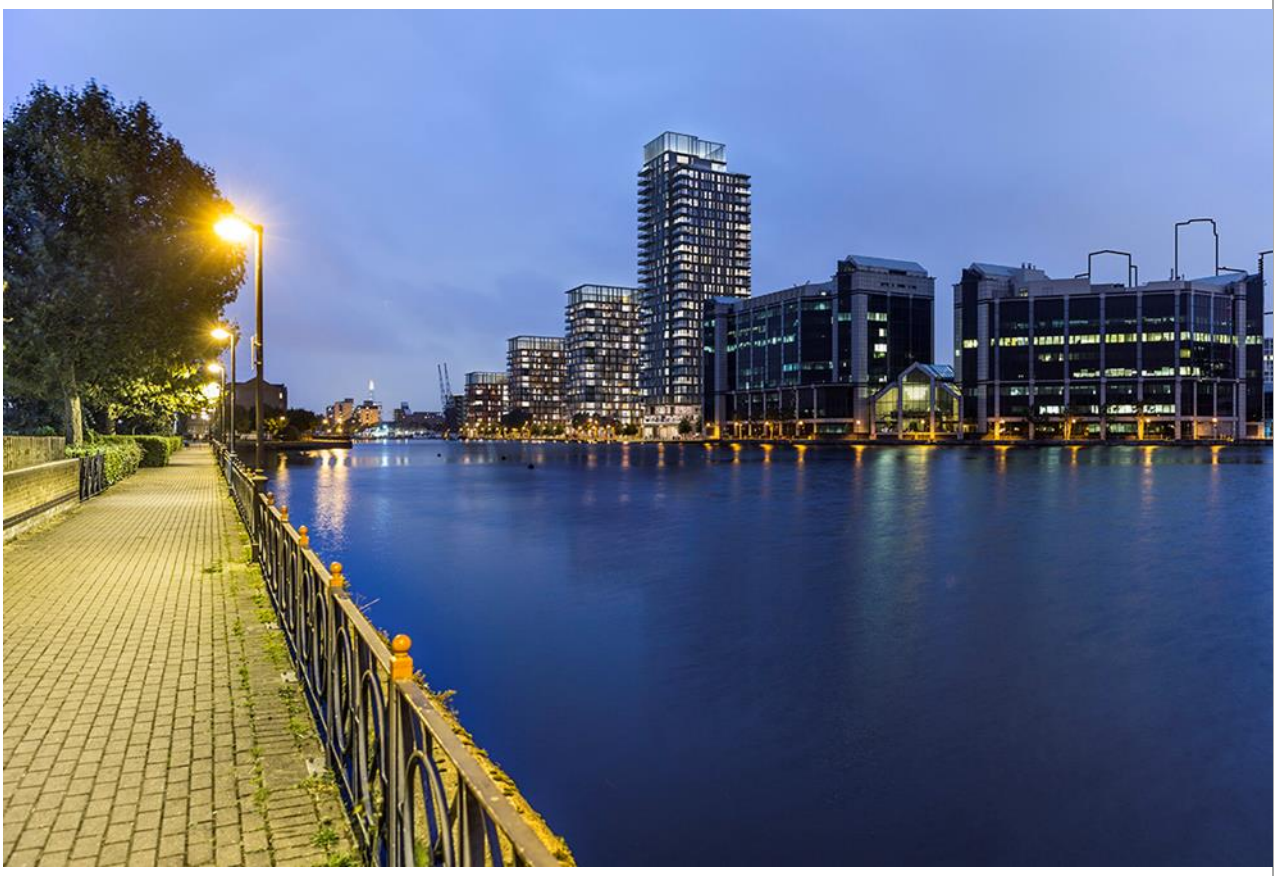
The development will have a site heat network with CHP supplying the base heat load; this will contribute a further 21 per cent to the overall carbon emission saving. Two CHP units (100kWe and 174kWe) are proposed, to align with the phased build-up of the development. The energy centre will accommodate thermal storage which will also contribute to the overall energy efficiency of the system, and will help to maximise the run-hours of the CHP.

The Westferry Printworks is situated adjacent to the Barkantine District Heating Network. The Barkantine currently has insufficient capacity to take on substantial extra heat demands; however the Westferry development will be equipped with a convenient tapping point to enable later connection should this situation change.

This development will also secure a meaningful contribution (6 per cent) from renewable energy technologies, by means of 814 PV panels (220kWp) to be installed on the residential buildings together with a further 314 panels (55kWp) on the school.

Figure 13: Site of the proposed Westferry Printworks redevelopment

Figure 14: Westferry Printworks development by night



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