MAYOR OF LONDON

Energy Monitoring Report

Monitoring the implementation of London Plan energy policies in 2017

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Executive summary

All cities have a responsibility to minimise their impact on climate change while providing the homes, workplaces and amenities that their residents need. The Mayor's target for London to be a zero carbon city by 2050 is London's response to that challenge. In practice, this means that all new buildings will need to be designed, built and operated within a zero carbon framework.

The London Plan[1] contains a range of targets and policies that new major developments are required to comply with, including those covering carbon emissions and energy consumption. These targets have been progressively strengthened over time and, since October 2016, applications for new major residential developments have been required to meet the Mayor's target for zero carbon homes[2]. This will be extended to all major non-residential development when the new London Plan is adopted (expected to be 2019), contributing to the Mayor's zero carbon ambition for London.

This report

This report presents the outcomes secured in 2017 from implementing the current London Plan energy policies for new development, covering the 129 strategic planning applications approved by the Mayor in that year. It focuses on the expected carbon emissions reductions[3] and low carbon energy infrastructure commitments secured from developers as a result of compliance with London Plan policy. It also provides details of how developers intend to achieve those carbon savings, including through energy efficiency measures, installation of heat network infrastructure and renewable energy sources such as solar photovoltaic (PV) panels 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 2017 is shown in Box 1.

Box 1 – key outcomes secured in 2017 across applications approved by the Mayor from implementation of London Plan energy policies
• A carbon emissions reduction[4] of 40.5 per cent more than required by the 2013 Building Regulations was secured. This comfortably surpasses the London Plan target of a 35 per cent reduction and is a notable improvement in performance compared to previous years.

[1] This document reports progress against the energy policies in the current London Plan and not the new draft London Plan (2017) which has not yet been adopted.

[2] Not all applications with residential elements that were approved in 2017 were required to meet the zero carbon homes target. This target only applies to those applications submitted on or after 1 October 2016.

[3] 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.

[4] This is regulated emissions, i.e. 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.

- In the domestic sector a 38.7 per cent reduction was secured, with a 41.6 per cent reduction secured in the non-domestic sector.
- A carbon emissions reduction of just over 37,000 tonnes per annum was secured. This is broadly equivalent to the savings achieved from retrofitting loft insulation in more than 60,000 existing houses.
- 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 15.8 per cent reduction in CO_2 emissions compared with Building Regulations, far exceeding the 2016 figure of 7.4 per cent.
  - Be Clean – over £55 million invested in heat network infrastructure and £6.7 million invested in CHP (approximately 9.6 MWe CHP capacity)
  - Be Green – more than £4 million invested in solar PV panels enabling more than 3.5 MW of new electricity capacity, and additional investment in other renewable energy technologies, most notably heat pumps (41 installations).

Overview of findings

In 2017, 129 applications were granted provisional permission by the local planning authority and were subsequently considered by the Mayor and approved. All these applications were assessed against the most recent national building regulations (specifically Part L 2013 of Building Regulations).

Overall performance against the Mayor's carbon reductions target improved considerably compared with the previous year. Cumulatively the overall reduction in CO_2 emissions is estimated to be 40.5 per cent more than required by Building Regulations, compared with 35.7 per cent in 2016. For non-domestic buildings the overall reduction was 41.6 per cent, while domestic buildings reached 38.7 per cent, both of which comfortably exceed the Mayor's target of a 35 per cent carbon reduction against Building Regulations.

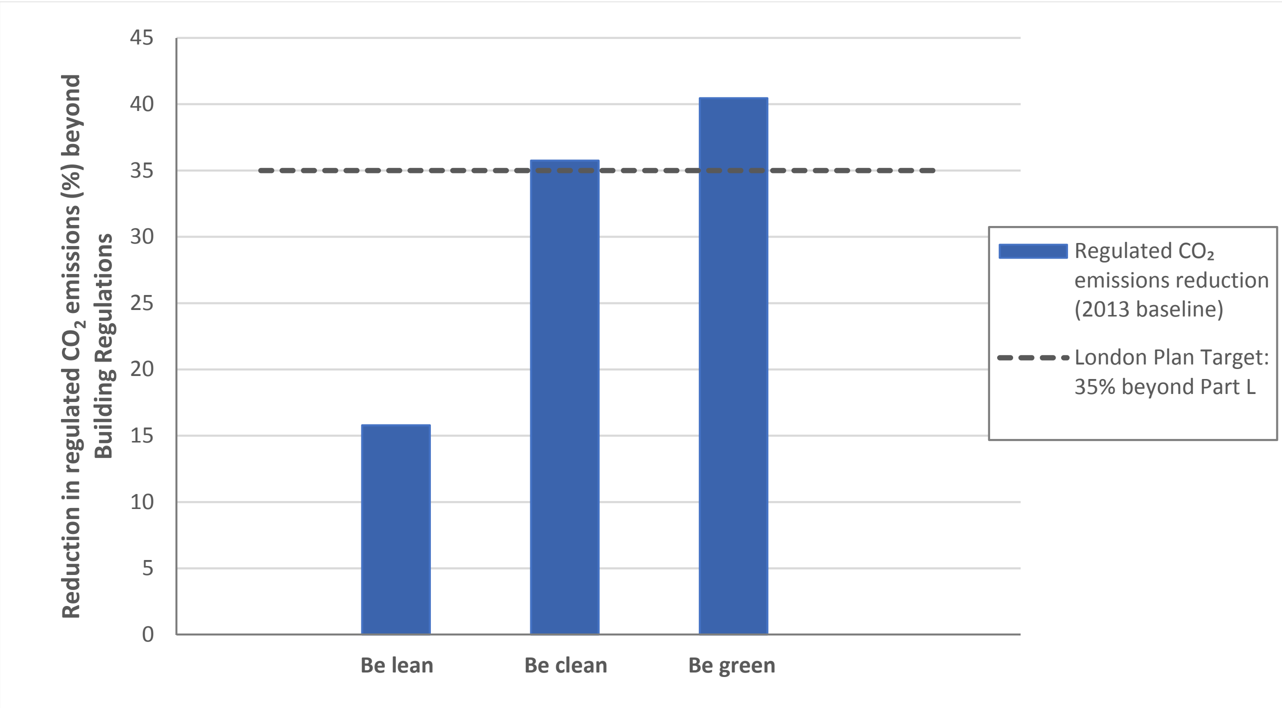
Of the applications approved by the Mayor in 2017, 23 included a residential element and therefore were required to meet the zero carbon homes target[5] by achieving at least a 35 per cent reduction in carbon emissions on-site, and to make a carbon offset payment for any shortfall. Of these 23 developments, an overall saving of 39.7 per cent was achieved. This compares favourably to a 36.7 per cent saving for the 56 applications with a residential element that were submitted before the zero carbon homes policy took effect on 1 October 2016 (and were therefore only required to meet the 35 per cent target). It is too early to confirm whether this increase signals a shift on the part of developers to seek increased emissions reductions on-site but this is a move in the right direction.

Developers are required to follow the Mayor's energy hierarchy, set out in the London Plan, to meet the carbon reduction target. By following the hierarchy, applications

[5] These applications were submitted on or after 1 October 2016 and were therefore required to meet the zero carbon homes policy. Any applications with residential elements submitted before this date were not subject to the zero carbon homes policy and instead were required to meet the previous target of a 35 per cent carbon reduction beyond Building Regulations.

submitted in 2017 have continued to demonstrate a range of energy solutions based on combinations of energy efficiency and low and zero carbon technologies. The average regulated CO_2 emissions after each stage of the energy hierarchy for all 2017 strategic applications is shown in Figure 1, and the case studies in Appendix 2 demonstrate some of these different approaches.

Figure 1: Cumulative CO_2 emission reductions secured at each stage of the London Plan hierarchy in 2017



The average savings arising from Be Lean (energy efficiency), the first stage of the hierarchy, more than doubled in 2017 compared with 2016, with all but 3 of the approved applications meeting or exceeding the Building Regulations through energy efficiency alone. This indicates that developers are becoming more proficient in selecting and combining suitable energy efficiency measures. Examples include, enhanced insulation and air tightness to reduce heating demand, mechanical ventilation with heat recovery, low energy light-emitting diodes (LED) lights, and design features that minimise energy demand associated with cooling.

Be Clean (supply energy efficiently), the second stage of the hierarchy, contributed the largest proportion of overall savings, although its contribution was reduced from 23.2 per cent in 2016 to 20 per cent in 2017. These savings are primarily derived from the installation of new gas-engine CHP capacity (75 per cent) with the remainder arising from connection to a local District Heating Network (DHN) usually supplied by gas-engine CHP, biomass boilers and/or waste heat.

The lower Be Clean contribution in 2017 may be explained by more of a focus being placed on the first part of the energy hierarchy and a reduction in average size of CHP installation. In general, larger schemes offer more diversity of load and are more likely to justify the inclusion of CHP. In light of this, and the growing concerns regarding the air quality impacts of gas-engine CHP, we will be engaging more closely with developers on the appropriateness of CHP for small sites going forward.

In addition, as the carbon emissions from grid electricity generation decrease, the savings achieved by gas-engine 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 use other forms of heat generation, such as heat pumps, which are lower carbon and will not worsen air quality, particularly in London's 187 Air Quality Focus Areas.

Almost 85 per cent of applications deployed renewable energy, with the overall contribution from this third stage of the hierarchy (Be Green) remaining stable. Deploying renewable energy technologies enabled 31 developments to extend their overall savings sufficiently to reach or exceed the carbon reduction target.

For any development that does not meet the applicable carbon reduction target the developer is required to make up for the shortfall in emissions, either through a cash-in-lieu contribution to a borough's carbon offset fund or by funding an off-site measure. The aggregate carbon emissions shortfall for zero carbon home developments was 4,870 tonnes, leading to a contribution to offset funds and investment in off-site measures of approximately £8.7 million, assuming an indicative CO_2 price of £60 per tonne[6] and a 30-year lifetime.

For all other developments that did not meet the 35 per cent carbon reduction target[7], this amounted to 2,069 tonnes of regulated CO_2 emissions per annum, slightly less than the 2016 figure of 2,298 tonnes. This shortfall equated in 2017 to approximately a £4.39 million contribution to offset funds.

Conclusions

The implementation of London Plan energy policies in 2017 has resulted in:

- Overall, developers committed to an average carbon reduction of 40.5 per cent beyond Building Regulations; comfortably exceeding the target of a 35 per cent reduction and a notable improvement on previous years.
- Residential developments where the zero carbon target applied achieved a 39.7 per cent reduction compared to a 36.7 per cent reduction where the zero carbon target did not apply.
- Developers committed to greater carbon reductions from energy efficiency than required by Building Regulations, achieving on average a 15.8 per cent improvement which was more than double the corresponding figure for 2016. This is driving investment in energy efficiency and is estimated to result in an energy cost savings of approximately

[6] £60 per tonne of CO_2 is the GLA's recommended carbon offset price. The new draft London Plan (2017) includes a new carbon offset price of £95 per tonne of CO_2. Alternatively, boroughs can set their own local carbon offset price.
[7] Some boroughs collect offset payments when this target is missed.

£120,000 per annum as a result of London Plan policy, which otherwise would have been paid by residents.[8]

- It is estimated that London Plan energy policies resulted in £55 million[9] investment in heat network infrastructure for the dwellings connecting to site-wide heat networks and £6.7 million[10] in CHP capacity in 2017.
- 18,575 dwellings (78 per cent of the total dwellings receiving approval) committed to a heat network connection.
- A total of 74 developments proposed to meet a proportion of their energy requirements through on-site gas-engine CHP. Of these, 29 cite connection to a local DHN, usually supplied by gas-engine CHP, biomass boilers and/or waste heat.
- 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 is broadly stable, reflecting the acceptance of these technologies.
- Offsetting shortfalls in emissions remains necessary and will continue to play a role in future planning applications.[11]

Overall, 2017 has seen a significant and welcome shift in the average carbon reductions being committed to by new development in London. The zero carbon target (now in place for residential buildings and due to be extended to all developments when the new London Plan is adopted, expected to be 2019) will drive developers to build on performance to date and to seek innovative solutions to meeting these targets and the Mayor's aim for London to be zero carbon by 2050.

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[8] 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.

[9] 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). Non-domestic buildings will require additional investment.

[10] Assuming an installed capital cost of £700 per kilowatt of electrical capacity for the 9.59MW of CHP electrical capacity committed to in 2017, i.e. 700 x 9.59 x 1000 = £6,713,000.

[11] The GLA has published a Carbon Offset Funds guidance document for boroughs which is available on the GLA's website.

1. 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 individual buildings to those involving thousands of new homes and mixed-use developments that will be delivered over several years and through a series of phases. 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),[12] 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 local capacity building both for the construction of new buildings and homes, and 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 reductions 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, increasing resilience to future climate and energy supply changes, building supply chains for energy efficiency and low carbon technologies and catalysing new, area-wide district heat networks.

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 version of the London Plan is expected to be adopted in 2019.

[12] https://www.london.gov.uk/what-we-do/planning/planning-applications-and-decisions/what-powers-does-mayor-have-planning

Current 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. 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 of new development on the energy network.

The London Plan carbon reduction targets are minimum improvements over the carbon targets[13] set for buildings in the 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 of changes to the baseline. A target of 35 per cent beyond the new national standards across both residential and non-domestic buildings was then applied by the Mayor. Subsequently, the target for new major residential developments[14] was raised to zero-carbon from 1 October 2016.

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 make a cash-in-lieu contribution to the borough's carbon offset fund, or install a carbon saving measures off-site in agreement with the local borough 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 the delivery of carbon dioxide savings elsewhere.

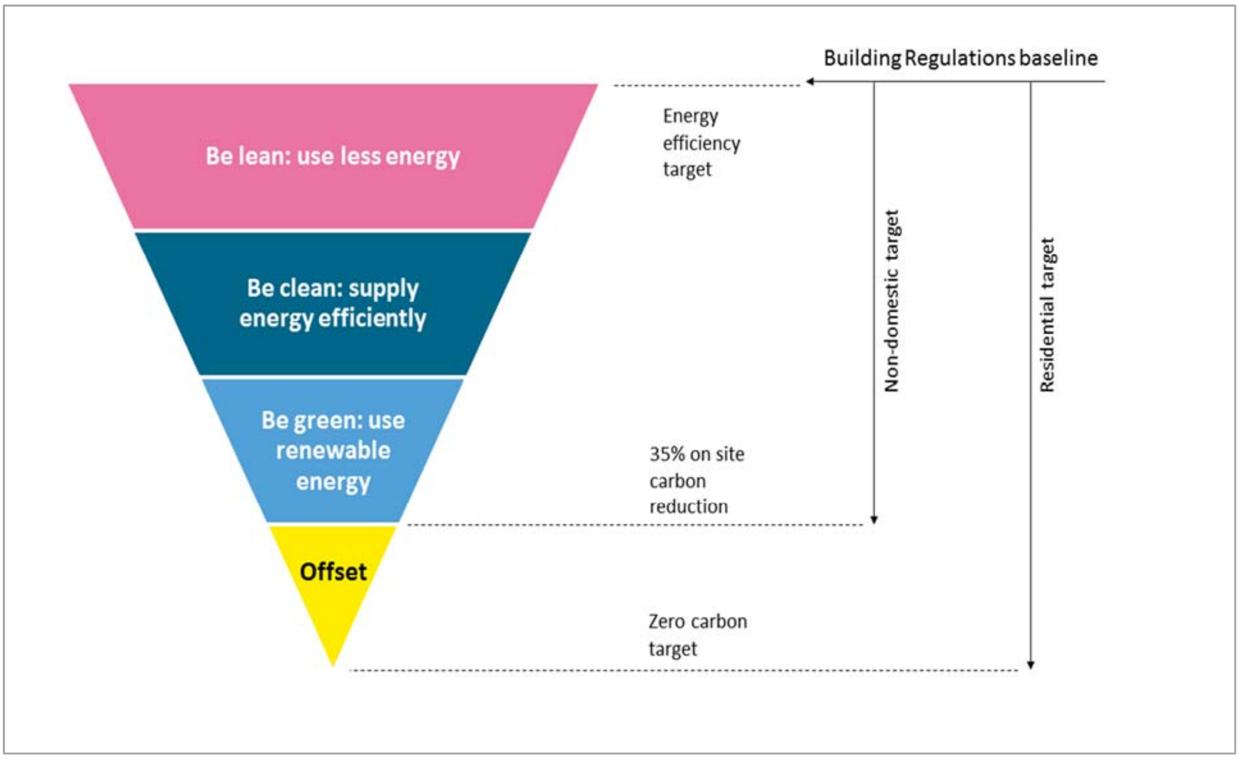
Energy policies

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 (Figure 2).

[13] Target Emission Rates outlined in Part L of Building Regulations.
[14] Developments comprising of ≥10 units.

Figure 2: The Energy Hierarchy



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.[15] Each energy assessment is evaluated by a dedicated GLA energy planning team to ensure compliance with 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 relating to individual developments and the opportunities and constraints that apply in each case.

The case studies in Appendix 2 demonstrate how the energy hierarchy can be applied to, and met, by very different types and sizes of developments, to meet the carbon reduction targets.

Be Lean: use less energy

The most effective initial approach to reducing energy consumption is to ensure that energy demand is minimised through high quality building fabric and installing effective energy efficiency measures.

[15] http://www.london.gov.uk/priorities/planning/strategic-planning-applications/preplanning-application-meeting-service/energy-planning-gla-guidance-on-preparing-energy-assessments

New developments are required to incorporate passive energy efficiency measures, such as optimising orientation and site layout, natural ventilation and lighting and thermal mass, to minimise the demand for energy for heating and cooling. In addition, to enhance 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, in line with Policy 5.3C which sets out a range of sustainable design principles.

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[16] below those of a Building Regulations compliant development through energy efficiency alone. The new draft London Plan proposes to drive further improvements by expecting residential developments to aim for a 10 per cent reduction and non-residential to aim for a 15 per cent reduction in regulated emissions over Building Regulations through energy efficiency measures. Once these new targets are adopted (expected to be 2019) developers will be required to put in place more innovative and ambitious measures.

Energy efficiency measures often focus on reducing heating demand but energy consumption should also be minimised to meet cooling demands. Energy consumption due to cooling demand 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 at the detailed design stage and is mitigated against appropriately.

Measures to reduce overheating included use of low temperature LED lighting and optimisation of the 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: supply energy efficiently

Policy 5.5 of the London Plan prioritises the development of heat networks at the development and area-wide levels accordingly. The delivery of district heating networks in London is supported through the planning process by prioritising connection to existing

[16] Regulated emissions include those associated with the energy consumed in the operation of the space heating/cooling and hot-water systems, ventilation and internal lighting.

networks and requiring the implementation of site-wide heat networks, where appropriate, in new developments which are the subject of strategic planning applications.

In London, new developments have an important role to play in catalysing the emergence of area wide low carbon heat networks that can facilitate the use of waste heat e.g. from sewers and the River Thames. 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.

Be Green: use renewable energy

Developers should use renewable energy on-site to meet the requirements of the London Plan; for example, boroughs should ensure that all developments maximise opportunities for on-site electricity and heat production from solar technologies (photovoltaic and thermal).

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 by means of on-site renewable energy generation.

Offsetting any shortfall in carbon emissions

On-site carbon reductions are expected to be maximised before an offset arrangement is considered, with all developments expected to achieve at least a 35 per cent reduction in carbon emissions on-site. Once the GLA is satisfied that this has been done, developers can either make a cash-in-lieu contribution to the borough's carbon offset fund or install carbon saving measures off-site in agreement with the borough.

While most boroughs use the nationally recognised carbon offset price of £60/tonne, boroughs can also undertake their own studies to determine the cost of offsetting locally and set their own prices. The new draft London Plan, which is expected to be adopted in 2019, introduces a new carbon offset price of £95/tonne.

2. Implementation

Overall 2017 results

A total of 137 applications were considered by the Mayor in 2017 and were approved. Of these, 6 applications had no regulated energy uses (these include, for example, a quarry); a further application contained no energy assessment, and one section 73 application[17] had no significant energy amendment. These are all excluded from this analysis leaving a total of 129 applications (Table 1). There were also 24 additional applications that were refused by the local planning authority but not taken over by the Mayor in 2017.

Table 1: Total number of developments (including dwellings and floor area) approved by the Mayor in 2017

Type of development	Number of developments	Number of dwellings	Non-domestic floor area (millions m^2)
Mixed-use[18]	65	21,127	0.4
Domestic	14	2,651	N/A
Non-domestic	50	N/A	1.1
Total	**129**	**23,778**	**1.5**

Overall regulated CO_2 reductions

During 2017, the compliance of new development with London Plan energy policies resulted in a cumulative regulated CO_2 emissions reduction of 37,053 tonnes per annum. This is broadly equivalent to the savings achieved from retrofitting loft insulation in approximately 60,000 existing houses.[19] The saving is significantly lower than in 2016, but this can be explained by the smaller number of applications (129 compared to 142 in 2016) and the smaller size of development for residential and mixed-use applications, meaning that the baseline emissions figure is much smaller to start with.

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 2017.

[17] An application can be made under section 73 of the Town and Country Planning Act 1990 to vary or remove conditions associated with a planning permission.
[18] All these developments have a residential and commercial component.
[19] 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 approved in 2017 and assessed against the target of a 35% improvement on Part L of 2013 Building Regulations

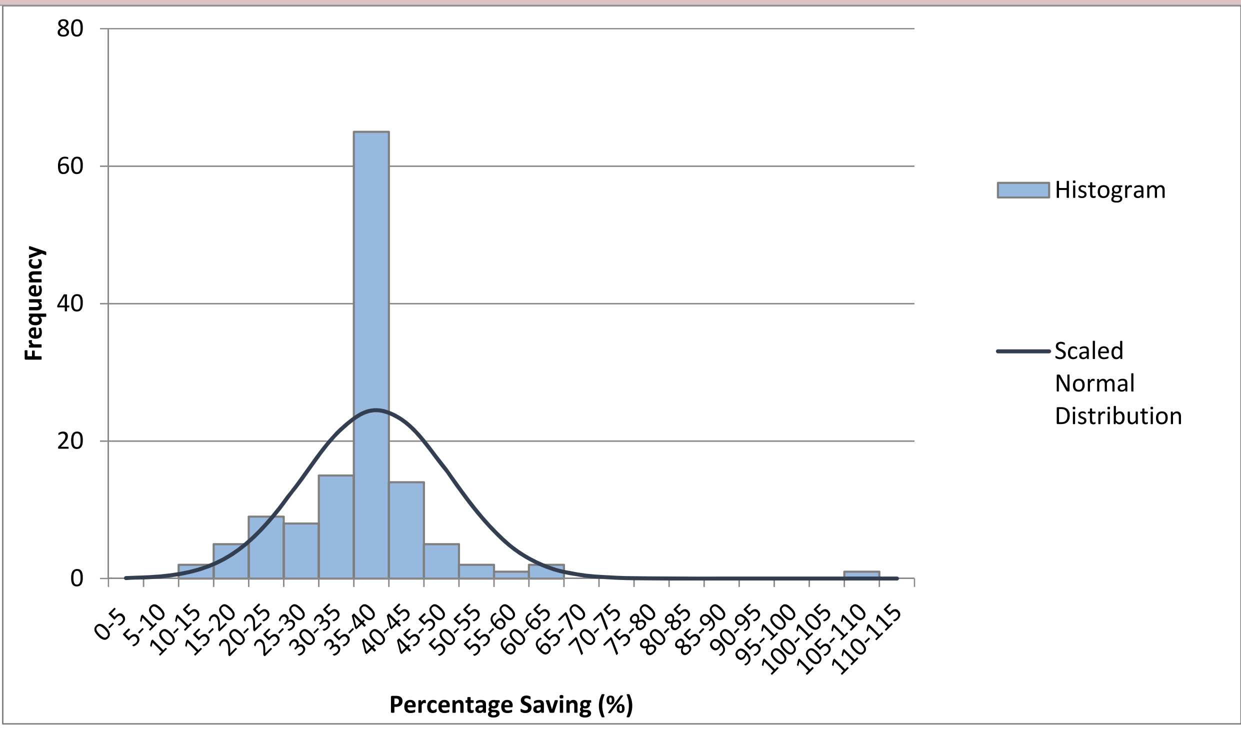
	Regulated CO_2 emissions	Cumulative regulated CO_2 emissions reductions relative to Part L 2013 Building Regulations	
	(tCO_2/year)	(tCO_2/year)	(per cent)
Baseline	91,597	-	-
After energy efficiency	77,141	14,456	15.8
After energy efficiency & heat networks	58,853	32,744	35.7
After energy efficiency, heat networks & renewables	54,544	37,053	40.5

The percentage savings made by developers in 2017 have significantly increased compared to previous years with an average carbon reduction of more than 40 per cent beyond Part L 2013, which comfortably surpasses the 35 per cent target. With the exception of three applications, developers have been able to meet the Part L 2013 target with energy efficiency only.

23 applications were required to achieve the zero carbon homes target. On average the residential elements within these applications achieved a 39.7 per cent reduction compared to a 36.7 per cent reduction where the zero carbon target did not apply. This goes some way to explain the improvement but not entirely, as there were also non-domestic applications that were able to significantly exceed their 35 per cent target, as evidenced by the average 41 per cent reduction for non-domestic applications. This demonstrates there has been a general trend across development types to put in place energy strategies that deliver higher carbon savings, and indicates that developers may be becoming more adept at selecting and combining suitable energy efficiency measures.

Figure 3 shows the range and distribution of the savings. The data here is presented as savings achieved by individual developments (as opposed to the overall carbon reduction figure). Most developments achieved savings in the range of 35 - 40 per cent.

Figure 3: Total carbon savings for developments approved in 2017 (bars represent the number of cases within each percentage saving group)



The most prominent outlier, achieving over a 105 per cent reduction in carbon emissions beyond Building Regulations, is a very small (1100 m^2) development comprising a school in Bexley that integrates a relatively large area of PV and achieved zero carbon status without offsetting. There were also two outlier groups of developments. The first is a highly performing group (at 60 - 65 per cent saving) comprising 6 mostly mixed-use developments for which the dominant stage was Be Clean and which achieved on average a 43 per cent saving.

By contrast there were 14 cases (7 non-domestic, 6 mixed-use, 1 residential) making up a group achieving only 15 - 25 per cent. Here, there was a notably small contribution from Be Clean; 3 per cent on average. Both these outlier groups achieved similar contributions from Be Lean (10 – 12 per cent); and from Be Green (4 – 6 per cent).

Figure 4 illustrates the cumulative percentage savings at each step of the hierarchy for applications approved during 2017, while figure 5 shows the relative contribution from each stage in the hierarchy.

Figure 4: Cumulative reductions secured in CO_2 emissions at each stage of the London Plan hierarchy assessed against Part L for developments approved during 2017

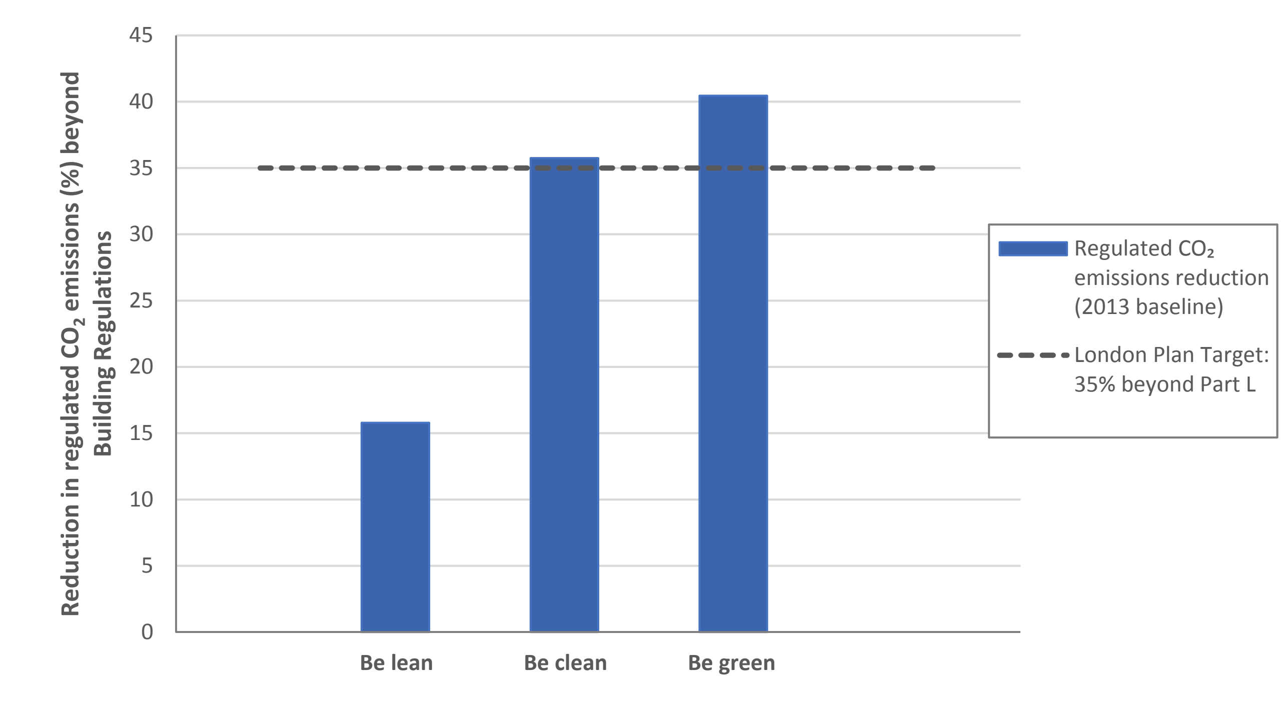
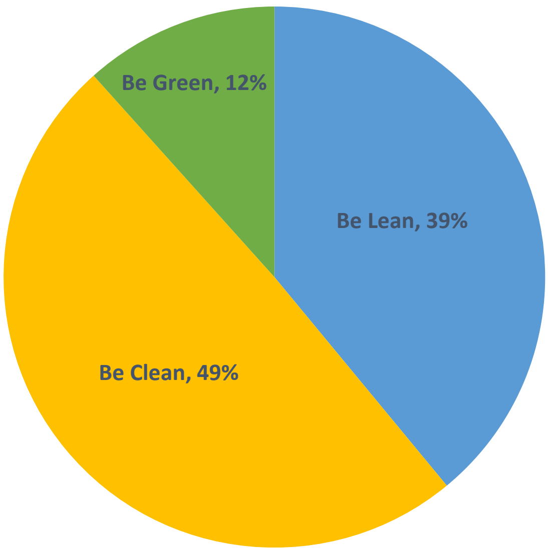


Figure 5: Breakdown of cumulative reductions secured in CO_2 emissions at each stage of the energy hierarchy



Additional CO_2 reductions from developments including refurbishment

Where developments involve significant building refurbishment, it is expected that an estimate of the CO_2 savings from the refurbishment 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 2017 there were no applications referred to the Mayor which comprised solely of buildings to be refurbished. GLA Energy Planning guidance provides further information on producing an energy strategy for major refurbishment projects.[20]

Targets

Table 3 sets out the London Plan targets that are currently in place. All 129 applications approved in 2017 were assessed against the same baseline of a 35 per cent carbon reduction beyond Part L 2013. For the majority of applications made in 2017 this remained the target, but for 23 applications with a residential element that were submitted on or after October 2016, the zero carbon homes target applied.

Table 3: London Plan carbon reduction targets	
Non-domestic	
Dates	Target
6th April 2014 – adoption of London Plan (expected 2019)	35 per cent beyond Part L 2013
2019 onwards	Zero carbon
Domestic	
Dates	Target
6th April 2014 – 30th Sept 2016	35 per cent beyond Part L 2013
1st October 2016 onwards	Zero carbon

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

Be Lean: use less energy

Be Lean reductions

On average, a 15.8 per cent reduction in regulated CO_2 emissions was achieved against Part L 2013 from the first step of the energy hierarchy; this was more than double the savings achieved in 2016. This is an encouraging result demonstrating compliance with the requirement to reduce energy demand first before considering low carbon or renewable technologies to achieve carbon savings. This also indicates that developers are becoming more proficient in selecting and combining available energy efficiency measures, including 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.

All but 3 of the 129 applications achieved the carbon reductions required by national Building Regulations alone through this first step of the energy hierarchy. Of these three, two were able to achieve the overall 35 per cent target; one was, however, approved on the condition that they undertook further measures to increase energy efficiency. The development that failed on both counts included a significant refurbishment element, but the new-build part did reach the energy efficiency requirement.

Residential elements within developments achieved 7.1 per cent on average from energy efficiency alone, while non-domestic elements achieved 19.2 per cent. This is encouraging considering that the new draft London Plan (once adopted) will seek to drive further improvements by requiring residential developments to aim for a 10 per cent reduction and non-residential to aim for a 15 per cent reduction over Building Regulations.

Overheating and cooling demand

A total of 6.2 GWh per annum of cooling demand is expected from the 68 developments which provided data, an approximate 5 per cent decrease in cooling demand compared with 2016. Of this, 96 per cent is attributed to non-domestic buildings, in which the overall decrease in demand is 6.4 per cent. A total of 65 of the 113 cases with non-domestic floor area are proposing active cooling.

Although the overall cooling demand from the residential sector remains small it grew by 42 per cent in 2017. Although this may appear to be a significant increase, it should be noted that three exclusively residential developments have proposed active cooling in 2017; in 2016 there were none. A total of 8 of the 79 cases with residential units are proposing active cooling within some or all the dwellings; in 2016 there were 3.

We will continue to require cooling demand data from all developments in future to build up an evidence base of performance.

Be Clean: supply energy efficiently

Be Clean reductions

The 2017 applications achieved, through the Be Clean part of the energy hierarchy, a 20 per cent reduction on average in regulated CO_2 emissions against the relevant Part L baseline. This is lower than the equivalent figure for 2016 (23.2 per cent), but still indicates the importance in 2017 of CHP and DHN connections in meeting the carbon reduction targets.

The savings derived from the installation of new CHP capacity amount to 13,718 tonnes of CO_2 per annum, with a further 4,570 tonnes of CO_2 per annum arising from connection to a local DHN amounting to an overall total of 18,288 tonnes of CO_2 per annum.

The relative contribution to the overall reduction declined from 65 per cent in 2016 to 49 per cent in 2017. This has arisen partly because of the significant rise in the relative contribution due to energy efficiency, but also due to a reduction in average size of CHP installation, such that there were 59 per cent of CHP installations that were below 100kWe (compared with 49 per cent in 2016). In general, larger schemes offer more diversity of load and are more likely to justify the inclusion of CHP. In light of this, and the growing concerns regarding the air quality impacts of gas-engine CHP, we will be engaging more closely with developers on the appropriateness of CHP for small sites going forward.

Heat networks

In order to aggregate the heat demands from a group of individual buildings or dwellings at a site, a pipe infrastructure can be installed connecting each of these to a central heat source known as an energy centre. This infrastructure is known as a site-wide heat network. For larger developments, this may become the basis for a large area-wide DHN, which comprises similar infrastructure but at a larger scale, to which other developments in the vicinity may also be able to connect. DHNs at this scale already exist in parts of London, and there are plans being developed for more. In such areas of high heat demand density, developments are expected either to connect to existing heat networks or, where this is not currently feasible, to design site-wide networks for ease of future connection to a district wide scheme.

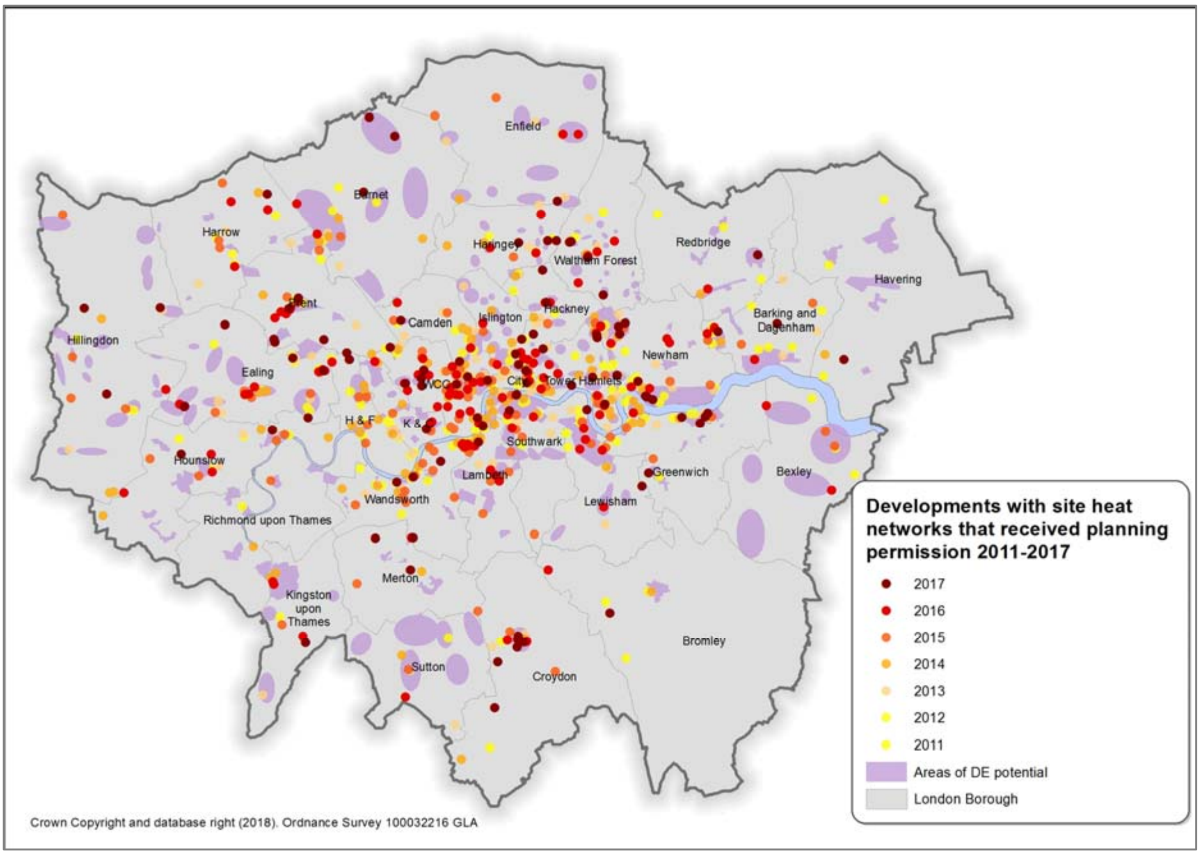
Site-wide heat networks

Out of 63 developments which have a domestic component and reached the on-site reduction target, 60 proposed a new site-wide heat network, with a total of 18,575 dwellings (78 per cent of the total dwellings receiving approval) expecting to connect. This ensures future flexibility in energy supply including possible connection to a wider heat network when this becomes possible. One of the developments that did not propose a site-wide heat network is the Trent Park site; this is a low-density development that also comprises a small number of residential units, so that a heat network was not viable, and there was insufficient demand for CHP.

More than half of the 33 non-domestic developments (out of a total of 50) that reached the on-site reduction target achieved their target without a site-wide heat network. These developments include those with small heat demands such as warehouses, where energy efficiency measures can have significant impact, and where there is likely to be extensive available roofspace for accommodating solar technologies, and schools where the heat demand profile is inconsistent due to their occupancy pattern.

Figure 5 illustrates the distribution of the developments which committed to providing site-wide heat networks between 2010 and 2017, mapped against identified areas of decentralised energy potential.[21] This shows that site-wide heat networks feature in boroughs across London, with greater concentration in the inner London boroughs, where the heat demand density will usually be higher and therefore more suitable for heat networks.

Figure 5: Distribution of developments committed to providing site-wide heat networks



Connection to District Heating Networks (DHNs)

Major new developments of any size that are close to a DHN should prioritise connection to that network. In 2017 there were 41 developments declaring a contribution from the second stage of the energy hierarchy, that propose connection either to an existing well-

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

established network such as the Olympic Park or, later on, to a planned heat network. There were a further 10 developments that do mention a nearby DHN, but do not include a corresponding carbon reduction.

Major new developments can promote the emergence of new DHN. Table 4 shows large new developments with more than 1,000 homes that obtained planning approval in 2017, all of which were mixed-use, and include a total of 5,616 dwellings. The energy infrastructure (e.g. site-wide heat networks) planned for these developments can be a key element in realising the plans for area-wide DHNs. Due to the scale of these developments they are inevitably multi-phase and often envisaged to take over a decade to complete.

Table 4: New large developments with > 1,000 dwellings obtaining planning permission in 2017

Development Name	Borough	Number of dwellings	Non-domestic floor area (m^2)	Total emission reduction (%)
Fairfield Masterplan	Croydon	2,427	100,000	64%
Former GSK site and Bakery site	Ealing	1,965	21,443	37%
Cherry Park	Newham	1,224	14,000	40%

Energy sources

A total of 41 developments committed to connect to an existing or proposed DHN; with 29 of these also proposing on-site CHP where the DHN is not currently in existence and connection is therefore a longer-term aim. The remaining 12 developments, with approximately 4,800 dwellings, derive their savings directly from connection to a local DHN that is either already existing (and usually supplied by gas-engine CHP, biomass boilers and/or waste heat) or under development, rather than from on-site CHP (Table 5). One of these developments, the former Perfume Factory in Ealing, appears as Case Study 2 (Appendix 2).

Table 5: DHN connection commitments

Network name	Existing/proposed	Number of developments connecting	
		With on-site CHP	DHN only
Croydon	Proposed	1	1
Excel	Existing	4	0
Wembley Masterplan	Proposed	1	0
South Acton	Proposed	1	0
Devon Wharf	Proposed	1	0
Church Street	Proposed	1	0
Olympic Park	Existing	2	3

Wandsworth RQ	Proposed	1	0
Old Oak & Park Royal Development Corporation (OPDC)	Proposed	2	2
Kilburn	Proposed	1	0
Whitehall	Existing	1	0
VNEB	Existing	2	0
LBBD	Proposed	2	0
Royal Arsenal	Existing	1	2
Lea Valley	Existing	3	1
Citigen	Existing	3	0
Ealing	Proposed	1	0
Hale Village	Existing	1	0
Colville Estate	Existing	0	1
Blackhorse Lane	Proposed	0	1
Pinnacle	Existing	0	1
	Network Total	**29**	**12**

A total of 74 developments proposed to meet a proportion of their energy requirements through on-site CHP; including the 29 which also proposed a DHN connection. Table 6 sets out the profile of CHP capacity for 73 of the 74 developments featuring CHP in 2017 (one development was unable to confirm the CHP size). While more than 80 per cent of the proposed aggregate electrical capacity arises from the middle and larger scale installations, nearly 60 per cent of the individual CHP installations are less than 100kWe. In general, larger schemes offer more diversity of load and are more likely to justify the inclusion of CHP depending on the development type.

In 2017 circa 9.6MW of new CHP electrical capacity has been proposed; a significant drop from 2016. As well as the decrease in developments utilising CHP, this can be explained in large part by the much lower number of very large developments in 2017.

As the carbon emissions from 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 use other forms of heat generation, such as heat pumps, which are lower carbon and won’t worsen air quality, particularly in London’s 187 Air Quality Focus Areas.

Table 6: Size distribution of CHP installations secured through planning in 2017

	Number of installations	Total electrical capacity (kWe)	Average size of installation (kWe)	Number of dwellings served	Non-domestic floor area (m^2)	Average number of dwellings served per installation	Average non-domestic floor area served per installation (m^2)
Less than 100kWe	43	1,764	41	5,154	331,080	120	7,700
100kWe to 499kWe	28[1]	6,421	230	11,479	445,753	410	15,900
500kWe and above	2	1,405	703	1,175	3,550	588	1,800
Total	**73**[2]	**9,590**	**131**	**17,808**	**780,383**	**244**	**10,700**

[1] One CHP uses liquid biomass.
[2] One further development committed to CHP, but the size is not confirmed.

Be Green: use renewable energy

Be Green reductions

Through the Be Green part of the energy hierarchy, an average 4.7 per cent reduction in regulated CO_2 emissions against the relevant Part L baseline was secured. This is slightly lower than the equivalent figure for 2016 (5.1 per cent) but the contribution of renewables to the carbon reduction targets has been broadly stable over the past few years (Table 7).

In 2017 the dominant renewable energy technologies remained solar PV and heat pumps. As the final element of the hierarchy, renewable energy technologies were responsible for nearly 12 per cent of the overall reduction. Despite this being the smallest reduction of the three elements, it remains an important additional enabling element for applicants to reach the target. A total of 109 developments (84 per cent) proposed to meet a proportion of their energy requirements by including renewable energy. Indeed, without their renewable energy component, 31 applications that successfully met or exceeded 35 per cent would have failed to do so.

A total of 100 developments proposed to include PV, accruing to a total installed area of 34,691m^2 and a corresponding total peak output of nearly 3.5MWe. Figure 6 shows by borough the total area of PV commitments in developments approved in 2017. The average commitment to PV per application in inner London boroughs was less than that in the outer London boroughs. However, this difference was markedly less than it was in 2016; it was in the outer boroughs where the average size per application fell most dramatically.

The total aggregate PV commitment in 2017 fell by approximately half compared with 2016. The total number of planning applications did fall; but this reduced aggregate arose primarily from a substantial decrease in the average size of PV array being proposed that in turn appears to be a result of a smaller average size of development. Specifically, there was a fall in average scheme size for residential developments compared with 2016; by contrast, the average size of non-domestic only developments remained approximately the same. However, in the case of the mixed-use developments, the same sharp decrease in scheme size was evident as with the residential developments.

The bigger PV installations were predominantly found on low-rise buildings such as schools and supermarkets. Other prominent cases included low-density residential developments that were not proposing CHP, and large mixed-use masterplans. The smallest uptake of PV was found on developments that were relying most on CHP; these included high rise residential developments where opportunities for solar technologies are limited.

A total of 41 applications specified heat pumps; 39 proposed Air Source Heat Pumps (ASHPs) with two Ground Source Heat Pumps (GSHPs) accounting for the remainder. However, the latter are much larger and account for a significantly higher heat output. The popularity of heat pumps has remained approximately the same as in 2016. Of the developments including heat pumps in their specification, 22 have also included CHP.

There were four cases of ASHPs exceeding 100kWe, all of which were serving non-domestic buildings. Of these, only one was proposing the ASHP to serve domestic hot water as well as space heating and cooling. The remaining cases were either serving a small element of a larger development, or a very small non-domestic development such as a small retail area. There were no ASHPs serving residential-only developments.

The GSHPs were each serving non-domestic developments, providing space heating and cooling. One example is shown in Case Study 3 (Appendix 2) where a retail company's head office derives a 28 per cent reduction in carbon emissions from renewables including a 600kWe GSHP.

As the carbon emissions from grid electricity generation decrease, the savings achieved by gas-engine CHP are expected to decrease. Developers will therefore need to seek secondary sources of heat that often require the integration of a heat pump. Secondary sources of heat that might be considered in order to make use of heat that is already within the vicinity, and which can help to elevate the heat pump coefficient of performance (COP), include the River Thames and its tributaries, sewage, and even the chillers of other buildings, particularly those with a high cooling load, most notably data centres.

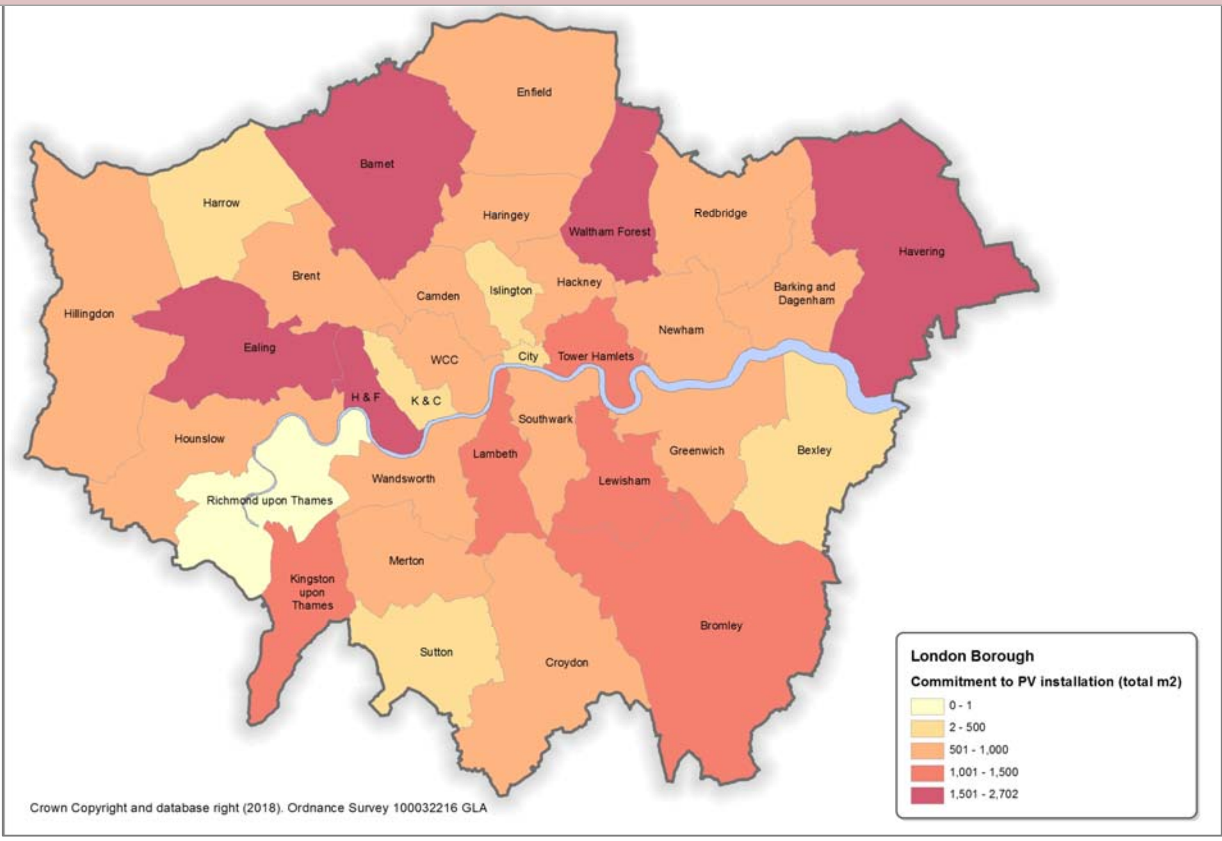
During 2017 there were only two applications featuring solar thermal, indicating that applicants give priority to PV for suitable available roof space.

There were no applications involving the use of a biomass boiler. Use of biomass is discouraged in many parts of London due to the air quality implications. There was one application citing the use of liquid biofuel for CHP.

Table 7: Number of applications installing different types of renewable energy systems

	2013	2014	2015	2016	2017
Solar PV	123	98	111	104	100
Biomass boilers	8	2	4	1	0[22]
Heat pumps	27	43	25	42	41
Solar thermal	12	9	4	3	2

Figure 6: Commitments to PV by borough



22 Not included here is one CHP unit running on liquid biomass. This is included in Table 5 CHP commitments.

Shortfalls and carbon offsetting

The cumulative shortfall in CO_2 reductions

For any development that does not meet the applicable carbon reduction target, the developer is required to make up for the shortfall in emissions, either through a cash-in-lieu contribution to a borough's carbon offset fund or by funding an off-site measure. The aggregate carbon emissions shortfall for zero-carbon home developments was 4,870 tonnes in 2017, leading to a contribution to offset funds and investment in off-site measures of approximately £8.7 million, assuming an indicative CO2 price of £60 per tonne and a 30-year lifetime.

For all other developments that did not meet the 35 per cent carbon reduction target[23], this amounted to 2,069 tonnes of regulated CO_2 emissions per annum, slightly less than the 2016 figure of 2,298 tonnes. This shortfall equated in 2017 to approximately £4.39 million.

Most boroughs across London have prepared their mechanisms for the collection of carbon offset payments and good progress is being made towards determining how these funds, which are ring-fenced for projects with demonstrable carbon savings, will be spent.

Results over time

The figures in Table 8 refer to on-site commitments since 2013.

Table 8: Comparison of applications 2013 – 2017 by type and CO_2 emission reductions

	2013	2014	2015	2016	2017
Number of applications approved	174	142	147	142	**129**
Number of dwellings in development	43,178	43,814	52,014	54,199	**23,778**
Estimated domestic floor area[24] (million m^2)	3.0	3.1	3.6	3.8	**1.7**
Non-domestic floor area (million m^2)	2.3	2.0	2.7	2.1	**1.5**
Regulated CO_2 emissions reductions compared to appropriate Part L (2010 or 2013)	36%	39%	35%	36%	**40%**

[23] Some boroughs collect offset payments when this target is missed.
[22] Assumes that the average dwelling receiving planning approval has an internal area of 70m2.

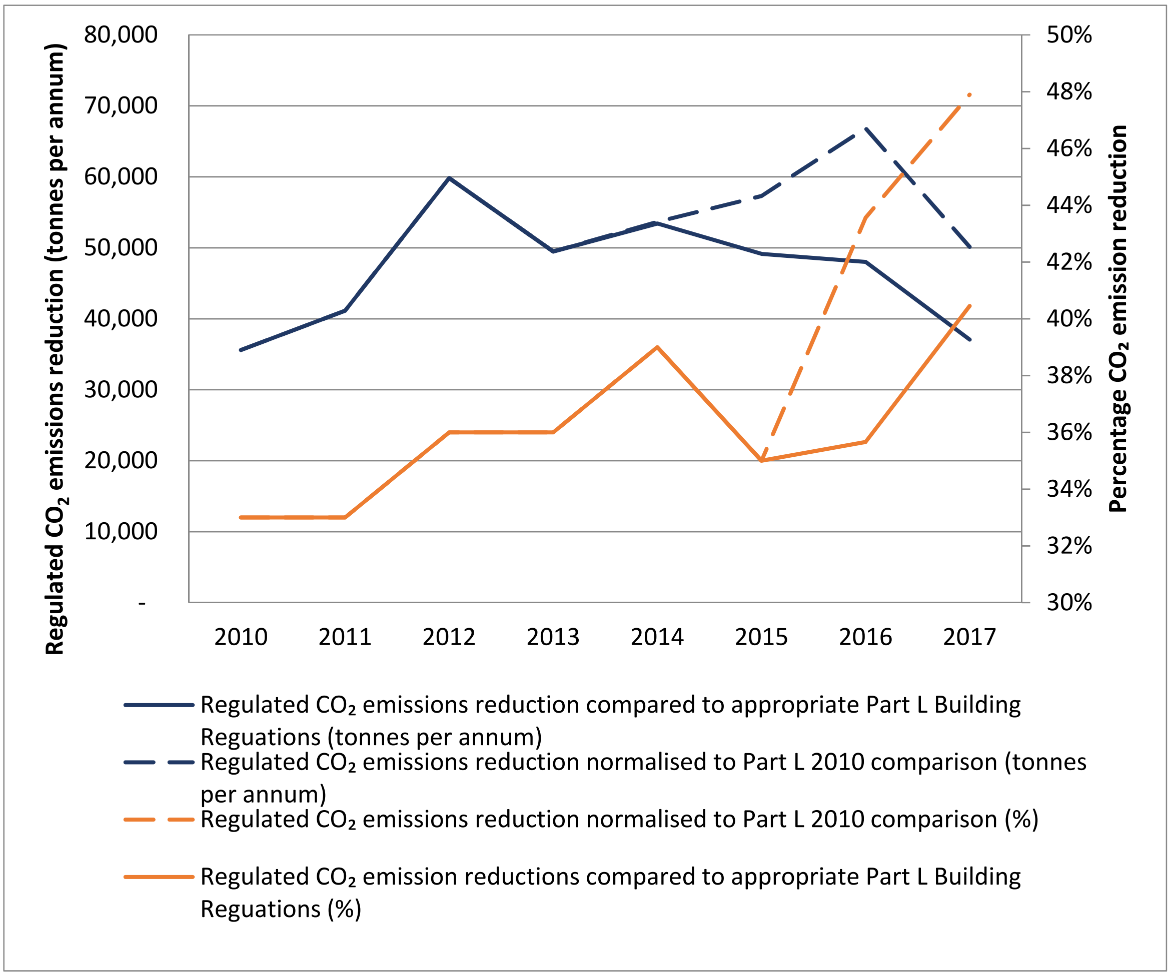
Building Regulations (percentage)					
Regulated CO_2 emissions reductions compared to appropriate Part L (2010 or 2013) Building Regulations (tonnes per annum)	49,474	53,423	49,147	48,011	**37,053**
Regulated CO_2 emissions reductions normalised to Part L 2010 Building Regulations (tonnes per annum)	49,474	53,643	57,305	66,846	**50,138**

The application of London Plan energy policies in these new developments resulted in cumulative regulated CO_2 emission reductions for applications approved during 2017 of 37,053 tonnes per annum. This amounts to 40.5 per cent which substantially exceeds the previous year (36 per cent).

When normalised to the earlier 2010 Part L baseline which allows for a more realistic comparison year-on-year, the savings in 2017 are 50,138 tonnes per annum, which is a lower saving compared to 2016. This can be explained by the smaller number of applications and the smaller size of development for residential and mixed-use applications which means that the baseline carbon emissions figure is much smaller to start with.

Figure 7 shows the trajectory in carbon emission reductions. The solid blue line indicates carbon emission reductions according to the differing baselines that have been in place over time, i.e. Part L 2010 or 2013. The dotted blue line provides a more realistic picture of how carbon emissions have reduced over time and normalises the data according to a common baseline of Part L 2010. The solid and dotted orange lines show the same information in percentage terms showing that, despite reduced overall carbon savings from a smaller number of developments, proportionately the carbon savings being achieved by developers are increasing.

Figure 7: Annual reduction in regulated CO_2 emissions referenced to applicable Part L (2010 or 2013) and normalised to Part L 2010



3. Investment due to London Plan energy policies

The London Plan energy policies are driving investment in low carbon and renewable energy generation and infrastructure. Despite a smaller number of developments in 2017 in both domestic and non-domestic sectors, substantial overall investment is anticipated as a result of commitments in 2017:

- **£55 million to fund heat network infrastructure**

  The site-wide heat network infrastructure for distributing low carbon and renewable heat requires significant investment. It is estimated that an outlay of circa £55 million[25] will be required to fund the heat network infrastructure for the 21,979 dwellings connecting to site-wide heat networks in 2017 applications. 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 2017 will result in about 37 permanent jobs,[26] the majority being in energy services companies (ESCOs).

- **£6.7 million investment in CHP capacity**

  Assuming an installed capital cost of £700 per kilowatt of electrical capacity, the 9.59MW of CHP electrical capacity committed to in 2017 is estimated to require investment of approximately £6.7million.[27]

- **£4 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[28] per kilowatt, providing more than 3.5MW[29] of PV panel electrical capacity will require an investment of approximately £4.3 million. Further investment will also be required to implement heat pumps, both at individual sites and for heat networks.

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[25] 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).
[26] Assumes 0.5 jobs per mixed-use/residential development for maintaining a site network and 120 networks
[27] i.e. 700 x 9.59 x 1000 = £6,713,000.
[28] Figure calculated based on PV costs sourced from the Microgeneration Certification Scheme - MCS Installation Database and cover schemes installed during 2015/16.
[29] Based on 1 kWp to each 10 m^2.

- **£120,000 energy savings from investment in energy efficiency**

  The estimated energy cost savings came to approximately £120,000 per annum[30] as a result of investment in energy efficiency in 2017, which otherwise would have been paid by residents, with additional energy cost savings for non-domestic building occupants. By requiring even higher energy efficiency standards than national building regulations in the new draft London Plan 2017, London's energy policies will continue to increase investment in energy efficiency in the future.

[30] 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.

4. Conclusions

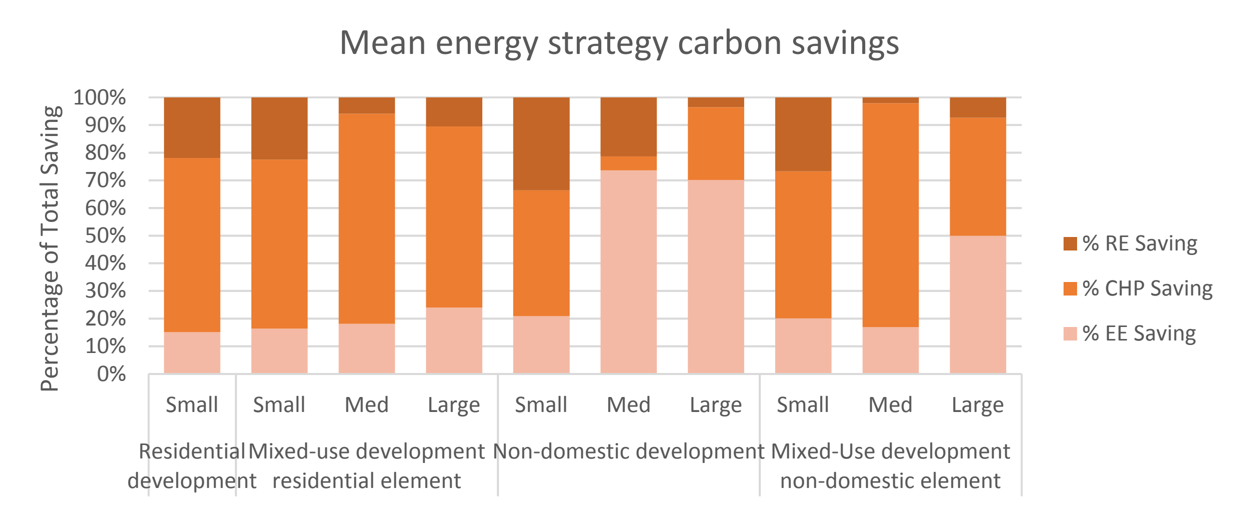
How different development types met the carbon target

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 8 shows the proportion of the total savings achieved at each stage of the energy hierarchy for developments that were successful in meeting their on-site target for carbon emission reductions. Together with the overall figures, it suggests that:

- Developments submitted during 2017 have shown an encouraging average rise in carbon savings compared with the previous year.
- Specifically, there has been a significant rise in the average contribution from energy efficiency in 2017, compared with the previous year. This may be because applicants have become accustomed to the latest Building Regulations, and have as a result become more adept at effective combinations of measures.
- Residential and mixed-use developments have maintained a high contribution from the second stage of the energy hierarchy. This is lower than the equivalent figure for 2016 (23.2 per cent), but still indicates the importance in 2017 of DHN connections and CHP in meeting the carbon reduction targets.
- There has been a reduction in average size of CHP installation in 2017. In general, larger schemes offer more diversity of load and are more likely to justify the inclusion of CHP. In light of this, and the growing concerns regarding the air quality impacts of gas-engine CHP, we will expect developers to follow the Energy Planning Guidance more closely which does not recommend the use of CHP on small sites.
- As the carbon emissions from grid electricity generation decrease, the savings achieved by gas-engine CHP are expected to decrease. Consequently, it will become progressively more important for developers to use other forms of heat generation, which are lower carbon and will not worsen air quality, particularly in London's 187 Air Quality Focus Areas.
- For example, developers will need to seek secondary sources of heat that often require the integration of a heat pump in order to reach the required temperature. Secondary sources of heat that might be considered in order to make use of heat that is already within the vicinity, and which can help to elevate the heat pump coefficient of performance (COP), include the River Thames and its tributaries, sewage, and even the chillers of other buildings, particularly those with a high cooling load, most notably data centres.
- Smaller schemes make the largest percentage use of renewable energy, most prominently PV. This is likely to be because there is generally more roof area per footprint area for such schemes.
- The non-domestic category includes a wide range of different building types with different characteristic demand profiles; each of which rely on different parts of the energy hierarchy to achieve carbon reductions. For example, the 'small' category includes schools, which most commonly integrate PV, while at 'large' scale there is a

high proportion of offices, which predominantly focus on reductions from energy efficiency.

Figure 8: Proportion of savings at each stage of the energy hierarchy for successful developments



Sizing parameters for development categories in Figure 8

Development Size	Development category sizing parameters		
	Residential (No. dwellings)	Non-domestic (m^2 total floor area)	Mixed-use (No. dwellings)
Small	<100	<15,000	<100
Medium	≥100	≥15,000	≥100
	<500	<30,000	<500
Large	≥500	≥30,000	≥500

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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-wide 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: Brunel Street Works, Silvertown Way, Newham

Large residential-led mixed-use development

Residential element commits to 57 per cent CO_2 reduction

Makes use of all three stages of the energy hierarchy

The Brunel Street Works occupies a strategic location in Canning Town, but one which was previously partly derelict with a few remaining poor quality commercial units. The aspiration now is for an exemplary residential led mixed-use urban quarter, in keeping with the extensive regeneration that has been taking place in the vicinity. Located along Silverton Way in the London Borough of Newham, the site occupies an approximately 2.5 hectare narrow wedge of land (Figure 9).

The planned development (Figure 10) comprises 975 residential units in 5 new buildings, together with just over 3500m^2 non-residential floorspace that will accommodate a 152-bed hotel, food retail, a nursery, and other commercial uses. Situated within the Royal Docks and Beckton Riverside Opportunity Area, and within an identified regeneration area, it will make a substantial contribution to the annual London Plan target for Newham of 1,994 new dwellings.

Submitted after the introduction of London's zero-carbon target for major residential developments, the Brunel Street Works commits to 57.4 per cent carbon savings for the residential part of the development, achieving this through the application of all three stages of the energy hierarchy. The non-residential parts of the development achieve carbon savings of 36.9 per cent, also through all three stages, complying with the target for non-residential development which remains at 35 per cent until 2019.

For the first stage of the energy hierarchy (Be Lean), consideration was initially made of the positioning of the 5 new blocks to reduce the risk of overheating; specifically, direct southerly and direct westerly aspects were avoided, the latter to avert low sun angles towards the end of the day. Instead, most dwellings face the prevailing south-westerly wind direction. Further measures to reduce overheating include balconies which provide shading, and the deployment of solar control glazing to minimise unwanted solar gains, while the use of LED lights with PIR occupancy sensors provides an efficient lighting system. Green roofs will also be integrated, both for their curtailment of thermal gains to the buildings and for their amenity value.

A focus on fabric measures is expected to deliver improved U-values to prevent heat from escaping, with Mechanical Ventilation Heat Recovery (MVHR) together with some natural ventilation providing sufficient ventilation to all but the lowest floors. The floors, in which the non-residential parts of the development are located, are equipped with air conditioning due to the proximity of busy transport links and accompanying pollution; for these systems efficient fans and air-tight air handling equipment have been specified.

Collectively, energy efficiency measures at this development will exceed the carbon savings requirements of Part L of the 2013 Building Regulations by 4.2 per cent, and for the residential part of the development this increases to almost 5 per cent.

For the second stage of the energy hierarchy (Be Clean), the development will be equipped with a 900 kWe CHP unit which has been sized to provide 80 per cent of the annual space heating and domestic hot water requirement, and which will contribute an overall 43.2 per cent carbon saving for the development. Buffer storage vessels will be integrated so that off-peak surplus heat can be stored to reduce the impact of the early morning peak hot water demand.

It is a priority, of both the London Plan and Newham Council, for new developments to connect to a local heat network where possible. Since the development is situated in an area of London identified for its decentralised energy potential, opportunities for imminent or later connection have been explored. Consequently, contact has been established with Engie to determine whether connection to the ExCel heat network would be viable. To cater for any future heat network in the immediate vicinity, or extension to the ExCel network, provision has been made to enable future connection.

For the third stage of the energy hierarchy (Be Green), the retail part of the development will be heated and cooled by means of an air source heat pump, and the roofs are to be equipped with PV panels, amounting to an overall area of 500m2 and delivering a combined peak power of 90kWp. These technologies will reduce carbon savings of the whole development by a further 2.1 per cent, extending to 3.1 per cent for the residential parts.

This example demonstrates what is possible when on-site reductions are focused on, rather than placing greater reliance on the offset payment mechanism. It has made use of all three stages of the energy hierarchy for both residential and non-residential elements, achieving with on-site measures the non-domestic target and reaching further than most towards the zero-carbon target for residential, thereby minimising the carbon offset payment.

Figure 9: Aerial view of the Brunel Street Works and its hinterland

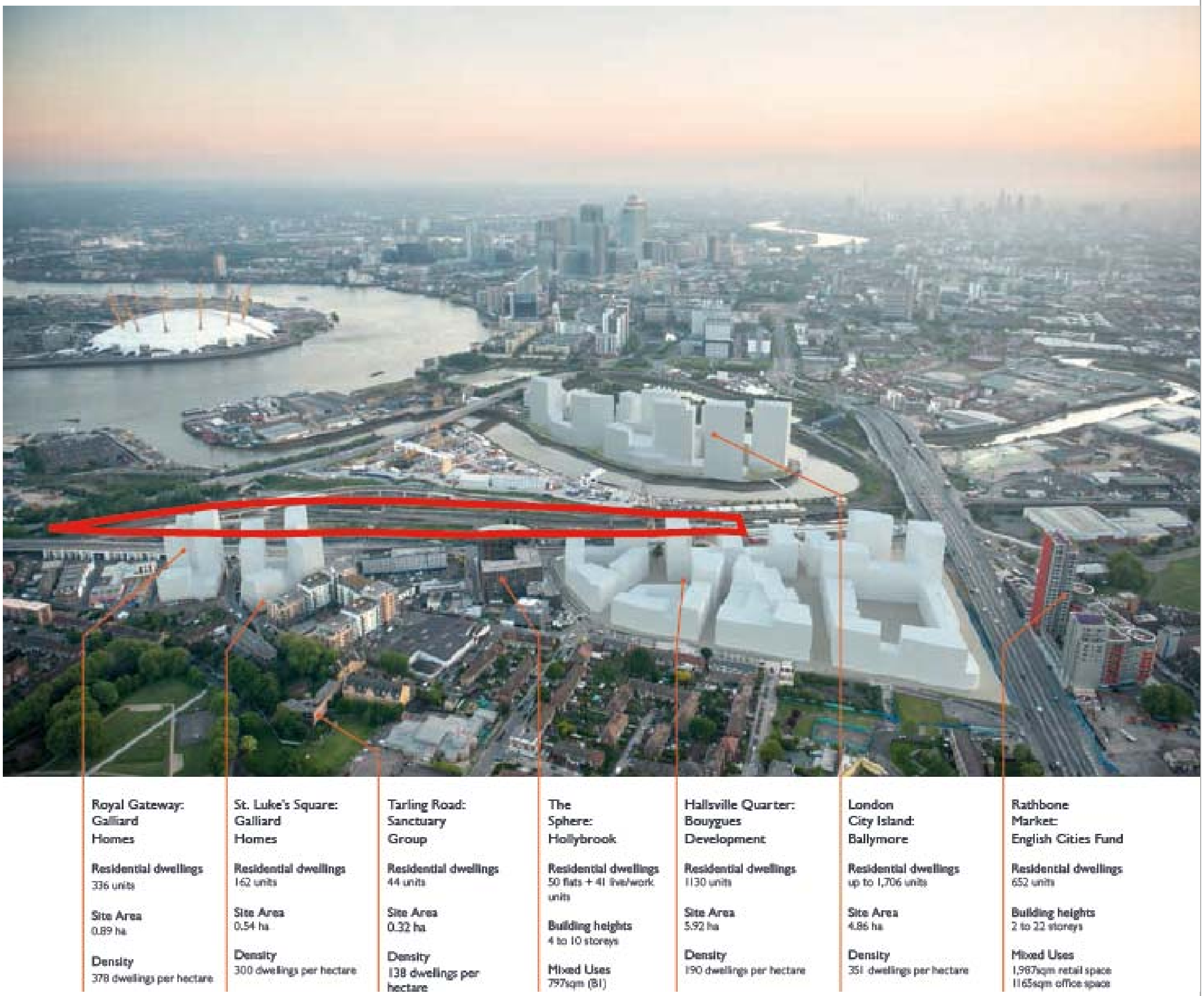

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Figure 10: Proposed development of the Brunel Street Works, Silverton Way

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Case Study 2: Perfume Factory, Ealing

Mixed-use development

Residential element commits to 63 per cent CO_2 reduction

Connection to a proposed local District Heating Network

The site is located at the southern part of the Perfume Factory in North Acton, first established in 1939. The Perfume Factory has its origins as the listed Elizabeth Arden Perfume Factory. The remainder of the site is no longer in industrial use, and now comprises a mix of buildings and uses. The proposed development comprises the southern portion of the Perfume Factory site, bounded by Wales Farm Road, the Victoria Industrial Estate and some residential areas.

The proposed mixed-use development (Figures 11, 12) comprises student accommodation with 603 rooms, office space amounting to just over 6,000m^2 and 85 residential units, in buildings ranging from 3 to 33 storeys. The area is identified for regeneration, with many more schemes also likely to emerge within the Opportunity Area Planning Framework.

A range of energy efficiency measures are proposed, ensuring that the development achieves and slightly exceeds the requirements of Part L of the 2013 Building Regulations through energy efficiency measures alone. However, for the residential part of the development, subject to the zero-carbon requirement, the savings exceed the requirement by an encouraging 7.1 per cent.

Following an overheating analysis, the applicant reduced the proportion of glazing, and incorporated blinds into the student residential areas. The demand for cooling will also be minimised by means of recessed facades, low glazing g-values (a measure of how much solar heat is allowed in through the windows), light coloured blinds, and passive ventilation. Low energy lighting will be used throughout the different parts of the development, and variable speed pumping will also help to minimise electricity consumption.

Natural ventilation will be used where possible, while MVHR units will be deployed where necessary. Openable windows will be provided above the 6th floor, and there will be a small amount of natural ventilation through infiltration. The MVHR units will incorporate a summer by-pass, which will allow the unit to supply fresh air without heat being transferred from the extract air into the fresh supply air.

The applicant has identified a proposed DHN within the vicinity of the development in North Acton and is proposing to connect to the network which is expected to include a 2MWe CHP. An alternative CHP solution has also been proposed, should the network not come forward. The reduction in CO_2 emissions, estimated for the connection to the North Acton heat network, amounts to 729 tonnes per annum, equivalent to an overall 56 per cent reduction from the second stage of the energy hierarchy (Be Clean).

The applicant has investigated the feasibility of a range of renewable energy technologies and is proposing to install 15 kWp photovoltaic panels to the residential block, adding a further 10 per cent reduction in CO_2 emissions for the residential part of the development from the third step of the energy hierarchy (Be Green).

Overall, an on-site reduction of 44 tonnes (residential) and 708 tonnes (commercial) of regulated CO_2 emissions compared to a 2013 Building Regulations compliant development is expected. This is equivalent to an overall saving of 63 per cent for the residential element and 58 per cent for the commercial element, significantly exceeding the minimum on-site 35 per cent reduction required and, for the residential element, going far beyond the average reduction for developments assessed against the zero-carbon target.

This example also demonstrates what is possible when on-site reductions are focused on, rather than relying on the offset payment mechanism. For the residential element of this development, significant contributions have been sought from all three stages of the energy hierarchy, so that the combination achieved has gone further than almost all other such developments.

Figures 11 and 12 show a schematic and modelled view of the proposed development.

Figure 11: Schematic of proposed development at the Perfume Factory

.

Figure 12: View of Perfume factory development

Case Study 3: LIDL HQ, Kingston

Non-residential development

Reaches target with energy efficiency and renewable technologies only: solar photovoltaic, solar thermal, and ground source heat pump

This site, which is to be redeveloped as the UK head office for the LIDL retail company, is a 'Gateway Site' where development is expected to make a positive contribution to the character of the area; in this case the use of materials will reference the tradition of brick-making in the area. It is located on the corner of the A240 Kingston Road and Jubilee Way in Tolworth, in the London Borough of Kingston.

The 1.92 hectare site will accommodate an area of 22,946m^2 for the main building and 9,415m^2 for the multi-storey car park. The site is not overlooked or shaded by adjacent structures; this is important because the development will integrate two solar technologies: solar thermal on the roof of the office building, and solar PV on the car park roof.

The land to the south and east of the site is predominantly Metropolitan Open Land (MOL) comprising sports grounds, informal recreation, a farm and a nature reserve. The south-west corner of the site is also designated as MOL, and this will be respected by integrating it into the new site, and landscaping it to provide both the nature reserve and amenity space for staff.

This case study is an example of a non-residential development deploying three renewable energy technologies, and reaching the target for carbon emissions reduction by means of energy efficiency measures and renewable technologies only; the first (Be Clean) and third (Be Green) stages of the energy hierarchy.

The development estimates a reduction of 39 tonnes per annum (7 per cent) in regulated CO_2 emissions from energy efficiency measures. Demand reduction measures include the use of low energy lighting, and heat recovery using low energy fans.

The glazed area has been optimised to provide high levels of daylighting; the building also benefits from a central atrium with a glazed roof. This allows natural light to penetrate the centre of the building so that luminaires can be automatically dimmed during the day. It contributes to a pleasant working environment as well as saving energy.

Importantly, the glazing has also been specified to limit unwanted solar gains to minimise extra cooling load. A shading analysis has been carried out using dynamic thermal modelling. This has established the optimal size and position of external shading that will reduce the demand for cooling.

A combination of three renewable energy technologies will be installed: the main source of heating and cooling will be a 600kWe Ground Source Heat Pump using a borehole array, and the roofs will be occupied by 1300m^2 of PV solar panels for electricity generation and 500m^2 of solar thermal collectors for heating or pre-heating domestic hot water.

The solar thermal panels will provide pre-heating of the domestic hot water for the office. The Ground Source Heat Pump will provide both heating and cooling for the office building with top-up boilers, and can also top-up domestic hot water when required.

The combination of solar thermal panels and a heat pump can be favourable; particularly during the summer there will be times when solar heated water completely fulfils the required hot water supply. At other times the solar contribution can provide useful pre-heating that will elevate the COP of the heat pump.

A reduction in regulated CO_2 emissions of 157 tonnes per annum (28 per cent) is expected through this third element of the energy hierarchy. This demonstrates what can be achieved through the deployment of renewable technologies, particularly when they are effectively combined.

Overall, by applying energy efficiency measures and renewable technologies only, this development achieves a reduction of 196 tonnes of CO_2 per year in regulated emissions, equating to an overall saving of 36 per cent, which exceeds the current target for non-domestic developments.

Figures 13 and 14 respectively show the layout and side view of the proposed development.

Figure 13: LIDL HQ Kingston

Figure 14: LIDL HQ

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