Monitoring the London Plan Energy Policies - Phase 3

Part 1 report

FINAL

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Executive Summary

The London Plan[1] was first published in February 2004. It included a requirement for all major new developments to maximise energy efficiency (EE) design and seek further carbon dioxide (CO_2) savings through the use of decentralised energy including combined heat and power (CHP) and renewable energy (RE) technologies where feasible. In September 2006, the draft Further Alterations to the London Plan[2] was published for public consultation and proposed a number of changes to the original energy policies. This included a target of 20% CO_2 savings from individual developments through the use of renewable energy. Other alterations included a change in the Mayor's original energy hierarchy (outlined in the 2004 Energy Strategy) from "be lean, be green and be clean" to "be lean, be clean and be green" and set this as planning policy. This increased the importance of investigating opportunities to incorporate decentralised energy systems in new developments.

As a result, greater emphasis has been placed in the planning process of the Greater London Authority (GLA) on connecting new development proposals to district heating networks and securing site wide networks and on-site CHP where feasible. Following publication of the proposed alterations, additional staff joined the GLA energy team in 2007. As the draft Further Alterations to the London Plan went through the Examination in Public (EiP) process in June-July 2007, the revised energy hierarchy and 20% renewable target gained more weight in planning decisions. In February 2008, the London Plan (Consolidated with Alterations since 2004)[3] was published and the changes were formally adopted as policy for London.

This report provides the findings from Part One of a two-part study conducted for the GLA by London South Bank University (LSBU). The objective of this part of the study was to analyse and report the energy and CO_2 savings achieved through the GLA's planning process and application of the London Plan energy policies. This report has been based on data from energy statements submitted with planning applications for strategic developments referred to the Mayor. The second part of the study will focus on the actual CO_2 savings gained from the implementation of these policies, based on 'as-built' data from developers/designers and site visits and will be available early 2010.

The first part of this study involved a review and analysis of a sample of 147 applications out of about 340 strategic planning applications referred to the Mayor and approved[4] between November 2006 and June 2009. These 147 developments represent the relevant planning cases for which detailed energy information was available. The main findings are as follows:

[1] Greater London Authority (February 2004), The London Plan – Spatial Development Strategy for Greater London, Available from: http://www.london.gov.uk/mayor/strategies/sds/london_plan/lon_plan_all.pdf Accessed 24th August 2009
[2] Greater London Authority (September 2006), Draft Further Alterations to the London Plan (Spatial Development Strategy for Greater London), Available from: http://www.london.gov.uk/mayor/strategies/sds/further-alts/docs/alts-all.pdf Accessed 24th August 2009
[3] Greater London Authority (February 2008), The London Plan - Spatial Development Strategy for Greater London, Consolidated with Alterations since 2004, Available from: http://www.london.gov.uk/thelondonplan/docs/londonplan08.pdf Accessed 24th August 2009
[4] Approved at Stage II with reports available from: http://www.london.gov.uk/mayor/planning_decisions/

- The Mayor's climate change mitigation and energy policies in the London Plan **have been successful in significantly reducing energy consumption and CO_2 emissions in new developments** and go well beyond the national requirements set out in 2006 Building Regulations Part L;

- Since the publication of the draft FALP in September 2006, **more than half of the planning applications analysed achieved CO_2 savings of at least 30%** and approximately **a quarter met or exceeded 40% CO_2 savings** through the use of a combination of energy efficiency, CHP and renewable energy measures.

- The CO_2 savings achieved demonstrate the impact that London Plan policies have had to date over and above building regulations. They also show the potential that the London Plan[5] has to drive CO_2 reductions. A number of the applications sampled through this study would meet the draft replacement Plan's tougher CO_2 standards for 2010-13, demonstrating that more challenging CO_2 targets are achievable and can drive even more efficient design solutions.

- On average, **30% reductions in CO_2 were achieved from the sample between November 2006 and June 2009.** These savings amount to just over 116,000 tonnes of CO_2 per year. The **average savings from the applications sampled has increased from 29% in 2006 to 33% in 2009**, and has consistently exceeded 30% from mid-2007 onwards;

- By 2009, the average step-by-step CO_2 savings achieved were 33%. This is made up of 14% from energy efficiency measures beyond the baseline, 9% related to the use of gas-fired[6] CHP and a further 10% from renewable energy technologies. Many applications were able to go well beyond the average savings, although many of the developments achieved well beyond these averages. The baseline reflects whole emissions i.e. both the emissions from regulated energy uses under the 2006 Building Regulations Part L minimum standard and the additional emissions from non-regulated energy uses such as cooking and equipment;

- **The number of gas-fired CHP installations has increased from 34 in the 2007 report[7] to 94 in the current sample**. Also, an additional 6 installations each of biomass and fuel cell CHP have recently been proposed compared to 2 installations each reported[8] in 2007;

- The emphasis on maximising overall CO_2 savings through the hierarchy, including the encouragement of district heating and on-site CHP has in some developments affected the opportunity for certain types of renewable energy technology. Following changes to London Plan energy policies, greater emphasis has been placed on connecting new developments into existing district heating schemes and

[5] http://www.london.gov.uk/shaping-london/london-plan/strategy/download.jsp
[6] Refers to natural gas from fossil fuels
[7] A.R. Day, P.G. Jones and P. Ogumka (July 2007), Review of the impact of the energy policies in the London plan on applications referred to the Mayor (Phase 2), London South Bank University/Greater London Authority, Available from: http://www.london.gov.uk/mayor/planning/docs/lsbu-research.pdf Accessed 26th March 2009
[8] Ibid

incorporating on-site CHP with site-wide communal heating networks where feasible. In certain schemes where gas-fired CHP has been proposed, the requirement to optimise the size of the CHP, based on total site thermal load has meant that the available demand met by from renewable energy (particularly renewable heat) became more limited. Thus, developments that achieved high CO_2 savings from CHP, delivered lower CO_2 savings from renewable energy technologies and vice versa;

- **A quarter of the sample met or exceeded 20% CO_2 savings from renewable energy technologies, a third of developments achieving between 10% and 20% CO_2 savings**, and a further 38% achieving up to 10% savings;

- The overall CO_2 savings made are continuing to increase. The share of how those savings are made varies from development to development. The contribution that energy efficiency, CHP and renewable energy can make varies from development to development. For example in some applications renewable energy was able to contribute well over 30 per cent of savings, but in some cases contributed under 10 per cent. Flexibility is important to achieve the maximum overall CO2 savings from developments.

- Biomass boilers, photovoltaics (PV), ground source heat pumps (GSHP) and solar thermal were the most popular renewable technologies (in that order). This order of popularity differs from that observed in the 2007 study (solar thermal, biomass boilers, PV and GSHP). The sudden growth in the proposed number of biomass boilers may be an indication of growing confidence in fuel source and its CO_2 saving potential, while the growth in proposed PV installations may be related to its compatibility with CHP as well as its ease of specification and installation;

- The order of technologies in terms of overall savings is similar to the previous study with CHP, biomass and GSHP systems in the lead. This is greatly influenced by the large scale nature of these technologies;

- Table 1 summarises the contribution from major renewable energy and CHP technologies of the applications assessed within this study, covering the period between November 2006 and June 2009. Biomass and fuel cell CHP schemes give comparatively higher tonnes CO_2 saved per megawatt (MW) and per installation. However, it should be noted that these are relatively novel applications and whilst supported in the London Plan, there are still uncertainties surrounding their installation and operation compared to the more conventional gas-fired option. Hence, in planning terms the use of such novel systems are approved on the condition that if they do not prove operationally viable, the conventional gas-fired option should be adopted. It is an aim of part two of this study to investigate some of these installations in order to provide a better indication of what is practically achievable.

Table 1 Contribution by main renewable energy and CHP technologies in study (147 applications)

	Biomass boilers	Ground source heating/ cooling	Photo-voltaics	Solar thermal	Wind	Gas-fired CHP	Fuel cell CHP	Biomass CHP
number of installations	74	31	55	26	10	94	6	6
tonnes CO_2 saved	11,695	3,351	1,718	560	2,735	25,331	5,575	6,946
MW reported	28.6	5.8	0.9	0	2.6	12.4	3.0	0.3
MW estimated	21.7	8.9	2.1	3.5	0	8.0	0	1.2
MW[9] TOTAL (reported and estimated)	50.3	14.7	3.0	3.5	2.6	20.4	3.0	1.5
tonnes CO_2 saved per MW specified	233	228	567	159	1,047	1,239	1,834	4,567
tonnes CO_2 saved per installation	158	108	31	22	274	269	929	1,158

Recommendations

In view of the success of the Mayor's policies, the following are recommended:

1. The GLA should consider moving towards overall carbon emissions reduction targets for development proposals whilst maintaining an obligation for renewable energy in accordance with the current energy hierarchy. This will encourage diversity of solutions and maintain the uptake of renewables. The evidence from this study suggests that total carbon savings of at least 30% with at least 10% renewables is being routinely met on average. Therefore as a starting point a more challenging

[9] This refers to either megawatts thermal or megawatts electric as appropriate for different technologies

target of at least 40% total carbon savings should be proposed, whilst bearing in mind that proposed tightening of Building Regulations Part L will make these savings even more challenging in future;

2. Further work should be conducted to analyse technology savings in relation to building types and sizes. This will help provide an indication of the best technology applications for different building types. There may well be a trend in the type and size of technologies used on specific building types;

3. A standard template for energy statement submissions to the GLA should be developed. This will help improve the quality of data submitted, make the submission process simpler and more precise, and ensure monitoring of data is easier in the future. The template developed by LSBU which has been used for gathering data for this study could serve as a first draft in taking this forward. In particular, recording installation sizes and capacities should be a standard requirement in any reporting;

4. The GLA should ensure that all planning applications, in particular the required energy statements, are submitted and filed electronically, with key information held on a central database and updated on a regular basis. This would enable future analysis to be conducted rapidly and reliably.

1. Introduction

The Mayor's climate change programmes and energy policies aim to reduce London's contribution to global climate change, tackle the problem of fuel poverty and promote London's economic development through increased energy efficiency and use of decentralised low carbon and renewable energy technologies. The energy policies in the London Plan (Consolidated with Alterations since 2004) promote energy efficiency (EE) and decentralised energy, including connection to district/community heating networks, use of combined heat and power (CHP) and other efficient sources of energy supply. In addition, they include a 20% CO_2 reduction target through the use of on-site renewables in individual developments referred to the Mayor. To demonstrate compliance, development proposals submitted to the Mayor are expected to include energy statements detailing the contribution and impact of proposed measures on the developments expected emissions.

LSBU was commissioned in March 2006 to conduct a review of the energy statements submitted on planning applications referred to the Mayor. 46 cases were identified with robust information that could be analysed from a list provided by the GLA. The LSBU team developed a Microsoft Access database to store and analyse the data. In April 2007 the study continued to review energy statement submissions to the Mayor between May 2004 and January 2007, boosting the sample size to 113 developments. The study formally reported to the GLA in July 2007. The report[10] was submitted as evidence to the Examination in Public (EiP)[11] on the draft Further Alterations to the London Plan (2006) to demonstrate the results of the application of the London Plan energy policies.

In March 2009, a new study was commissioned with the following objectives:

Part one: Analyse and report the estimated energy and carbon savings gained from the application of the energy policies contained in the London Plan, based on data collected from energy statements submitted for planning approval. Provide recommendations to feed into the GLA's London Plan energy policies and planning process.

Part two: Gather and report the actual energy and carbon savings gained from the application of the energy policies contained in the London Plan, based on 'as-built' data from developers/designers and site visits. Compare "as-built" data with planning submissions in order to identify relationships, areas of improvement and optimisation. Provide recommendations to feed into the GLA's London Plan energy policies and planning process.

[10] A.R. Day, P.G. Jones and P. Ogumka (July 2007), Review of the impact of the energy policies in the London plan on applications referred to the Mayor (Phase 2), London South Bank University/Greater London Authority, Available from: http://www.london.gov.uk/mayor/planning/docs/lsbu-research.pdf Accessed 26th March 2009

[11] The EiP panel report is available from: http://www.london.gov.uk/mayor/strategies/sds/eip-report07/panel-report-further-alts-eip.pdf

This report (based on part one) presents the findings from a sample of 147 new applications approved[12] by the Mayor between September 2005 and March 2009 out of about 340 total planning applications referred to the Mayor in the study period. The subset of 147 approved developments (see Appendix 1 – List of applications analysed) represents the relevant planning cases for which detailed energy information were available from the GLA. Some developments that were considered either unsuitable (e.g. golf courses, wharf and road extensions, application for floodlights, etc.) or too small, have been excluded from the analysis. In particular, one significantly sized development with zero carbon ambitions has been excluded as it distorted the results of the analysis. While the quality of the energy statement submissions has improved since the last study conducted in 2007, there is still the absence of a standard template for submissions. The variability in submissions affects the quality of the data extracted from them and makes the process of analysing and reporting more time consuming. In a few instances, assumptions were made in order to fill gaps where data was incomplete or ambiguous.

[12] Approved at Stage II with reports available from: http://www.london.gov.uk/mayor/planning_decisions/

2. Results

The 2006 Building Regulations Part L[13] document requires all new developments to achieve 20 – 28% reductions[14] in CO_2 emissions as a minimum over the 2002 Building Regulations requirement. This can be achieved through the use of energy efficient design and the inclusion of low and zero carbon technologies. As a requirement of the energy policies of the London Plan, the baseline emissions in individual developments go beyond 2006 Part L and must reflect "whole" emissions. This requirement includes both the emissions from regulated energy uses under the 2006 standard, and the additional emissions from non-regulated energy uses such as cooking and small power equipment. Compliance with the London Plan requires individual developments to meet the requirements of Building Regulations 2006 (and exceed where possible) through energy efficiency measures first before the introduction of low and zero carbon technologies as indicated in Figure 1.

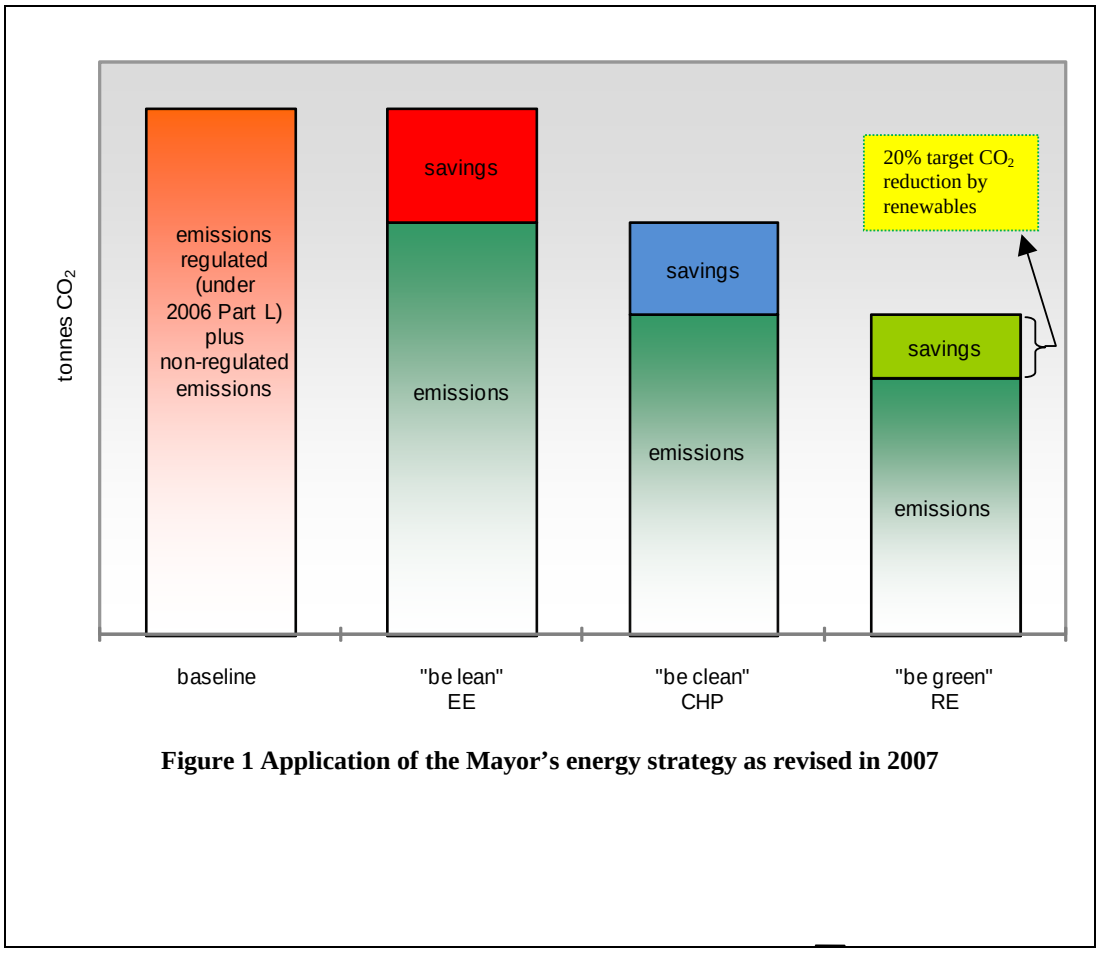

Figure 1 Application of the Mayor's energy strategy as revised in 2007

[13] Office of the Deputy Prime Minister (2006), Approved Document L - Conservation of Fuel & Power (England & Wales)
[14] For individual new dwellings no greater than 450m2 (ADL1A), the improvement factor is 20% over notional dwellings built to SAP 2005 standard while for individual new buildings other than dwellings (ADL2A), the improvement factor is 23 – 28% over notional buildings built to 2002 Part L standards.

2.1. Emissions

Figure 2 shows the CO_2 emissions from the 147 new developments analysed in this study. The baseline emissions (388 kilo tonnes) are reduced after the adoption of energy efficiency measures (335 kilo tonnes), implementation of gas-fired CHP (304 kilo tonnes) and inclusion of renewable technologies (272 kilo tonnes) per annum. The red and black lines indicate the target emissions if 10% and 20% CO_2 savings respectively were met on all developments through the use of on-site renewable generation. It should be noted that about a third of these developments were approved prior to the publication of the London Plan (Consolidated with Alterations since 2004) in February 2008, at which time the 20% renewable target was fully adopted.

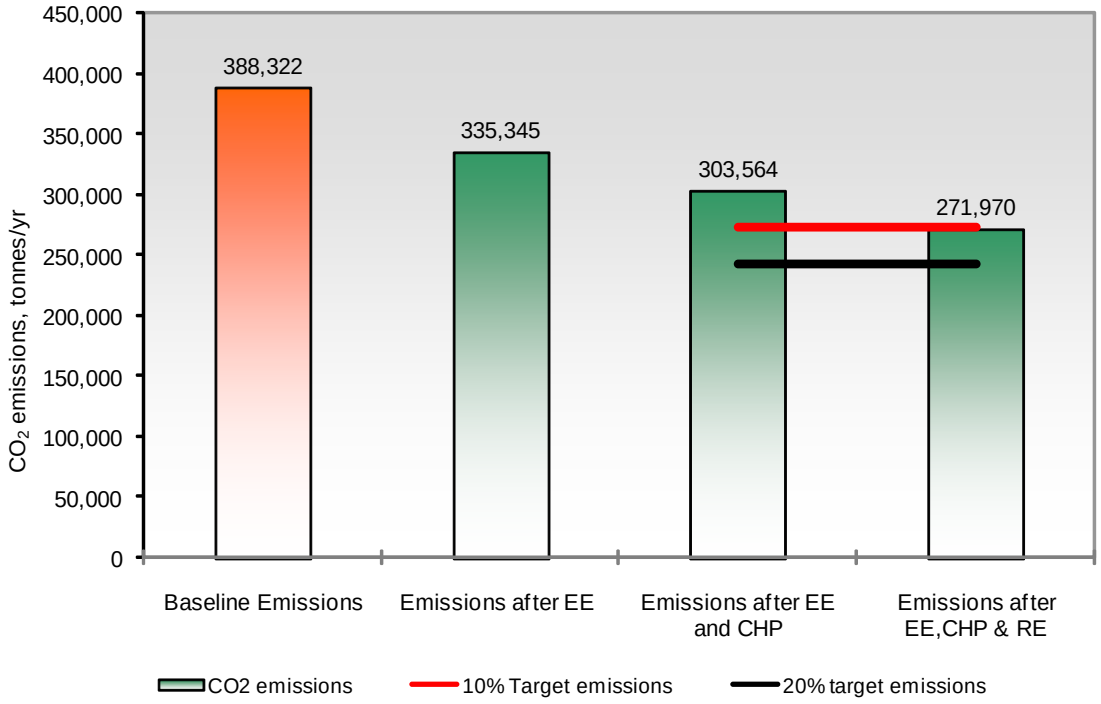

Figure 2 CO_2 emissions in tonnes/year (across 147 developments)

Adding the reported contribution[15] from 113 developments previously analysed, provides Figure 3. This shows the reduction in overall emissions as a result of the application of the energy policies of the London Plan on the sample of planning applications analysed since the first publication in 2004. It indicates total savings of 251,880 tonnes CO_2 per year through the use of energy efficiency, CHP and renewable energy technologies across 260 developments.

[15] A.R. Day, P.G. Jones and P. Ogumka (July 2007), Review of the impact of the energy policies in the London plan on applications referred to the Mayor (Phase 2), London South Bank University/Greater London Authority, Available from: http://www.london.gov.uk/mayor/planning/docs/lsbu-research.pdf Accessed 26th March 2009 – See page 8-10

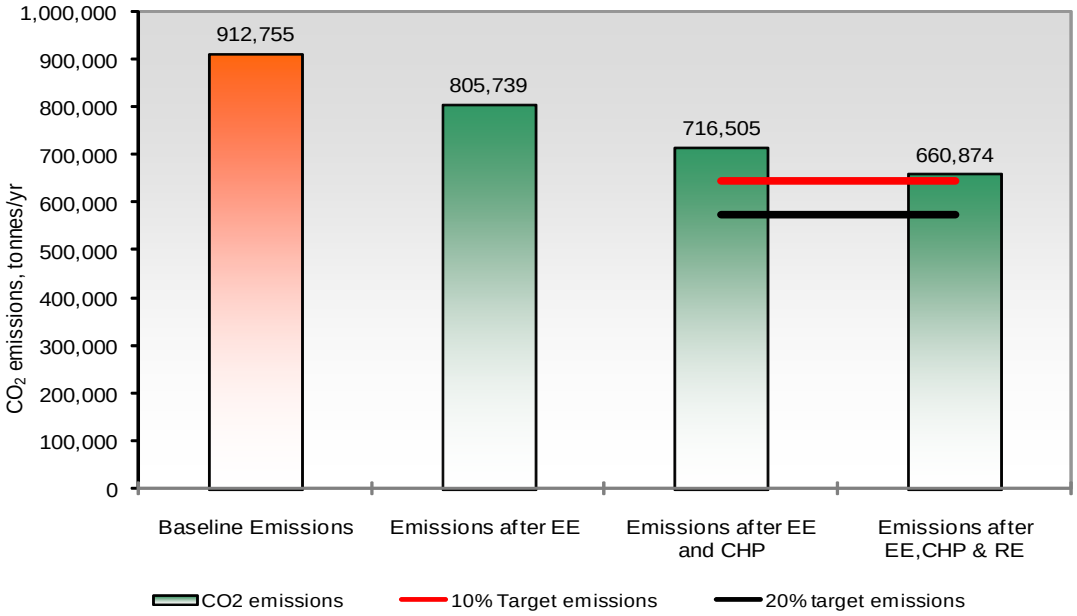

Figure 3 CO_2 emissions in tonnes/year (across 260 developments)[16]

2.2. Savings

The CO_2 savings per annum are shown in Figure 4 as 53 kilo tonnes from energy efficiency, 32 kilo tonnes from CHP and 32 kilo tonnes from renewable energy technologies across the sample of 147 planning applications analysed in the current study. Altogether, these give total savings of 116,352 tonnes of CO_2 per annum which represent an average 30% CO_2 savings from the whole emissions baseline. Table 2 summarises the step by step contribution in terms of CO_2 savings (tonnes per year) and percentages over adjusted baselines.

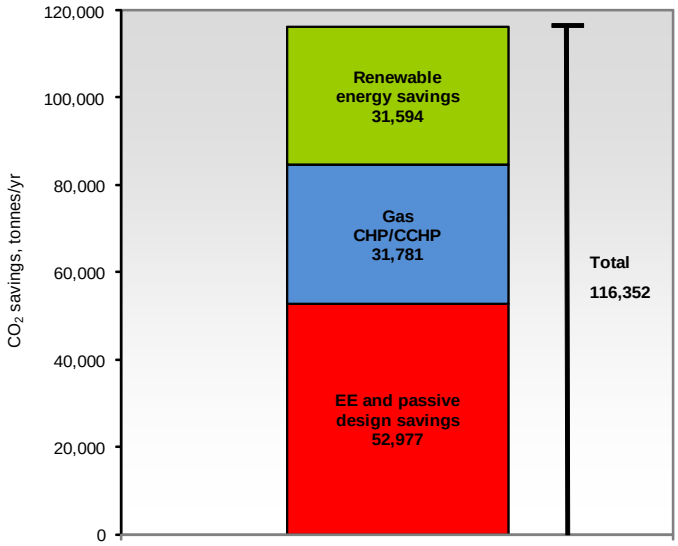

Figure 4 Overall CO_2 savings from EE, gas-fired CHP and RE (across 147 developments)

[16] This figure represents the total emissions from the developments studied in 2007 (113) and the developments in this current study (147) – a total of 260 developments studied so far

Table 2 Breakdown of CO_2 savings (across 147 developments)

	tonnes CO_2/year	percentage savings
EE	**52,977**	**14%**
CHP	**31,781**	**9%**
RE	**31,594**	**10.4%**
Total	**116,352**	**30%**[17]

The growth in CO_2 savings over time[18] from energy efficiency, CHP, renewable energy technologies and the combined total (for 147 developments) are presented in Figure 5.

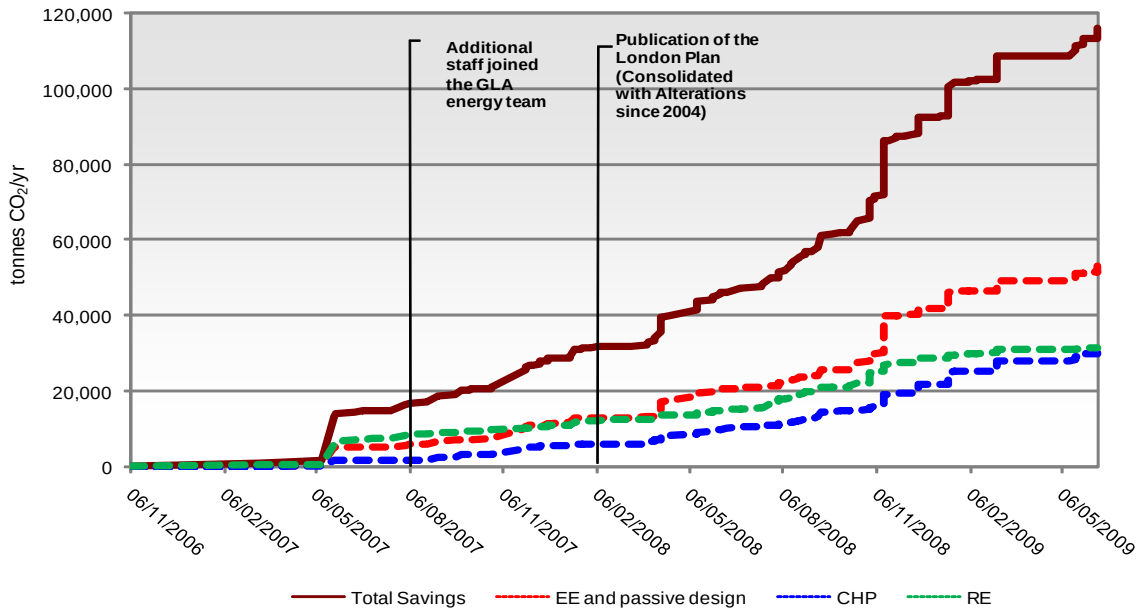

Figure 5 Cumulative CO_2 savings over time (across 147 developments)

Figure 6 represents the average percentage savings from a combination of energy efficiency, CHP and renewable energy technologies over progressive 12-monthly periods. The blue trend line indicates that average savings rose from 29% to 34%. On average, developments started to regularly meet 30% (indicated by the horizontal green line) annually after July 2007 (indicated by the vertical red line).

[17] Percentage over the baseline
[18] The dates used here refer to the Stage II report dates at which time the applications were formally approved by the Mayor. The Stage II reports are available from: http://www.london.gov.uk/mayor/planning_decisions/

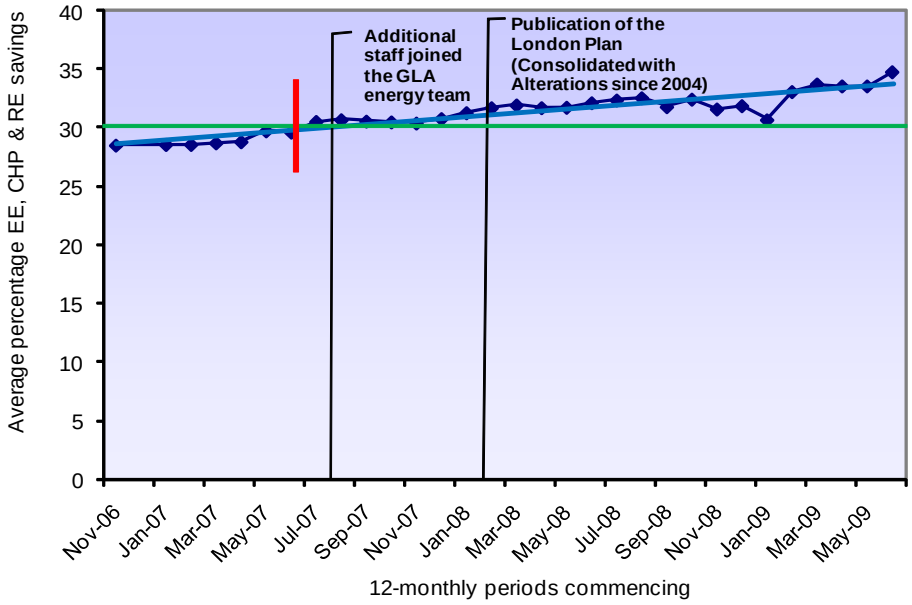

Figure 6 Average percentage savings from combined EE, CHP and RE over progressive 12-monthly periods (across 147 developments)

Figure 7 shows the total percentage savings from a combination of EE, CHP and RE against the Mayor's report Stage II approval dates. While the trend line tells a similar story to Figure 6, this graph particularly illustrates the spread of percentage savings over time. More developments tend to achieve 30% CO_2 savings and beyond following the publication of the London Plan (Consolidated with Alterations since 2004) in February 2008, with about a quarter having met or exceeded 40% CO_2 savings.

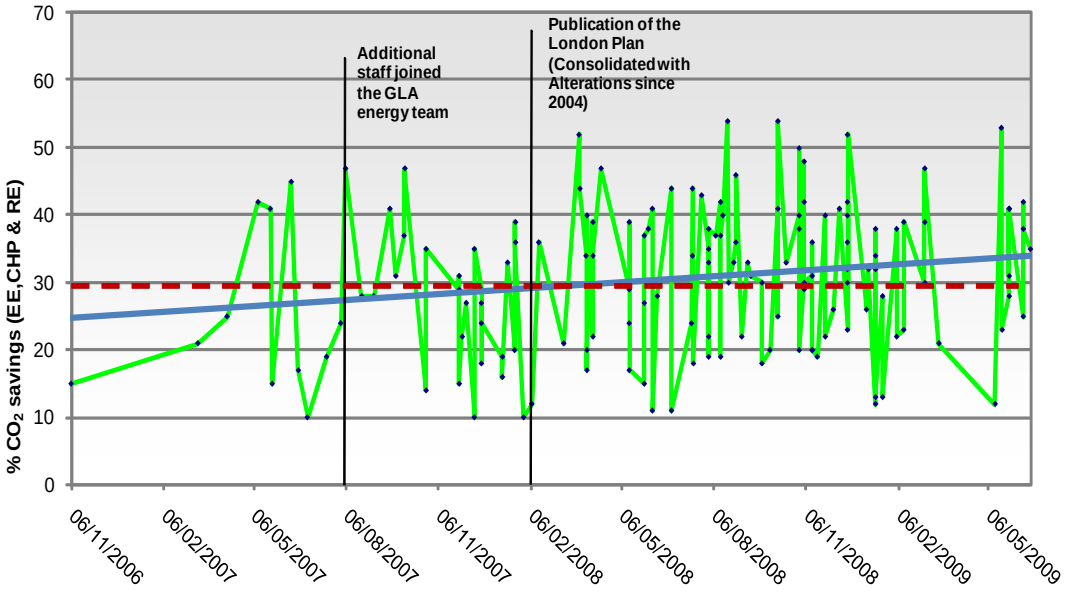

Figure 7 Percentage savings from combined EE, CHP and RE over time (across 147 developments)

Developments can be grouped into four broad categories of total percentage CO_2 savings (through a combination of EE, CHP and RE) as shown in Figure 8. While 23% of the developments achieved 40% savings and above, 32% achieved between 30% and 40% savings, 12% achieved between 25% and 30% savings, and 33% achieved less than 25% savings.

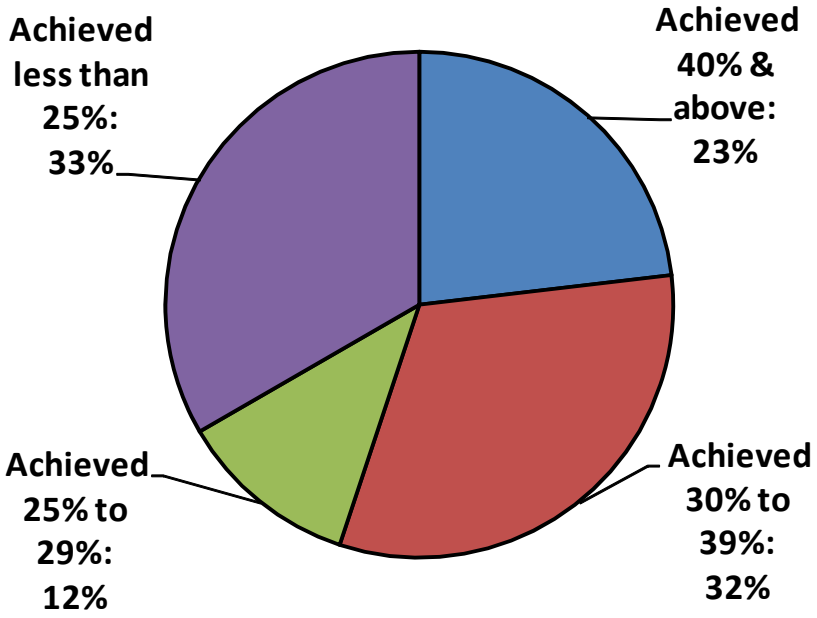

Figure 8 Grouping developments by percentage savings of combined EE, CHP and RE (across 147 developments)

It has also been possible to gather information about the specified technology generation capacity on a number of developments as reported in the energy statements. However, this information was not provided in all cases. As a result, methodologies for each technology, based on a back-calculation from CO_2 savings and assuming standard parameters were derived to infer the capacities (see Appendix 2 – Calculating technology capacities). Figure 9 shows the reported (bottom series) and estimated (top series) capacities in MW thermal and electric as appropriate, aggregated for different renewable energy and CHP technologies.

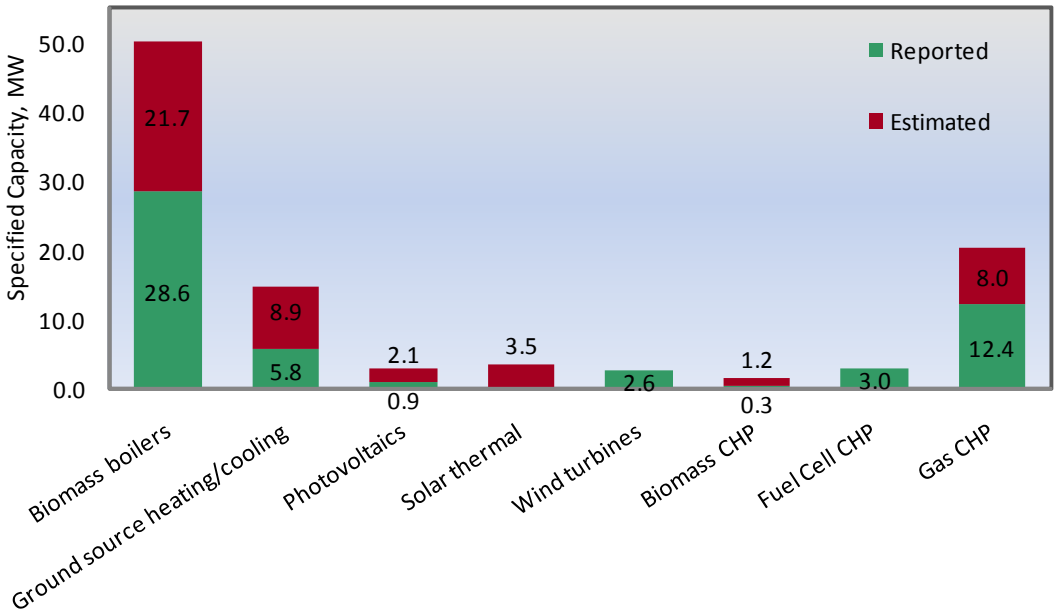

Figure 9 Specified capacity in MW for major RE and CHP technologies (across 147 developments)

2.3. Analysis of Energy Efficiency contributions

Figure 10 shows the trend of average energy efficiency percentage savings beyond the baseline over progressive 12-monthly periods. These percentage savings are over and above the regulated 2006 Building regulations Part L minimum standard. They have been calculated over baseline emissions, which include emissions from both regulated and non-regulated energy uses (i.e. "whole" energy). Savings rose from about 12% up to 15%. The blue line represents an upward trend in savings while the green line indicates average savings across the entire period (12%) from November 2006 to June 2009.

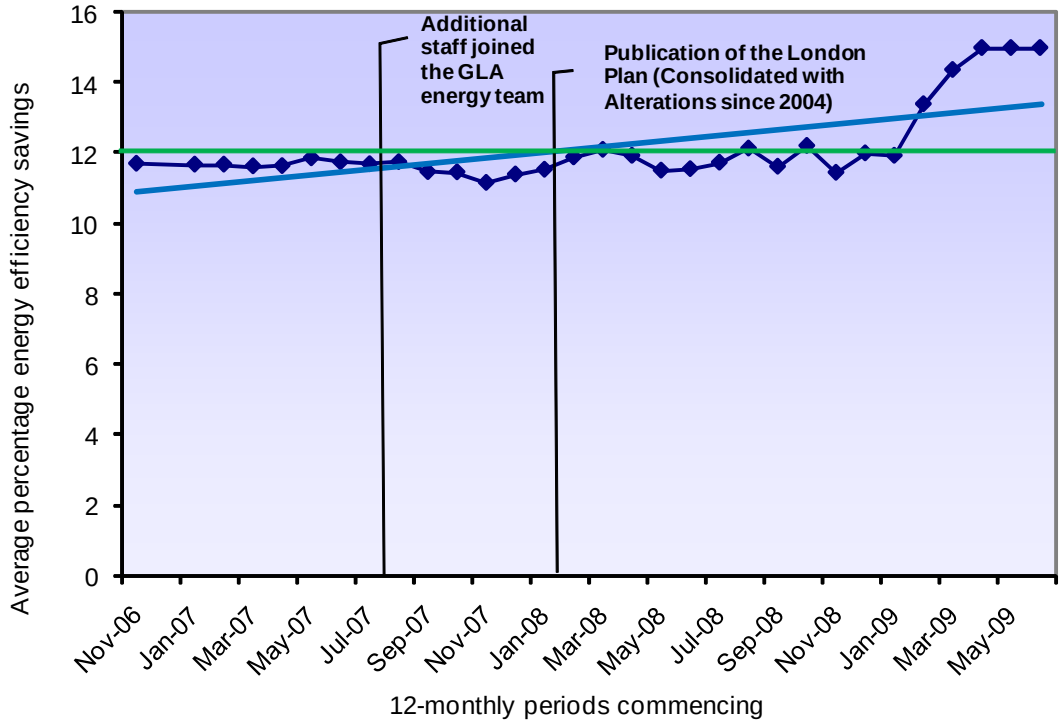

Figure 10 Average percentage savings from EE over progressive 12-monthly periods (across 147 developments)

While it has been difficult to quantify the savings beyond Part L 2006 minimum standard from individual energy efficiency technologies utilised, it has been possible to quantify the number of installations per measure as presented in Figure 11. There are over 700 installations of energy efficiency measures across the 147 new developments. It should be noted that the building type (for example residential housing or flats, commercial or office space) significantly influences the level of energy efficiency savings possible in schemes. Passive solar design and the installation of energy efficient lighting with lighting controls are the most common measures used by developers to reduce demand

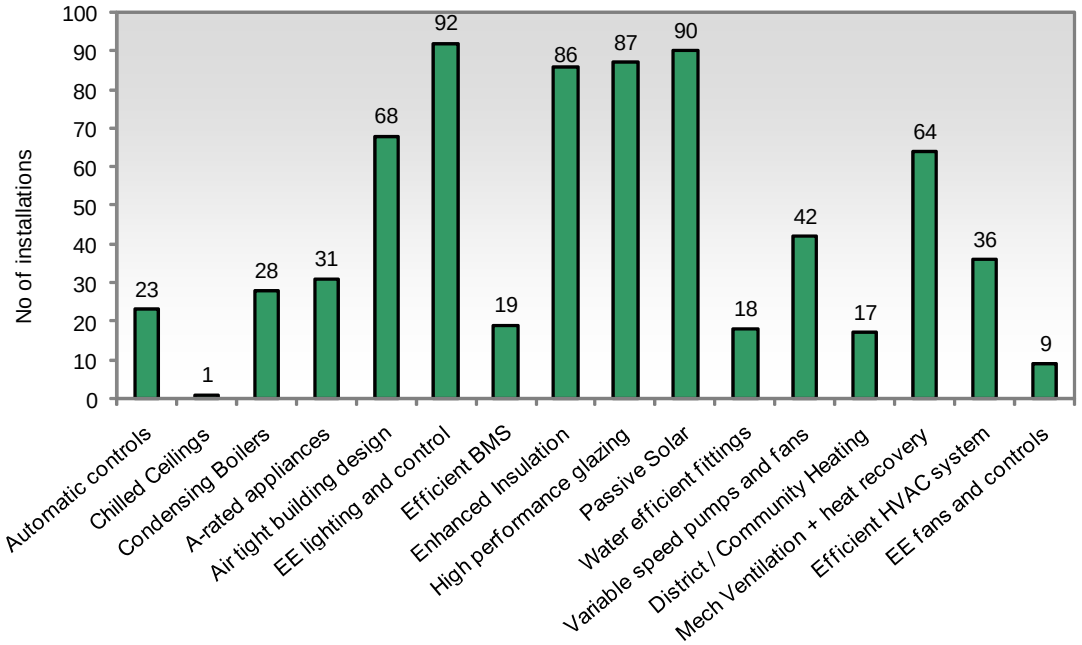

Figure 11 Number of installations of energy efficiency measures (across 147 developments)

Figure 12 shows the frequency of percentage CO_2 savings from energy efficiency beyond the baseline. CO_2 savings of 6% and 10% are most common, each met by 11 developments. This is followed closely by 15% which has been met by 10 developments. However, some developments have achieved up to 40% CO_2 savings. The higher levels of savings achieved are typically driven by the developer or client from the initial design/architectural stages.

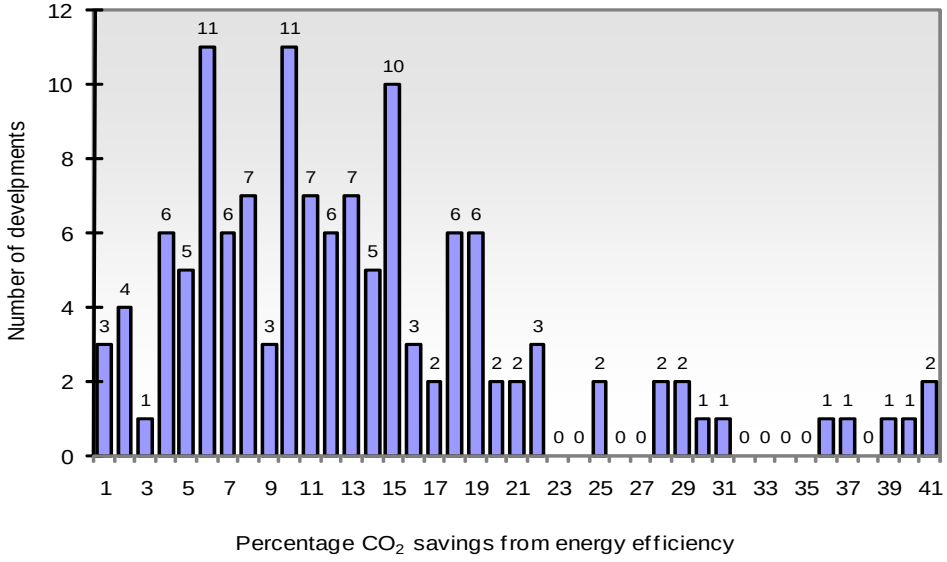

Figure 12 Frequency of percentage savings from energy efficiency (across 130 developments)[19]

[19] The number of developments given here is less than the total because it excludes developments which made no more reduction through energy efficiency beyond the baseline

2.4. Analysis of contributions from CHP with communal heating

This section details the savings from combined heat and power (CHP) with communal heating. Percentage savings from gas-fired and fuel cell CHP are calculated over the development's emissions after energy efficiency savings have been incorporated. Figure 13 represents the trend in average savings by gas-fired CHP over progressive 12-monthly periods. An upward trend (marked by the blue line) is clearly observed as savings rose from about 6% (in November 2006) to about 15% (in May 2009). Across the entire period, the average savings was 10% (indicated by the horizontal green line) and developments started to regularly meet this average after May 2008. However, 49 developments did not include CHP due to the small nature of the developments and/or absence of sufficient heat load to support the plant. If these were excluded from the 147 developments, average CO_2 savings would be 13% of those using CHP.

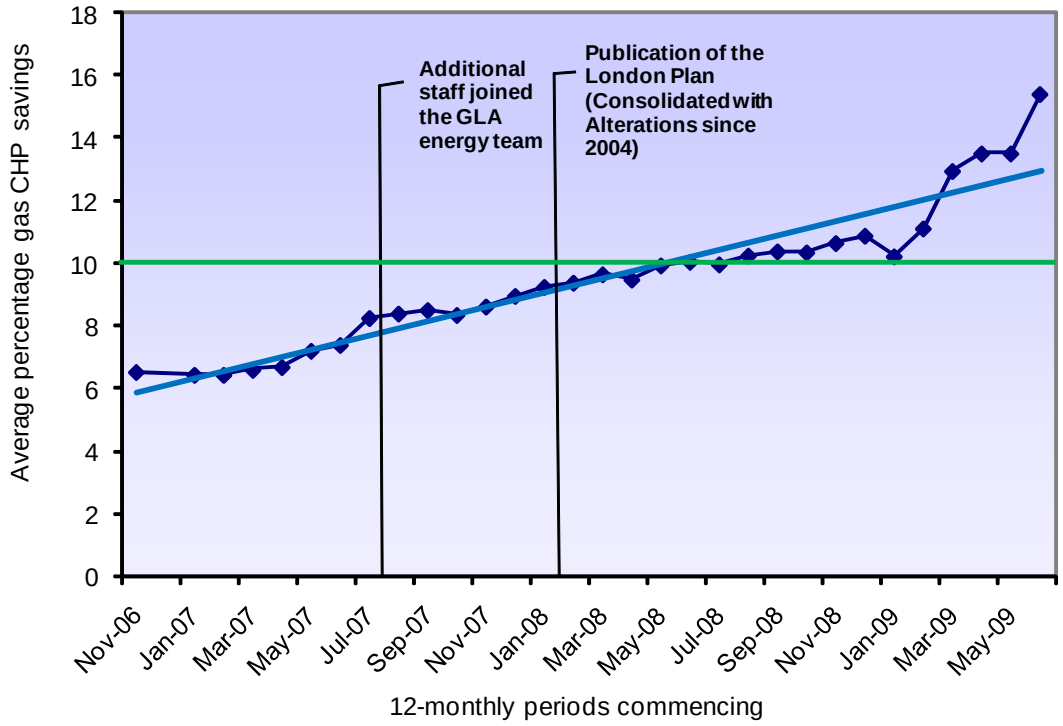

Figure 13 Average percentage savings from gas-fired CHP over progressive 12-monthly periods (across 147 developments)

Figure 14 shows the frequency of percentage CO_2 savings from gas-fired CHP. CO_2 savings of 11% is most common, met by 9 developments. This is followed closely by 10% which has been met by 8 developments and 9% met by 7 developments, while some developments have achieved up to 40% CO_2 savings. The higher levels of savings are influenced by several factors such as the plant size and running hours.

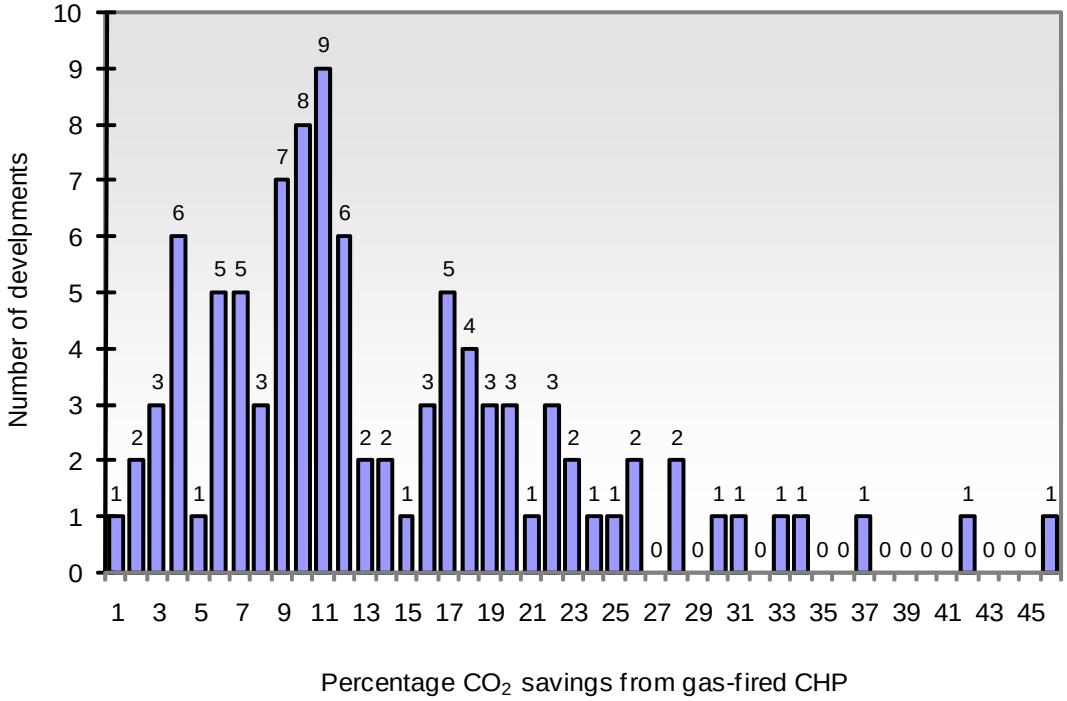

Figure 14 Frequency of percentage savings from gas-fired CHP (across 98 developments)[20]

2.4.1. Contribution by CHP type

Table 3 summarises the contribution by different CHP technologies. These are categorised in terms of fuel type: natural gas, fuel cell and biomass[21]. Gas-fired CHP makes by far the largest contribution to CO_2 savings across all technologies (energy efficiency and renewables) and has the highest number of installations. Biomass and fuel cell CHP schemes give comparatively higher tonnes CO_2 saved per megawatt (MW) and per installation. However, it should be noted that these are relatively novel applications and whilst supported in the London Plan, there are still uncertainties surrounding their installation and operation compared to the more conventional gas-fired option. Hence, in planning terms the use of such novel systems are approved on the condition that if they do not prove operationally viable, the conventional gas-fired option should be adopted. It is an aim of Part Two of this study to investigate some installations in order to provide a better indication of what is practically achievable.

In terms of specified capacity, out of 94 installations of gas-fired CHP, 50 cases reported the plant capacity while the other 44 were estimated by back-calculating from the CO_2 savings (see Appendix 2 – Calculating technology capacities). For biomass CHP, one of the cases reported the plant capacity while the other five cases were back-calculated.

[20] The number of developments given here is less than the total because it excludes developments which did not include CHP as they were considered to be unsuitable for the application of CHP due to the small nature of such schemes and/or absence of sufficient heat load to support the plant

[21] Biomass CHP savings are cited in this section simply for comparison with other CHP types. However, the use of this technology forms part of the third step in the energy hierarchy – renewable energy technologies.

Table 3 Contribution by CHP technology type (across 147 developments)

	Gas-fired CHP	Fuel cell CHP	Biomass CHP[22]
number of installations	94	6	6
tonnes CO_2 saved	25,331	5,575	6,946
MW (reported)	12.4	3.0	0.3
MW (estimated)	8.0	0	1.2
MW TOTAL (reported and estimated)	20.4	3.0	1.5
tonnes CO_2 saved per MW (total)	1,239	1,834	4,567
tonnes CO_2 saved per installation	269	929	1,158

Figure 15 shows the cumulative growth in savings from CHP over time[23]. The step changes indicate when large CHP installations were proposed.

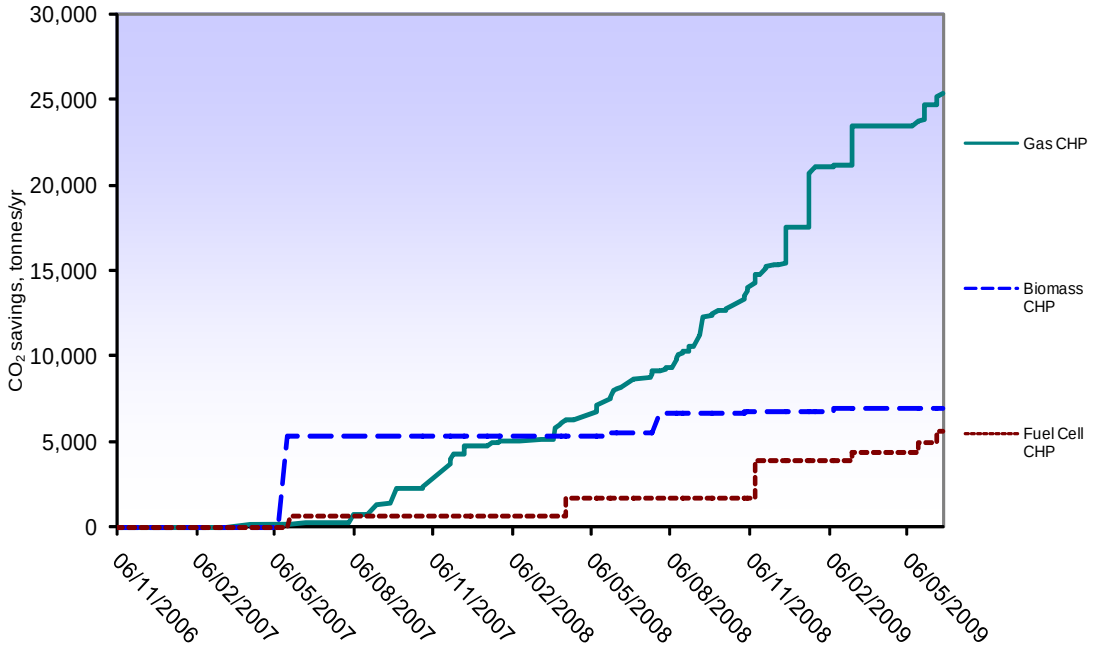

Figure 15 Cumulative CO_2 savings from CHP technology type (across 147 developments)

[22] Biomass CHP savings are cited in this section simply for comparison with other CHP types. However, the use of this technology forms part of the third step in the energy hierarchy – renewable energy technologies.
[23] The dates used here refer to the Stage II report dates at which time the applications were formally approved by the Mayor. The Stage II reports are available from: http://www.london.gov.uk/mayor/planning_decisions/

2.5. Analysis of Renewable Energy contributions

In September 2006, the draft Further Alterations to the London Plan was published proposing a number of changes, including the establishment of a 20% CO_2 emissions reduction target through the use of renewables, an advance on the previous practice of a 10% reduction target. This reduction target is calculated over the emissions from the development after energy efficiency and CHP savings have been incorporated as pictorially illustrated in Figure 1. The Mayor's energy hierarchy (originally outlined in the Energy Strategy 2004) was also revised and included as planning policy. As a result, greater emphasis was placed in planning work around connection to existing communal heating schemes, site wide heat networks and the use of on-site CHP. In line with the London Plan policy requirements, if a CHP system was deemed to be appropriate for a scheme, the size of the CHP needed to be optimised based on total site thermal load to maximise CO_2 savings delivered. This reduced the available demand to be met from renewable energy (particularly renewable heat) in certain schemes where gas-fired CHP has been proposed. Figure 16 illustrates that developments which secured high percentage CO_2 savings through on-site CHP, found it challenging to meet the 20% RE target. Developments that were unsuitable for the application of CHP (mainly due to the absence of sufficient heat load for on-site CHP) achieved comparatively higher RE savings.

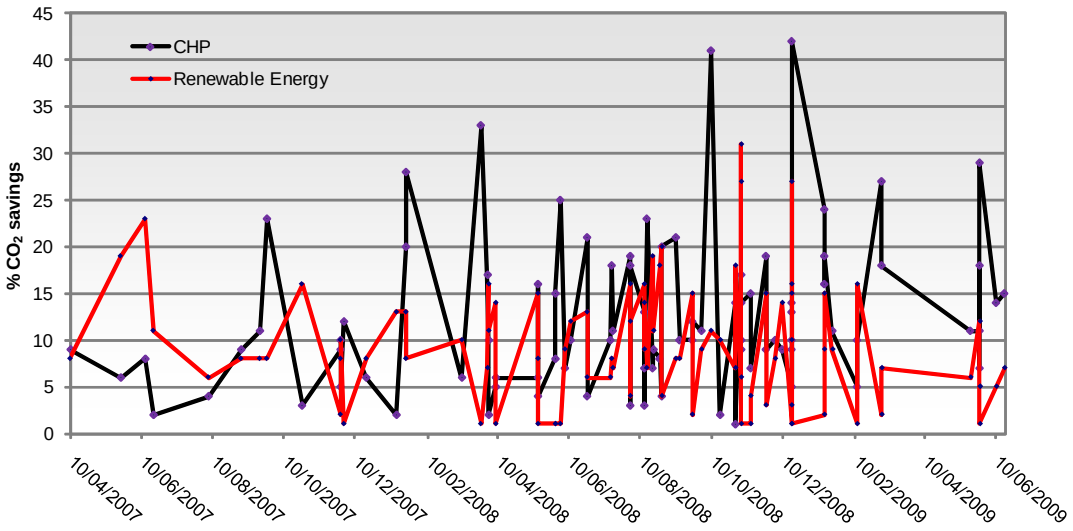

Figure 16 Effect of the revised hierarchy on percentage CO_2 savings (across 90 developments) [24]

Figure 17 shows that due to increasing levels of CO_2 savings from CHP, there is a small downward trend (shown by the blue line) in CO_2 savings from renewable energy technologies over the most recent period. However, it should be noted that there has been an overall increasing trend in CO_2 savings from renewables as a result of the implementation of the London Plan energy policies since the first publication in 2004 (across 260 developments)[25]. The red line marks the 10% renewable energy target

[24] The number of developments given here represents those that mutually included CHP and RE
[25] Taking into account renewable savings from the 113 developments studied in 2007 and the 147 developments in this current study

savings while the black line marks the 20% renewable energy target through on-site renewable generation.

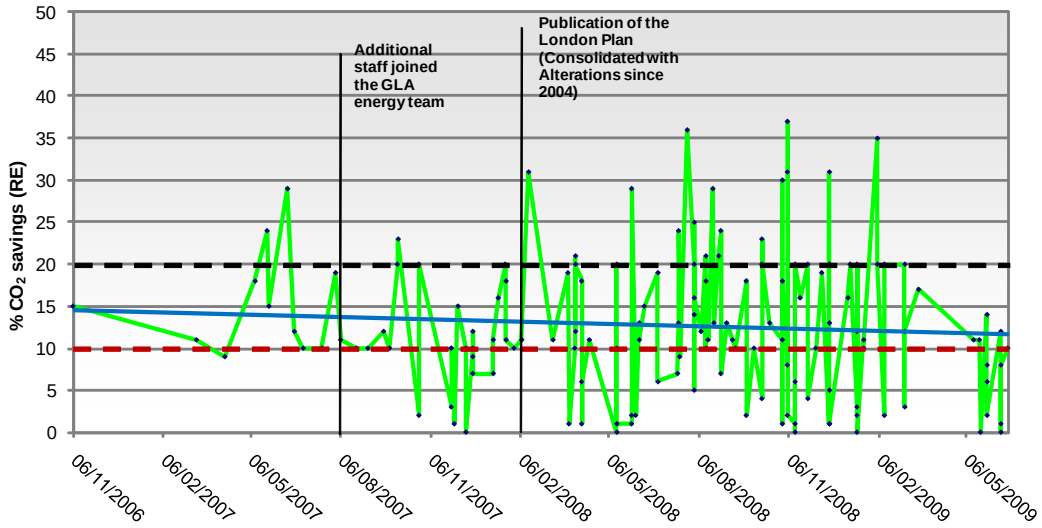

Figure 17 Percentage CO_2 savings from RE over time (across 147 developments)

Figure 18 shows the average CO_2 savings from renewables over progressive 12-monthly periods. It illustrates more clearly the recent downward trend in CO_2 savings from renewables due to increasing levels of CHP application, which has been explained above. The green horizontal line represents the average savings (10%) over the entire period (November 2006 to June 2009), although many of these developments individually achieved well above these averages.

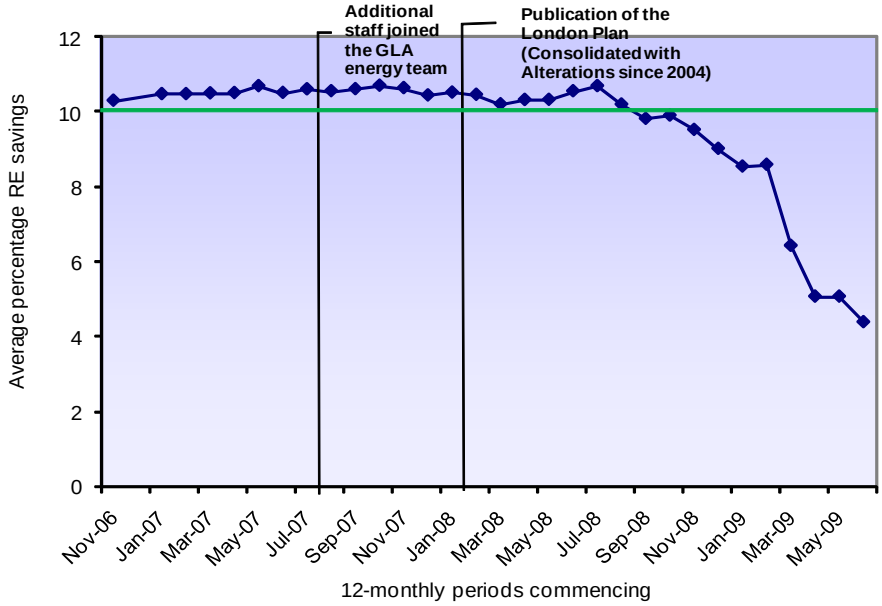

Figure 18 Average percentage savings from RE over progressive 12-monthly periods (across 147 developments)

Figure 19 shows the frequency of percentage CO_2 savings from renewables. 10% CO_2 savings is most common, met by 18 developments. This is followed closely by 20% which has been met by 16 developments and 11% met by 14 developments. Some developments exceeded 20% CO_2 savings from renewables and at least 6 developments achieved more than 30%. The higher levels of savings are influenced by a number of factors such as the size and type of development, available demand, appropriate infrastructure both for equipment and for fuel storage (for example in cases with biomass).

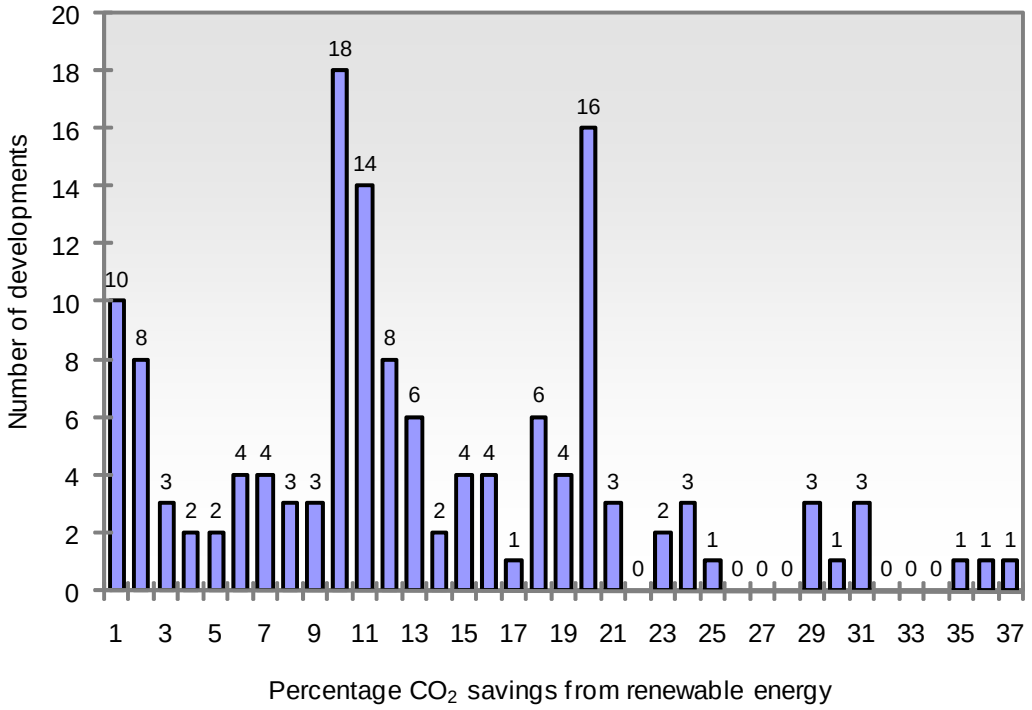

Figure 19 Frequency of percentage savings from RE (across 141 developments)[26]

An alternative presentation of the same data is shown in Figure 20. Here developments have been grouped into four categories: those that had no renewable savings, those that met up to 10% CO_2 savings from renewables, those that achieved between 10% and 20% and lastly those that met 20% and above. It is interesting to note that 25% of the developments showed RE savings in excess of the 20% target. Whilst it would be useful to know the type of buildings in each category, this information has not been analysed in this study and should be included in future analysis.

[26] The number of developments given here is less than the total because it excludes developments which did not include renewable energy technologies.

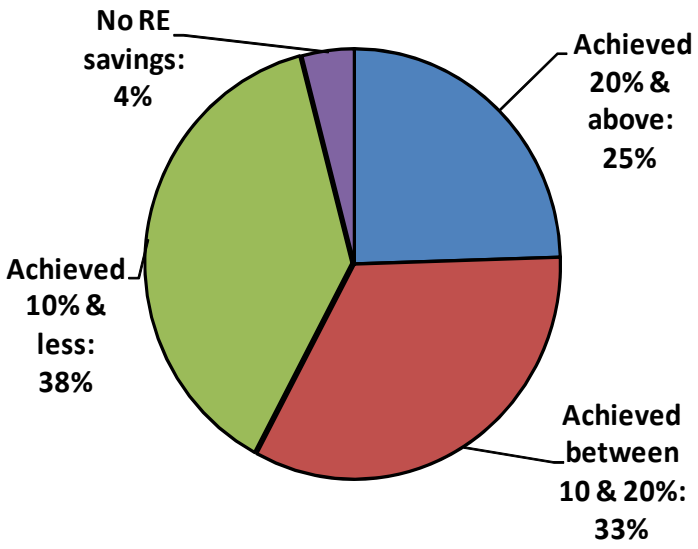

Figure 20 Grouping developments by percentage RE savings (across 147 developments)

2.5.1. Contribution by RE type

Table 4 summarises the contribution from the main renewable technologies. In terms of specified technology generation capacity, some developments reported plant capacity while others did not. The number of developments that reported technology generation capacities for the different technologies is given in parentheses for each technology type. For example, 42 out of 74 installations reported the biomass boiler capacities while for solar thermal none of the cases reported the technology capacity. Hence, the others have been estimated by back-calculating from the CO_2 savings based on assumptions (see Appendix 2 – Calculating technology capacities). There is a need to improve the quality of energy data submissions.

Table 4 Contribution by major RE technologies (across 147 developments)

	Biomass boilers	Ground source heating/cooling	Photo-voltaics	Solar thermal	Wind turbines	Biomass CHP
number of installations	74 (42)	31 (13)	55 (10)	26 (0)	10 (7)	6 (1)
tonnes CO_2 saved	11,695	3,351	1,718	560	2,735	6,946
MW reported	28.6	5.8	0.9	0	2.6	0.3
MW estimated	21.7	8.9	2.1	3.5	0	1.2
MW TOTAL (reported and estimated)	50.3	14.7	3.0	3.5	2.6	1.5
tonnes CO_2 saved per MW (total)	233	228	567	159	1,047	4,567
tonnes CO_2 saved	158	108	31	22	274	1,158

per installation						

Figure 21 shows the CO_2 savings by renewable technologies across the entire sample of 147 developments whereas Figure 22 shows the number of installations per technology type. Biomass boilers made the most savings (11,695 tonnes CO_2 per year) and were the most regularly specified (74 installations). Biomass supply chain issues have always been cited as a problem for London, but this result may indicate increased confidence in this technology (as more experience has been gained) and more reliable fuel source. Also, when correctly installed and operated, biomass boilers prove to be more economically viable (£/tonne saved) than some of the other RE options. While Figure 21 shows that biomass CHP made high savings (6,946 tonnes CO_2 per year) considering the lower number of installations (6 installations) shown in Figure 22, these schemes are novel applications (see explanation given in Section 2.4.1).

Photovoltaics (PV) are also popular (55 individual installations) albeit their savings (1,718 tonnes CO_2/year) are lower than some of the other technologies. Their popularity could perhaps be related to the increase in the use of CHP, which means that most of the heat load has been met and only electricity displacing/exporting systems can be employed. Considering the issues associated with urban wind, developers may well be driven towards the use of PV although it is an expensive technology. PV systems are also comparatively easier to specify and install. Ground source heating and cooling and solar thermal continue to be popular due to their competitive price and relative maturity.

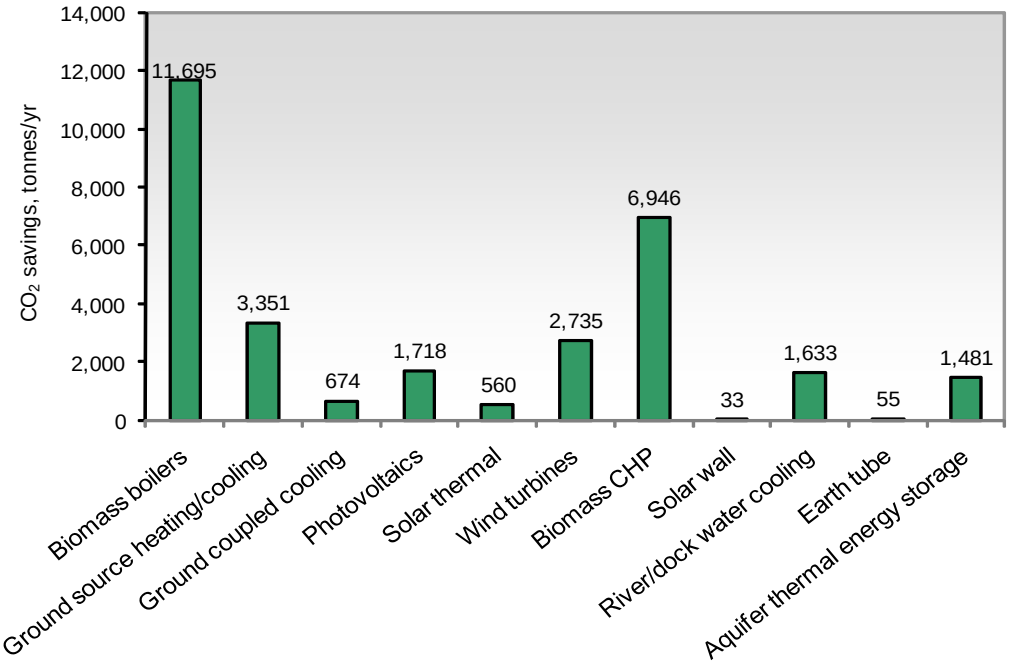

Figure 21 Overall CO_2 savings by RE technology type (across 147 developments)

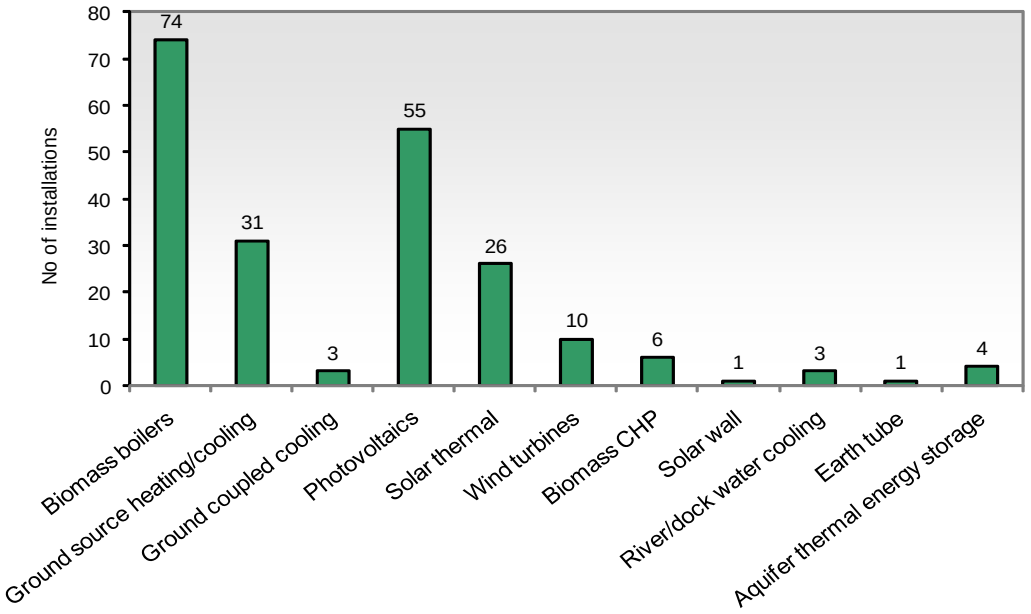

Figure 22 Number of installations by RE technology type (across 147 developments)

Figure 23 indicates that the highest savings per installation were made using biomass CHP (see explanation given in Section 2.4.1). More renewable energy technologies have emerged including river/dock water cooling systems (3 installations) and Aquifer Thermal Energy Storage (ATES) or Borehole Thermal Energy Storage (BTES) systems (4 installations). These schemes also give relatively higher savings per installation compared with the other more conventional options. Whilst these novel applications are supported in the London Plan, there are still uncertainties surrounding their installation and operation.

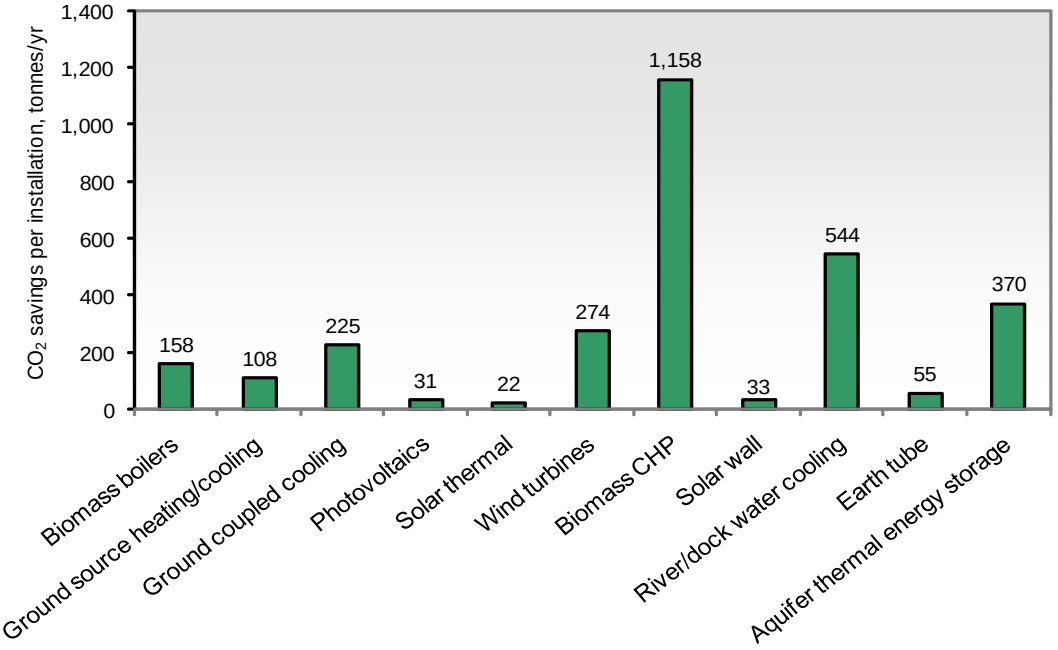

Figure 23 Average CO_2 savings per installation of RE technology type (across 147 developments)

Figure 24 and Figure 25 show the growth in CO_2 savings and number of installations specified by technology respectively over time[27]. These show strong growth in biomass heating and steady specification of ground source heat pumps, PV and solar thermal. The others show step changes - indicating their size and relative potential contribution.

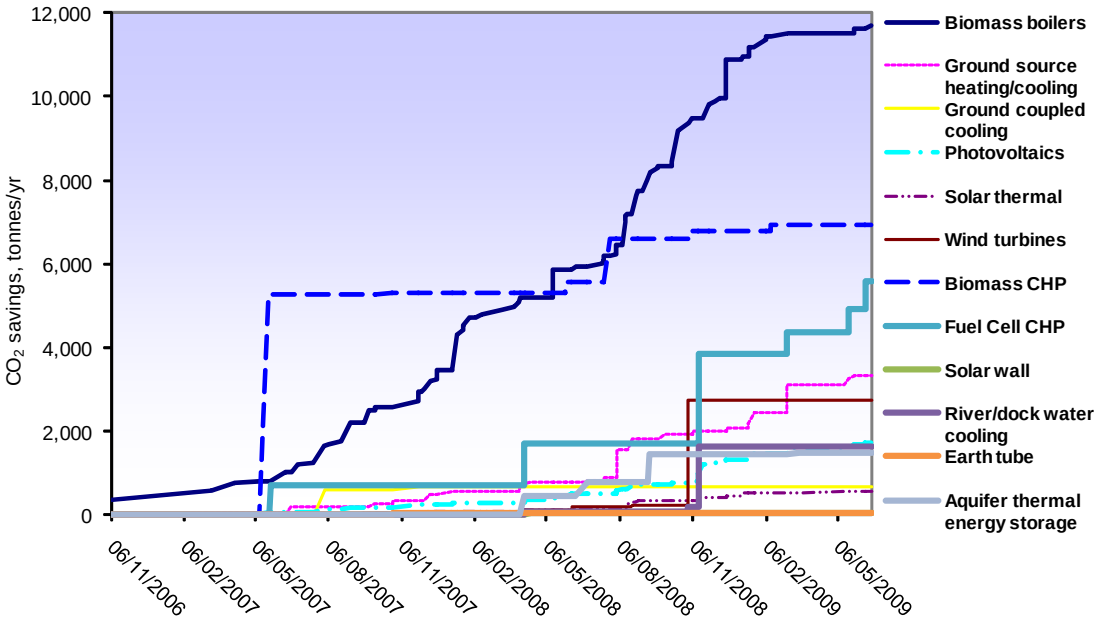

Figure 24 Cumulative CO_2 savings by RE technology type (across 147 developments)

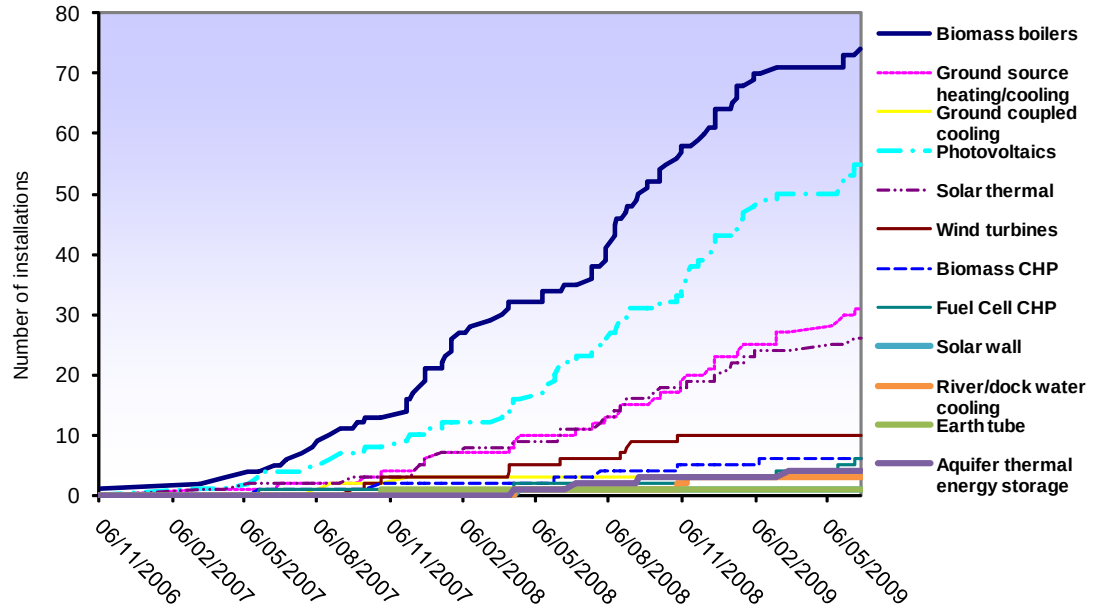

Figure 25 Cumulative number of installations by RE technology type (across 147 developments)

[27] The dates used here refer to the Stage II report dates at which time the applications were formally approved by the Mayor. The Stage II reports are available from: http://www.london.gov.uk/mayor/planning_decisions/

3. Conclusions and Recommendations

The results of the study suggest that:

- The Mayor's climate change mitigation and energy policies in the London Plan **have been successful in significantly reducing energy consumption and CO_2 emissions in new developments** and go well beyond the national requirements set out in 2006 Building Regulations Part L;

- Since the publication of the draft FALP in September 2006, **more than half of the planning applications analysed achieved CO_2 savings of at least 30%** and approximately **a quarter met or exceeded 40% CO_2 savings** through the use of a combination of energy efficiency, CHP and renewable energy measures;

- The CO_2 savings achieved demonstrate the impact that London Plan policies have had to date over and above building regulations. They also show the potential that London Plan[28] has to drive CO_2. A number of the applications sampled through this study would meet the draft replacement Plan's tougher CO_2 standards for 2010-13, demonstrating that more challenging CO_2 targets are achievable and can drive even more efficient design solutions.

- On average, **30% reductions in CO_2 were achieved from the sample between November 2006 and June 2009.** These savings amount to just over 116,000 tonnes of CO_2 per year. The **average savings from the applications sampled has increased from 29% in 2006 to 33% in 2009**, and has consistently exceeded 30% from mid-2007 onwards;

- By 2009, the average CO_2 savings achieved were 33%, this is made up of 14% from energy efficiency measures beyond the baseline, 9% related to the use of gas-fired[29] CHP and a further 10% from renewable energy technologies. Many applications were able to ge well beyond the average savings. , although many of the developments achieved well beyond these averages. The baseline reflects whole emissions i.e. both the emissions from regulated energy uses under the 2006 Building Regulations Part L minimum standard and the additional emissions from non-regulated energy uses such as cooking and equipment;

- **The number of gas-fired CHP installations has increased from 34 in the 2007 report[30] to 94 in the current sample**. Also, an additional 6 installations each of biomass and fuel cell CHP have recently been proposed compared to 2 installations each reported[31] in 2007;

- The emphasis on maximising overall CO_2 savings through the hierachy, including the encouragement of district heating and on-site CHP has in some developments affected the opportunity for certain types of renewable energy technology.

[28] http://www.london.gov.uk/shaping-london/london-plan/strategy/download.jsp
[29] Refers to natural gas from fossil fuels
[30] A.R. Day, P.G. Jones and P. Ogumka (July 2007), Review of the impact of the energy policies in the London plan on applications referred to the Mayor (Phase 2), London South Bank University/Greater London Authority, Available from: http://www.london.gov.uk/mayor/planning/docs/lsbu-research.pdf Accessed 26th March 2009
[31] Ibid

Following changes to London Plan energy policies, greater emphasis has been placed on connecting new developments into existing district heating schemes and incorporating on-site CHP with site-wide communal heating networks where feasible. In certain schemes where gas-fired CHP has been proposed, the requirement to optimise the size of the CHP, based on total site thermal load has meant that the available demand met by from renewable energy (particularly renewable heat) became more limited. Thus, developments that achieved high CO_2 savings from CHP, delivered lower CO_2 savings from renewable energy technologies and vice versa;

- The overall CO_2 savings made are continuing to increase. The share of how those savings are made varies from development to development. The contribution that energy efficiency, CHP and renewable energy can make varies from development to development. For example in some applications renewable energy was able to contribute well over 30 per cent of savings, but in some cases contributed under 10 per cent. Flexibility is important to achieve the maximum overall CO2 savings from developments.

- **A quarter of the sample met or exceeded 20% CO_2 savings from renewable energy technologies, a third of developments achieving between 10% and 20% CO_2 savings**, and a further 38% achieving up to 10% savings;

- Biomass boilers, photovoltaics (PV), ground source heat pumps (GSHP) and solar thermal were the most popular renewable technologies (in that order). This order of popularity differs from that observed in the 2007 study (solar thermal, biomass boilers, PV and GSHP). The sudden growth in the proposed number of biomass boilers may be an indication of growing confidence in fuel source and its CO_2 saving potential, while the growth in proposed PV installations may be related to its compatibility with CHP as well as its ease of specification and installation;

- The order of technologies in terms of overall savings is similar to the previous study with CHP, biomass and GSHP systems in the lead. This is greatly influenced by the large scale nature of these technologies;

Recommendations

In view of the success of the Mayor's policies, the following are recommended:

1. The GLA should consider moving towards overall carbon emissions reduction targets for development proposals whilst maintaining an obligation for renewable energy in accordance with the current energy hierarchy. This will encourage diversity of solutions and maintain the uptake of renewables. The evidence from this study suggests that total carbon savings of at least 30% with at least 10% renewables is being routinely met on average. Therefore as a starting point a more challenging target of at least 40% total carbon savings should be proposed, whilst bearing in mind that proposed tightening of Building Regulations Part L will make these savings even more challenging in future;

2. Further work should be conducted to analyse technology savings in relation to building types and sizes. This will help provide an indication of the best technology applications for different building types. There may well be a trend in the type and size of technologies used on specific building types;

3. A standard template for energy statement submissions to the GLA should be developed. This will help improve the quality of data submitted, make the submission process simpler and more precise, and ensure monitoring of data is easier in the future. The template developed by LSBU which has been used for gathering data for this study could serve as a first draft in taking this forward. In particular, recording installation sizes and capacities should be a standard requirement in any reporting;

4. The GLA should ensure that all planning applications, in particular the required energy statements, are submitted and filed electronically, with key information held on a central database and updated on a regular basis. This would enable future analysis to be conducted rapidly and reliably.

5. Acknowledgements

We would like to acknowledge the valuable assistance given by all the GLA staff, in particular Alina Lazar, Syed Ahmed, Peter Daw and David Taylor-Valiant. We thank the LSBU team that helped with this project, especially Godswill Arum. The contribution of Metropolis Green has been very valuable. Also, we value the input of developers, architects and energy consultants assisting us with Part Two (reviewing the 'as-built' status of renewable installations) of this on-going study.

Appendix 1 – List of applications analysed

S/No	GLA Case name	PDU No.	Mayor's report Stage II approval date	Planning Application Number	Developer	Architect	Energy Consultant ID	Borough
1	Eastern side of Indescon Court, 20 Millharbour	0176c	06/11/2006	05/01294	Sir Robert Ogden	Metropolitan Workshops	RPS	Tower Hamlets
2	Ropemaker Place, 25 Ropemaker Street	0206a	12/03/2007	P062728	Dominion Corporate Trustees & British Land	Arup Associates	Arup Associates	Islington
3	22 Marsh Wall, Isle of Dogs	1050a	10/04/2007	PA/06/01439	Chalegrove Properties Limited	Squire and Partners	Hoare LEA	Tower Hamlets
4	Sedgehill school	1608	11/05/2007	06/64389	Learning 21	Learning 21	Scott Wilson	Lewisham
5	Heathrow East Terminal	1538	23/05/2007	62360/APP/2006/2942	BAA	Fosters and Partners	BAA	Hillingdon
6	Arrowhead Quay, Marsh Wall	0018b	25/05/2007	PA/07/00347	Cartman Ltd	SOM	DSA Engineering	Tower Hamlets
7	London Metropolitan University, Pentonville	1563a	13/06/2007	P070448	London Metropolitan University	TP Bennett	Cundall Genesys Environmental	Islington
8	former Essex House, 100 George Street, Croydon	1585	20/06/2007	06/04991	Terrace Hill Croydon Ltd	Sheppard Robson	RYB Konsult	Croydon
9	Creekside Village (West)	0312d	29/06/2007	06/2062	Creekside Ltd.	Squire and Partners	Ove Arup & Partners Ltd	Greenwich
10	Crown Woods School	1666	18/07/2007	07/0899	Greenwich Council	Nicholas Hare Architects	BDP	Greenwich
11	Bucklersbury House, Walbrook Square	1207	01/08/2007	06/00442/FUL	Legal and General City Offices Limited Partnership	Foster and Partners and Ateliers Jean Nouvel	NDY Consulting Ltd	City of London
12	79-89 Uxbridge Road	1431	06/08/2007	P/2007/1119	Standard Life Investment Funds Limited	YRM Architects	Watkin Payne Partnership	Ealing

							(WPP)	
13	West Brook Crescent, East Barnet	1740	22/08/2007	N02587K/07	Jewish Community Secondary School	RHWL	Foreman Roberts	Barnet
14	Merchant Square, Paddington Basin	1317	03/09/2007	06/00929	Paddington Development Corporation Ltd	Perkins + Will	NDY Consulting Engineers	Westminister
15	Zenith House	1447 & 1696	19/09/2007	W01156AH/07 & W01156AJ/07	Genesis Housing Group	European Urban Architecture	RYB Konsult	Barnet
16	former Middlesex Hospital, Mortimer Street	1561	25/09/2007	PT/07/01120/FULL	Project Abbey (Guernsey) Holdings Ltd	Make	Ove Arup & Partners Ltd	Westminister
17	Wandsworth Business Village, Broomhill Road	1334	03/10/2007	2007-2999	Workspace Glebe	Rolfe Judd Architects	Waterman building services	Wandsworth
18	Uxbridge High School	1805 & 1806	04/10/2007	6528/APP/2007/2043 & 2074	Uxbridge High School	Architects Design Partnership LLP	BDP	Hillingdon
19	Sainsbury's, Stadium Way, Crayford	1203b	25/10/2007	06/11504/FULM	Sainsbury's Stores Limited	Chetwood Associates	Synergy	Bexley
20	Highbury Grove School	1935	25/10/2007	P071736	Transform Schools (on behalf of BSF)		Transform schools and BDP	Islington
21	Riverside South, Canary Wharf	0524a	27/11/2007	PA/07/00935	Canary Wharf Ltd	Rogers Stirk Harbour & Partners	Hilson Moran Ltd	Tower Hamlets
22	150 High Street Stratford (Kessler Site)	1581a	27/11/2007	07/01166/LTGDC	Seapoint Dev. Ltd & Genesis Housing Group	Stock Woolstencroft Architects	ESD	Newham
23	Tottenham Hotspur football training facility Land at Bulls Cross, Enfield	1330b	27/11/2007	TP/07/1623	Tottenham Hotspur Football Club,	KSS	Fulcrum Consulting	Enfield
24	National Car Park site, Hammersmith Grove	1654	30/11/2007	07/02005/FUL	Development Securities & London Underground Ltd	Hamiltons Architects		Hammersmith & Fulham

25	Thomas Tallis School	1667a	04/12/2007	07/2217	Greenwich Council	John McAslan and Partners	BDP	Greenwich
26	Creekside Village (East)	1402	12/12/2007	DC/06/63352B & DC/06/63352C. LBG: 06/2290/F	Ampurius NuHomes Investments Ltd	Squire and Partners	Battle McCarthy Consulting	Greenwich
27	Milton Court, The Guildhall School	1408 & 1408a	12/12/2007	06/01160/FULEIA and 06/01161/LBC	Heron Property Corporation Ltd	David Walker Architects	Foreman Roberts	City of London
28	721-737 Commercial Road, E14	1434	19/12/2007	PA/06/02081	Sure Estates Limited	Stock Woolstencroft	Energy for Sustainable Development	Tower Hamlets
29	Thurston Road Industrial Estate	0612b	19/12/2007	07/65251	Chesterhouse Properties	Barton Willmore	Whitecode Design Associates	Lewisham
30	160-188 High Street, Stratford	0584d	19/12/2007	07/01390/LTGDC	McFeely Group	Stock Woolstencroft Architects	Energy for Sustainable Development	Newham
31	Chichester House 278 - 282 High Holborn	1778	19/12/2007	2007/3967/P	HEDF	GMW	Faber Maunsell	Camden
32	Crown House 51 Aldwych WC1	1930	09/01/2008	PT/07/06901/FUL	UKI (Kingsway) Ltd	Sidell Gibson Architects	Fulcrum Consulting	Westminister
33	Wedge House, 32-40 Blackfriars Road, SE1	1989	09/01/2008	07-AP-2332	Derwent Valley London Ltd	Lifschutz Davidson	Norman Disney Young	Southwark
34	Greenwich Millennium Village	0519e	14/01/2008	07/2704/F	Greenwich Millennium Village Ltd	Broadway Malyan	Hoare Lea	Greenwich
35	Bedfont Trading Estate	1569	21/01/2008	06/3263	Trehaven Group	Nathaniel Lichfield and Partners	URS Corporation Ltd	Hounslow
36	181-183 Warwick Road	0739a	22/01/2008	06/2568	Warwick Road Developments Ltd.	Allies & Morrison	Centreline Building Services Consultants	Kensington and Chelsea
37	Central Square Wembley	2032	22/01/2008	07/3548	Sowcrest Ltd	Dexter Moren Architects	Halcrow Yolles	Brent
38	Land Adjacent to	1715	30/01/2008	07/03483/OUTM	Burt Bolton Housings,	PRC Group	Cudd Bentley	Bexley

	Nufarm Ltd, Belvedere				Aynho Estates, L&P Ltd		Consulting Ltd	
39	Norwood Green Road, Southall	1798	07/02/2008	2007/3165	Trustees of Gurdwara Sri Guru Singh Sabha Southal	Architects Co-Partnership	QuinnRoss Consutants Ltd	Ealing
40	160 Bromley Road	2000	14/02/2008	DC/07/67513	Access Self Storage Ltd	MMA	SRE	Lewisham
41	21 Wapping Lane	1040a	10/03/2008	PA/06/1787	Eulysses Ltd (part of the Ballymore grp of coy)	PDP Architects	HOARE LEA	Tower Hamlets
42	Former Elizabeth Garrett Anderson Hospital, Euston Road	0140a	25/03/2008	2007/3736/P	UNISON	Squire and Partners	Foreman Roberts	Camden
43	London Park Hotel Site, Elephant & Castle	1517	26/03/2008	07-AP-0760	English Partnerships and First Base	Richard Rogers	First Base	Southwark
44	Stonegrove and Spur Road Estates	1652	01/04/2008	W13582E/07	Barratt Homes, Barnet Council & FMHA	Sprunt Architects	HBS Consulting Engineers	Barnet
45	32 - 42 Bethnal Green Road, Shoreditch	1621	02/04/2008	07/2193	Telford Homes and Genesis Housing Group	Stock Woolstencroft	ESD	Tower Hamlets
46	100 George Street (former Essex House site)	1585a	02/04/2008	08/00131/P	Terrace Hill Croydon Limited	Sheppard Robson	RYB Konsult	Croydon
47	Former Pirelli Works, Erith	2122	02/04/2008	07/17924/FUL	Bericote Properties Ltd	Michael Sparks Associates		Bexley
48	20 Blackfriars Road	1024	08/04/2008	07-AP-0301	Land Securities	Wilkinson Eyre Architects	Roger Preston Environmental	Southwark
49	Heron Quays West	1995	08/04/2008	PA/07/03088, PA/07/03089 & PA/07/03090	South Quay Properties Ltd	Rogers, Stirk, Harbour & Partners & Patel Taylor	Hilson Moran	Tower Hamlets
50	Royal London House, 22-25 Finsbury Square, EC2	2028	08/04/2008	PO60001	Shieldpoint 22 Ltd	Sheppard Robson	HOARE LEE Sustainability	Islington

51	B & Q, 500 Purley Way	1750	16/04/2008	07/02350/P	B & Q Properties Ltd	Harris Partnership	White Young Green	Croydon
52	North East Quadrant,. Regents Place	1294	14/05/2008	2007/0823/P	British Land Company Plc	Wilkinson Eyre & Munkenbeck& Marshall Urbanism	Watkins Payne	Camden
53	Woodberry Down Estate - Kick Start Site One	1826	14/05/2008	07/1841	Berkeley Homes Ltd	Wilkinson Eyre Architects and Rolfe Judd.	WSP Energy & Environment	Hackney
54	Caspian Works, Strong & Hoe sites	1982	14/05/2008	PA/07/2706	Berkeley Homes	KKM Architects		Tower Hamlets
55	York House, Waterloo	2120	14/05/2008	08/00629/FUL	York Trust for Land	Sheppard Robson	Faber Maunsell Limited	Lambeth
56	30 Old Bailey	1450	29/05/2008	07/00382/FULEIA	City of London Real Property Company Ltd	MAKE Architects	Ove Arup & Partners Ltd	City of London
57	Trocadero, 13 Coventry Street, W1	1813	29/05/2008	PT/07/05504/FUL L	London Trocadero Ltd	Sheppard Robson	Charterhouse energy	Westminister
58	Gayton Road car park	2030	29/05/2008	P/4126/07/CFU & P/1254/08/CFU	Fairview New Homes and Mount Anvil	Metropolis Architectural Studios	Scott Wilson	Harrow
59	Former TACentre, Warwick Road	1604b	02/06/2008	08/00218	Nalex Limited	SOM	Faber Maunsell	Kensington and Chelsea
60	Ibis Hotel, Lillie Road, Fulham	1482a	06/06/2008	07/00608/OUT	Goodearth Hotels Ltd	Halpern	Scott Wilson	Hammersmith & Fulham
61	Former Sleepeze Site, 61 Morden Road	2016	06/06/2008	07/P3812	Easter Properties Ltd and Norwich Union Life	Hamiltons	Faber Maunsell	Merton
62	Ransomel's Wharf, Battersea	1759	11/06/2008	2008/0407	The Curatus Trust Company	CZWG Architects llP	Fulcrum consulting	Wandsworth
63	East India Dock Road	0181a	25/06/2008	PA/07/00391	Barret Homes Ltd., Circle Anglia Ltd.,etc	CZWG	URS Corporation Ltd	Tower Hamlets
64	Wah Kwong House	2033a	25/06/2008	08/01136	G&G Properties	RHWL Architects	Halcrow Yolles	Lambeth

65	Croydon Vocational College	1345&1345a	15/07/2008	06/00845/P and 06/00855/P	Croydon College	Nightingale Associates	Ove Arup & Partners Ltd	Croydon
66	Terminal 5 Hotel	2173	16/07/2008	2008/1333	Arora International	One Architecture Ltd	SFaber Maunsell	Hillingdon
67	61-63 Great Suffolk Street, SE1	1969a	16/07/2008	08-AP-1034	Q Developments Ltd	Conran and Partners	Richard Hodkinson Consultancy	Southwark
68	Harrow College, Harrow	1623	17/07/2008	P/0707/08CFU	Harrow College	MJP Architects	HOARE LEA	Harrow
69	Tesco site, High Road & Trout Road, Yiewsley	2087	25/07/2008	60929/APP/2007/3744	Tesco Stores Ltd	ColladoCollins	Scott Wilson	Hillingdon
70	Land at Prestons Road and Yabsley Street	1376	01/08/2008	PA/05/1866	Baladine Properties	HKR Architects	Hilson Moran Partnership Ltd	Tower Hamlets
71	Trinity EC3 (Aldgate Bus Station)	1497	01/08/2008	06/00727/FULEIA	Minories Estate Ltd	Foreign Office Architects	Atelier Ten	City of London
72	Grand Union Centre, Ladbroke Grove	1576 & 1576a	01/08/2008	07/01345 and 07/01346	Workspace Glebe	Stiff and Trevillion	Hoare Lea	Kensington and Chelsea
73	56 Bloemfontein Road	1419a	01/08/2008	2007/04690	Building Better Health Ltd	Rogers Stirk Harbour & Partners	Cundall Genesys Environmental	Hammersmith & Fulham
74	former Bishop Challoner School site	0961b	01/08/2008	PA/08/00305	Bellway Thames Gateway North	Stock Woolstencroft	URS Corporation Ltd.	Tower Hamlets
75	Kender Triangle NDC	2165	08/08/2008	DC/08/68448	New Cross Gate New Deal for Com. & Rydon	Feilden Clegg Bradley Studios LLP	Max fordham	Lewisham
76	UEL Barking Campus	1292	13/08/2008	06/01284/OUT	George Wimpey and Quadrant Housing Trust	Assael Architecture Ltd	Fulcrum Consulting	Barking and Dagenham
77	Former EMI site,Hayes	1502a	13/08/2008	59872/APP/2007/3060	Hayes General Partner Limited	Munkenbeck & Marshall	Fulcrum Consulting	Hillingdon
78	Haggerston West	1047	13/08/2008	2007/2889	London and Quadrant	PRP Architects	WATERMAN	Hackney

	and Kingsland Estates				Housing Trust		BUILDING SERVICES	
79	land at the corner of Great Suffolk Street and Lavington Street, Bankside	1786a	15/08/2008	08-AP-1330	UNITE group PLC	Allies and Morrison	WATERMAN BUILDING SERVICES	Southwark
80	144-152 Bermondsey Street	1712a	20/08/2008	08/AP/1096	Haysboro Limited	Munkenbeck & Marshall	McBains Cooper	Southwark
81	Chambers Wharf, Bermondsey	1645	21/08/2008	07-AP-1262	St. Martins Property Investments Ltd	Ian Simpson Architects	hoare Lea	Southwark
82	St. Paul's School	1291a	26/08/2008	08/1760/OUT	St. Paul's School	Patel Taylor Architects	ROGER PRESTON ENVIRONMENTAL	Richmond upon Thames
83	Stonebridge Schools Site, Stonebridge Estate	1988	28/08/2008	07/2932	Stonebridge Housing Action Trust	Shepheard Epstein	Calford Seaden consultants	Brent
84	Telephone Exchange, Warwick Road	2144	28/08/2008	08/01214	Northacre	Squire and Partners	Faber Maunsell Limited	Kensington and Chelsea
85	Colonite Wharf, River Road, Barking	1675	03/09/2008	07/00224/FUL	Barking Riverside Ltd.		Barking Riverside Ltd.	Barking and Dagenham
86	Land to the western side of Central Parade, New Addington	1529	09/09/2008	08/00216/P	Tesco Stores Limited	accord architecture	Scott Wilson	Croydon
87	Minoco Wharf	1768/1769/1776/1777	12/09/2008	07/01140, 07/01141, 07/01142, & 07/01143	Clearstorm Ltd	3D Ried	Hoare Lea	Newham
88	Roman Place	2070	23/09/2008	PA/07/03277	Goldquest Investments Limited	Stock Woolstencroft	Hoare Lea	Tower Hamlets
89	Stockwell Street, Greenwich	0346a	23/09/2008	07/0897/F	Capital & Counties Properties Ltd	Sidell Gibson Architects	ARUP	Greenwich

90	Rayners Lane phases E to H	0489a	01/10/2008	P/0431/08COU	Home Group RSL	MEPK architects	RPS	Harrow
91	Turks Boatyard	2089	09/10/2008	07/12536	UA Developments Limited	MAA Architects	SRE	Kingston upon Thames
92	Apart-hotel, Olympia	2137	09/10/2008	2008/00547/FUL	Sunlight Projects Ltd/Earls Court and Olympia Grou	Glenn Howells Architects	Centreline Building Services Consultants	Hammersmith & Fulham
93	RAF Bentley Priory, Stanmore	2099	09/10/2008	P/1452	VSM Estates	Robert Adam Architects	Halcrow Yolles	Harrow
94	Elizabeth House, Waterloo	0935a	17/10/2008	07/02628/FUL	P & O Estates (DP World)	Allies and Morrison	Roger Preston Environmental	Lambeth
95	Packington Estate	1433	30/10/2008	P062806	Hyde Housing Ass. & Rydon Construction Ltd	Pollard Thomas Edwards Architects	HOARE LEA	Islington
96	Crossness Sewage Treatment Works	2151	30/10/2008	08/03936/FULEA	Thames Water Utilities Ltd	Charles Planning Associates Ltd	Ove Arup & Partners Ltd	Bexley
97	Odeon West End	1580	30/10/2008	08/03016/FULL	Leicester Square Group	Make architects	Roger Preston Environmental	Westminister
98	Millwall Cutting and South Dock	2218	30/10/2008	PA/08/01359	Aquiva (Thames Quay) Limited		White Young Green	Tower Hamlets
99	Greenwich Peninsula (Plot N0602)	2124	04/11/2008	08/1013/F	Peninsula Quays Limited	Patel Taylor LLP	HILSON MORAN PARTNERSHIP LTD	Greenwich
100	World of Golf	2216	04/11/2008	08/02139/FULL1	Ashtour Ltd	Strutt Parker	J W Associates	Bromley
101	Swiss Cottage School	2230	04/11/2008	2008/3662/P	Camden Building Schools for the Future	Seymour Harris Architecture	RYB Konsult	Camden
102	Vauxhall Sky Gardens	2116	04/11/2008	08/02750/FUL	Fairbriar Projects	Amin Taha Associates and Carey Jones	WSP	Lambeth
103	Newfoundland, Canary Wharf	2110	12/11/2008	PA/08/00598	South Quay Properties Ltd	Patel Taylor	HOARE LEA	Tower Hamlets
104	Wood Wharf, Isle of Dogs	2208	12/11/2008	PA/08/01215, PA/08/01217,	Wood Wharf (General Partner) Ltd.	Rogers Stirk Harbour + Partners	Hilson Moran	Tower Hamlets

				PA/08/01218				
105	Crossrail Station, Isle of Dogs	2184a	12/11/2008	PA/08/01651	Cross London Rail Links Ltd &Canary Wharf Group	Tony Meadows Associates & Foster + Partners	ARUP	Tower Hamlets
106	Cumberland Avenue and Rainsford Road	2261	12/11/2008	08/2380	Standard Life and Canmoor Ltd	Michael Sparks	DSA ENGINEERING	Brent
107	former Catford Greyhound Stadium	1723	17/11/2008	DC/07/67276	Countryside Prop, Eng Part. &Hyde Housing Ass	Hunter and Partners Ltd	Faber Maunsell	Lewisham
108	St. Andrew's Hospital site	684	25/11/2008	PA/08/01161 and PA/08/01162	London Development Agency and Barratt Homes	Allies and Morrison Architects		Tower Hamlets
109	land at Downtown Road	2215	25/11/2008	08-AP-1563	Barratt Homes Ltd	Proctor and Matthews	Bespoke Builder Services Ltd	Southwark
110	Wards Corner, Seven Sisters	1973	03/12/2008	HGY/2008/0303	Grainger (Seven Sisters) Ltd	Pollard Thomas Edwards	Fulcrum Consulting	Haringey
111	GE Lighting Site, Great Cambridge Road	2080	09/12/2008	TP/08/1077	Frontier Key (Enfield) Ltd	Powell Dobson.	RPS Planning & Development	Enfield
112	Hartfield Road Car Park	1457a	17/12/2008	07/P3813	Wimbledon Phoenix Limited	Woods Hardwick	Faber Maunsell/Aecom	Merton
113	Crystal Palace Park, Bromley	1295a	17/12/2008	DC/07/03897/OUT	London Development Agency	Latz and partners	Latz + Partner / Waterman Environmental	Bromley
114	Safestore Storage Compound	2233	17/12/2008	HGY/2008/1431	London Borough of Haringey	TP Bennett Architects	RYBKonsult	Haringey
115	Seager Distillery Site, Deptford	0098c	17/12/2008	DC/08/69448	Galliard Homes	BUJ Architects	HOARE LEA	Lewisham
116	Area 3, Canning Town	2168	17/12/2008	08/01599/FUL	Countryside Properties	Maccreanor Lavington and Mouchel	Faber Maunsell Limited	Newham
117	Malcolm House	2273	17/12/2008	08/2633	Summit Hotels Ltd	Ica Architects	RPS	Brent
118	Castle Industrial	1795	17/12/2008	08-AP-2403	Eadon Limited	Tate Hindle	McBain Cooper	Southwark

	Estate, Elephant & Castle							
119	95-111 Brighton Road & 1 Old Lodge Lane, Purley	2333	05/01/2009	08/03343/P	Crest Nicholson (South East) Ltd	Hamiltons	RHB Partnership LLP	Croydon
120	Beavers Lane	2250	07/01/2009	00092/J/P1	Hounslow Homes	Stanford, Eatwell and Associates	PRP	Hounslow
121	Telephone Exchange	1704	14/01/2009	07/00092/FULL	Telereal Services Ltd and British Tel plc	HKR Architects	Hilson Moran	City of London
122	The former Ram Brewery site	1519	14/01/2009	2008/0955	Minerva (Wandsworth) Ltd	EPR Architects Ltd	Hoare Lea	Wandsworth
123	Cockpen House, 20-30 Buckhold Road	1743a	14/01/2009	2008/0960	Minerva plc	ERM Architects	Hoare Lea	Wandsworth
124	Orchard Hill Hospital, Carshalton	1269; 1269a & 1269b	14/01/2009	C2008/59828/OUT & C2008/59820/FUL	Sutton and Merton PCT	HP and Haverstock Associates	Faber Maunsell	Sutton
125	Telehouse West	2192	14/01/2009	PA/08/01799	Telehouse Europe	YRM architects	TELEHOUSE WEST DOCKLANDS	Tower Hamlets
126	Arcadia redevelopment, Ealing	1668	21/01/2009	P/2007/4246-ST	Glenkerrin (UK) LTD	HKR and Foster & Partners	RYB:KONSULT	Ealing
127	1 North Road, Brentford	2195	21/01/2009	00816/A/P11	Betterline Enterprise LTD	Squire and Partners	Mecserve Sustainability	Hounslow
128	Lascar works, Staines Road	1996a	04/02/2009	01054/AB/P10	Beldam Lascar Seals Ltd & Howard Teesland Ltd	Hamilton Associates.	ION Consulting Engineers Ltd	Hounslow
129	6 Paris Garden & 20-21 Hatfields	1815b	04/02/2009	08-AP-2809	JG Paris Gardens LLP and Central School of Ballet	Allies and Morrison	URS	Southwark
130	153 - 157 Tower Bridge Road	0792a	11/02/2009	08-AP-0813	Sunlight Properties Ltd	Weston Williamson Architects	Centreline	Southwark
131	40 Common Road, Stanmore	2321	11/02/2009	P/3206/08	Jewish Care	Kenneth W. Reed & Associates	Hoare Lea	Harrow

132	Middleton Road Playing Fields	2205	04/03/2009	08/P1509	London Borough of Merton	Curl La Tourelle	Halcrow Yolles	Merton
133	Arundel Great Court	2172	04/03/2009	08/08518/FULL	Land Securities	Wilkinson Eyre and Horden Cherry Lee	Roger Preston and Partners	Westminster
134	Airport Bowl, Bath Road	2133a	04/03/2009	38807/APP/2008/3493	Riva Bowl Limited	Foster and Partners.	PHA Consult	Hillingdon
135	National Maritime Museum	2138	18/03/2009	08/2920 & 08/2921 & 08/2910/F	National Maritime Museum	Purcell Miller Tritton	Fulcrum consulting	Greenwich
136	Bridge Road Recreation Ground	1702	13/05/2009	08/2842	Mr John Christie	Studio E Architects Ltd	Faber maunsell/aecom	Brent
137	ExCeL, Phase 2a	2361	19/05/2009	09/00311/0UT	ExCeL London Ltd	Jestico and Whiles	Hoare Lee	Newham
138	20 Fenchurch Street	0044b	20/05/2009	08/01061/FULMAJ	The City of London Real Property Company Ltd	Rafael Viñoly Architects	Hilson Moran	City of London
139	Central Middlesex Hospital	0492a	27/05/2009	08/1043	Montpelier Estates	HLM architects	Services Design Partnership	Brent
140	Compound D Hotel, Terminal 5	2395	27/05/2009	47853/APP/2008/3326	Arora International Hotels	One Architecture Ltd	Faber Maunsell Limited	Hillingdon
141	50 – 57 High Holborn	1814b	27/05/2009	2009/0675/P & 2009/0677/C	Bedell Corporate Trustees & Atrium Trustees Ltd	Sheppard Robson	ARUP	Camden
142	Thistle Hotel, Heathrow	2343	27/05/2009	3063/APP/2009/415	Guoman Hotels	EPR	ME engineers	Hillingdon
143	RAF East Camp (now known as Beaufort Park), Colindale	0522b	10/06/2009	W00198BT/07	St George (Central London) Ltd	Broadway Malayan	Hoare Lee	Barnet
144	10 East Road (New Roman House)	2201	10/06/2009	2008/1991	East Road Investments Ltd	Lifschutz Davidson and Sandilands	Capita Symonds Consulting Engineers	Hackney
145	Aldgate Place, Aldgate	1439a	10/06/2009	PA/08/02690	TST Aldgate Holdings LLC	Wilkinson Eyre	DSA Engineering	Tower Hamlets

146	former General Lying-In Hospital	2430	10/06/2009	09/00841/FUL	General Lying In (York Road) Ltd	Hamiltons	Capita Symonds Ltd	Lambeth
147	18-42 Wharf Road	2127	17/06/2009	2008/1753	RREEF UK Industrial Property Fund	Munkenbeck + Marshall Urbanism Ltd	Hoare Lee	Hackney

Appendix 2 – Calculating technology capacities

- **Biomass/bio fuelled boiler**

Calculation = CO_2 savings / (A * average running hours)

Where:

A = [(gas emission factor/ $\eta_{gas\ boiler}$) – (biomass emission factor/ $\eta_{biomass\ boiler}$)]

Gas emission factor = 0.194 kg CO_2/kWh (Part L 2006)

Biomass emission factor = 0.025 kg CO_2/kWh (Part L 2006)

Average running hours = 1,218 hours (estimated based on the average running hours of cases with reported capacity)

$\eta_{gas\ boiler}$ = 86%

$\eta_{biomass\ boiler}$ = 80%

- **Ground source heating/cooling**

Calculation = CO_2 savings /{C * [A + (B * F * G)]}

Where:

A = [(gas emission factor/ $\eta_{gas\ boiler}$) – (grid supplied electricity emission factor/ GSHP Seasonal COP $_{heating}$)]

B = [(grid supplied electricity emission factor / Seasonal COP $_{electrical\ chiller}$) – (grid supplied electricity emission factor/ GSHP Seasonal COP $_{cooling}$)]

C = [(24* Heating degree days @ 15.5°C)/delta $T_{heating}$]

F = (cooling degree days @ 13°C/ heating degree days @ 15.5°C)*(delta $T_{heating}$/delta $T_{cooling}$)

G = 0.75 (ratio of cooling to heating fuel input to heat pump)

Gas emission factor = 0.194 kg CO_2/kWh (Part L 2006)

Grid supplied electricity emission factor = 0.422 kg CO_2/kWh (Part L 2006)

Hours run = 5,520 hours

$\eta_{gas\ boiler}$ = 86%

Seasonal COP $_{electrical\ chiller}$ = 2.7

GSHP Seasonal COP $_{heating}$ = 4

GSHP Seasonal COP $_{cooling}$ = 3

Difference in system heating design temperature, delta T = 21°C

Difference in system cooling design temperature, delta T = 6°C

Heating degree days @ 15.5°C = 1,862

(sum of heating degree days per annum for London taken from http://www.eci.ox.ac.uk/~rlayber/weekly_updated_data/monthly/Heathrow_monthly_hdd.csv)

Cooling degree days @ 13°C = 579

(sum of cooling degree days per annum for London taken from http://www.eci.ox.ac.uk/~rlayber/weekly_updated_data/monthly_cooling/Heathrow_monthly_cdd.csv)

- **Photovoltaics (PV)**

Calculation = {[CO_2 savings*module rated output]/ [annual power output* grid displaced electricity emission factor]}

Where:

Annual peak irradiance = 1,022 kWh/m^2 (London Renewables Toolkit)

Efficiency factor (Module conversion efficiency*positioning factor*inverter efficiency*system losses factor*packing density factor) = 12% (London Renewables Toolkit)

Annual power output = 123 kWh/m^2

Module rated output = 0.11 kWp/m^2

Grid displaced electricity emission factor = 0.568 kg CO_2/kWh (Part L 2006)

- **Solar water collectors**

Calculation = {[CO_2 savings*module rated output]/ [annual heat output* gas emission factor]}

Where:

Annual peak irradiance = 1,022 kWh/m^2 (London Renewables Toolkit)

Efficiency factor (Module conversion efficiency*positioning factor*utilisation factor) = 40%

Annual heat output = 409 kWh/ m^2

Module rated output = 0.5 kWp/m^2

Gas emission factor = 0.194 kgCO_2/kWh (Part L 2006)

- **Small wind turbines**

Calculation = {[CO_2 savings/ grid displaced electricity emission factor]/ [load factor*number of hours]}

Where:

Grid displaced electricity emission factor = 0.568 kg CO_2/kWh (Part L 2006)

Load factor = 20%

Number of hours = 8,760 hours

- **Gas fired CHP**

Calculation = [CO_2 savings /(A – B + C)]

Where:

A = [(Heat ratio*hours run*gas emission factor)/ $\eta_{gas\ boiler}$]

B = {[(Heat ratio + Power ratio)*hours run*gas emission factor]/η_{CHP}}

C = (hours run*grid displaced electricity emission factor)

Heat ratio = 1.65

Power ratio = 1

Gas emission factor = 0.194 kg CO_2/kWh (Part L 2006)

Grid displaced electricity emission factor = 0.568 kg CO_2/kWh (Part L 2006)

Hours run = 5,520 hours

$\eta_{gas\ boiler}$ = 86%

$\eta_{gas\ CHP}$ = 78%

- **Biomass/bio fuelled CHP**

Calculation = [CO_2 savings / (A – B + C)]

Where:

A = [(Heat ratio*hours run*gas emission factor)/ $\eta_{gas\ boiler}$]

B = {[(Heat ratio + Power ratio)*hours run*gas emission factor]/η_{CHP}}

C = (hours run* grid displaced electricity emission factor)

Heat ratio = 1.80

Power ratio = 1

Gas emission factor = 0.194 kg CO_2/kWh (Part L 2006)

Biomass emission factor = 0.025 kg CO_2/kWh (Part L 2006)

Grid displaced electricity emission factor = 0.568 kg CO_2/kWh (Part L 2006)

Hours run = 5,520 hours

$\eta_{gas\ boiler}$ = 86%

$\eta_{biomass\ CHP}$ = 90%

- **Fuel Cell CHP**

Calculation = [CO_2 savings / (A – B + C)]

Where:

A = [(Heat ratio*hours run*gas emission factor)/ $\eta_{gas\ boiler}$]

B = {[(Heat ratio + Power ratio)*hours run*gas emission factor]/η_{CHP}}

C = (hours run* grid displaced electricity emission factor)

Heat ratio = 1

Power ratio = 1

Gas emission factor = 0.194 kg CO_2/kWh (Part L 2006)

Fuel emission factor = 0.025 kg CO_2/kWh (Part L 2006)

Grid displaced electricity emission factor = 0.568 kg CO_2/kWh (Part L 2006)

Hours run = 5,520 hours

$\eta_{gas\ boiler}$ = 86%

$\eta_{fuel\ cell\ CHP}$ = 90%