CAMDEN GOODS YARD

SUSTAINABLE DESIGN AND CONSTRUCTION STATEMENT

Volume2

Energy Statement

30 June 2017

Site address

Camden Goods Yard

Chalk Farm Road, London NW1 8AA

Energy Statement

Appendix A to the Sustainable Design and Construction Statement

Prepared by

BBS Environmental

For

Safeway Stores Limited and BDW Trading Limited

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Contents

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Assessment type: Full Planning Application

1. Introduction

This Energy Statement has been prepared for the joint Applicants, Safeway Stores Limited Ltd and BDW Trading Limited, by BBS Environmental, a construction consultancy specialising in sustainability, energy conservation and the application of renewable energy technologies. It has been prepared to accompany a detailed planning application for the redevelopment of a site currently occupied by a Morrison's supermarket and a petrol filling station, located just off Chalk Farm Road in the London Borough of Camden.

The proposals for the site comprise the following:

Demolition of existing buildings (Class A1 foodstore and Sui Generis petrol filling station) and associated highways and site works including removal of existing surface level car parking and retaining walls along with road junction alterations.

Redevelopment of petrol filling station site to include the erection of a new building of up to six storeys and up to 11,243 sq m GEA floorspace to accommodate a petrol filling station (Sui Generis), flexible Class A1, A3 and A4 floorspace, Class B1 floorspace and a winter garden; associated cycle parking; public green space; public toilets and other associated works and highways works. For a temporary period of up to thirty months part of the ground and all of the 1st floor of the building will be used for a Class A1 foodstore with associated car parking.

Redevelopment of the main supermarket site to include the erection of buildings (Blocks A to F, including Blocks E1 and E2) of up to 14 storeys accommodating up to 573 homes and up to 60,568 sq m GEA of residential floorspace together with up to 28,333 sq m GEA non-residential floorspace within Class A1 (foodstore), flexible Class A1 and A3, Class B1a and B1c, Class D2 community centre, Sui Generis use at roof level of "Block B" for food and plant growing and production facility (including small scale brewing and distilling) with associated ancillary office, storage, education, training, café and restaurant activities; together with associated new streets and squares; hard and soft landscaping and play space; lifts; public cycle parking and cycle hire facility; and other associated works, including highways works.

Throughout this report, the petrol filling station site is referred to as the "PFS Site" and the main supermarket site is referred to as the "Main Site".

The development will enable a valuable centrally-located site to be utilised in a far more efficient manner, and create a new residential and employment hub on a site that is currently very under-used. The Main Site, which is currently occupied only by the modern supermarket building and an adjoining surface-level car park, is artificially elevated due to its historical use as a railway goods yard, and to enable the railway lines to cross the Regents Canal to the south-east of the site.

The proposed scheme provides for the excavation of the central elevated section of the Main Site to create a single-level of basement parking beneath the original ground level, and a new supermarket, residential ancillary and services spaces, and further undercroft parking at the original ground level. Above this, the scheme features two large podium blocks with mixed use at the lower levels, two taller apartment buildings, two smaller apartment buildings and a terrace containing duplex apartments and town houses. The massing and scale of the scheme has been carefully designed to respond to the surrounding buildings and reduces towards the south-east where the site adjoins streets of low-rise terraced housing. The proposal for the PFS Site includes a new filling station facility and other retail space on the ground floor and office space on the upper five floors.

This Energy Statement sets out the applicable London Plan 2016[(1)] and London Borough of Camden policies on energy, and the methodology for and the results from an energy demand assessment, and is structured as prescribed in guidance issued by the GLA in March 2016[(2)]. It contains an energy demand assessment for regulated energy based on SAP2012 and iSBEMv5 as used for Part L1A/L2A: 2013 of the Building Regulations. It details the energy efficiency measures being incorporated within the development and shows that these will ensure that the dwellings will exceed the requirements of the 2013 Building Regulations using these measures alone. It further shows that the careful façade design and intelligent use of glazing means that the risk of summer overheating and the consequent energy required for comfort cooling is minimal. It also provides an overview of the proposed CHP-based communal heating network that will serve all the apartment buildings and the majority of the non-residential buildings and describes the renewable energy technologies that are proposed as part of the scheme and the reasons why other technologies have been excluded.

Finally, it shows that the selected technologies will result in a reduction in emissions from the development of 35.17% compared to a Part L1A/L2A: 2013 baseline. In presenting this information, this Energy Statement demonstrates that the proposed development will fully satisfy the applicable planning policies relating to energy conservation, distributed energy networks and renewable energy.

Note 1: *The Spatial Development Strategy for London, consolidated with alterations since 2011, GLA (March 2016)*
Note 2: *Energy Planning: GLA Guidance on preparing energy assessments, GLA (March 2016)*

2. Executive Summary

2.1 Introduction

This summary sets out the key measures and carbon dioxide emissions targets proposed for the development in the three stages of the London Plan 2016 energy hierarchy.

The concept of the hierarchy is that in the first instance, at the “Be Lean” stage, passive energy efficiency measures, such as building topology and orientation, and improved insulation, together with certain active measures such as using plant with higher efficiency, should be employed to reduce the energy demand as far as is feasible. The energy hierarchy then requires that at the “Be Clean” stage, the potential for decentralised energy systems and combined heat and power (CHP) is considered. Finally, at the “Be Green” stage, there is a requirement to evaluate the possible application of renewable energy technologies such as solar panels or wind turbines.

The London Plan 2016 sets targets for and requires evaluations of regulated energy use – i.e. energy related to building services such as heating and lighting. Other energy use is classed as unregulated and covers energy used by the building occupants, for, in the case of dwellings, cooking and appliances. The assessment methods do not allow this energy use to be influenced by the Applicant.

2.2 Key results

Table 1: Carbon dioxide emissions (domestic) at each stage of the energy hierarchy

Stage	*Domestic Buildings Carbon dioxide emissions (Tonnes CO_2/yr)*	
	Regulated	*Unregulated*
Building Regulations compliant	***617.47***	***733.17***
After efficiency measures	***582.16***	***733.17***
After CHP	***431.55***	***733.17***
After renewable energy systems	***379.31***	***733.17***

Table 2: Regulated emissions savings (domestic) at each stage of the energy hierarchy

Stage	*Domestic Buildings Carbon dioxide emissions (Tonnes CO_2/yr)*	
	(T CO_2/yr)	*Percentage*
Savings from efficiency measures	***35.31***	***5.72%***
Savings from CHP	***150.61***	***24.39%***
Savings from renewables	***51.39***	***8.32%***
Cumulative on-site savings	***237.31***	***38.43%***
Annual savings to be from offset payment	***380.16***	***61.57%***
30-year savings from offset payment	***11,405 Tonnes***	

Table 3: Carbon dioxide emissions (non-domestic) at each stage of the energy hierarchy

Stage	*Non-domestic Buildings Carbon dioxide emissions (Tonnes CO_2/yr)*	
	Regulated	*Unregulated*
Building Regulations compliant	***526.73***	***401.42***
After efficiency measures	***400.43***	***401.42***
After CHP	***376.33***	***401.42***
After renewable energy systems(3)	***361.58***	***401.42***

Note 3: The buildings on the Main Site are all mixed use, so although they have PV panels, it is planned at this stage to connect them all to the residential intakes. The building on the PFS Site has retail and commercial uses. The PV panels on this building will be connected to supply electricity to the main ASHP heating plant. In the above table (and Table 4) the renewables saving is therefore presented as the contribution from the PFS building PV as a percentage of the total non-residential emissions.

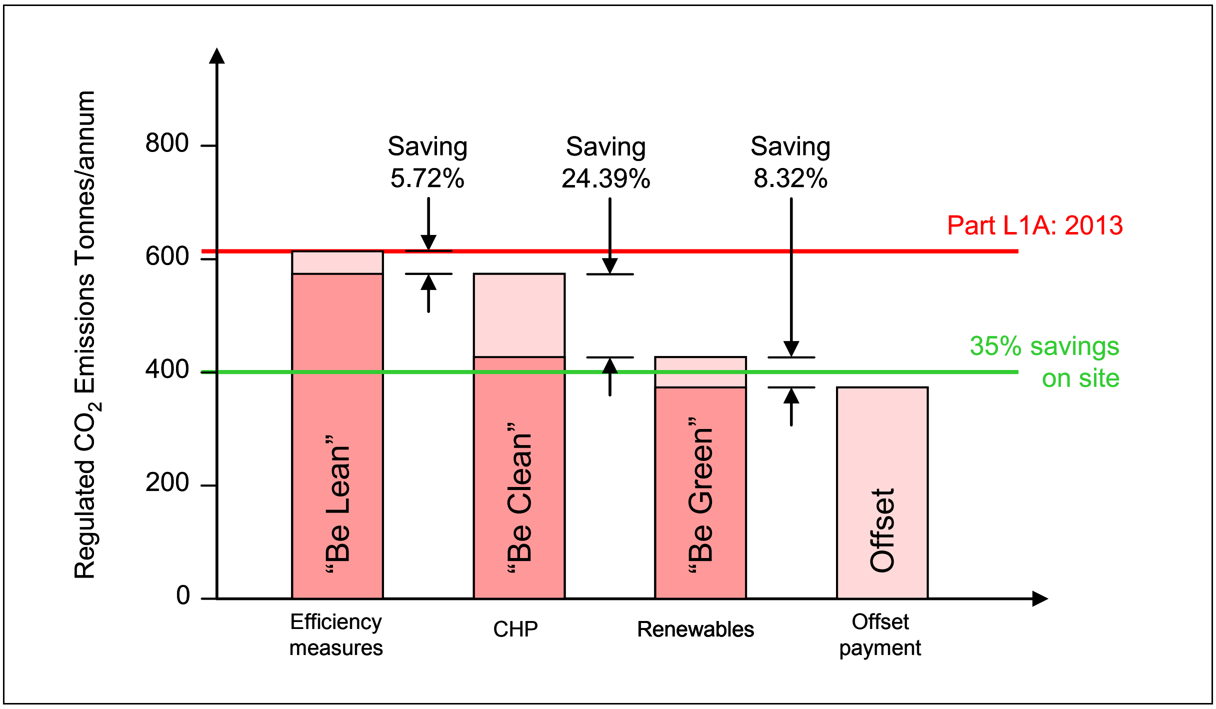
Table 4: Regulated emissions savings (non-domestic) at each stage of the energy hierarchy

Stage	*Non-domestic Buildings Carbon dioxide emissions (Tonnes CO_2/yr)*	
	(T CO_2/yr)	*Percentage*
Savings from efficiency measures	***126.30***	***23.98%***
Savings from CHP	***24.10***	***4.58%***
Savings from renewables	***14.75***	***2.80%***
Cumulative on-site savings	***165.15***	***31.35%***
Annual savings to be from offset payment	***19.20***	***3.65%***
30-year savings from offset payment	***576 Tonnes***	

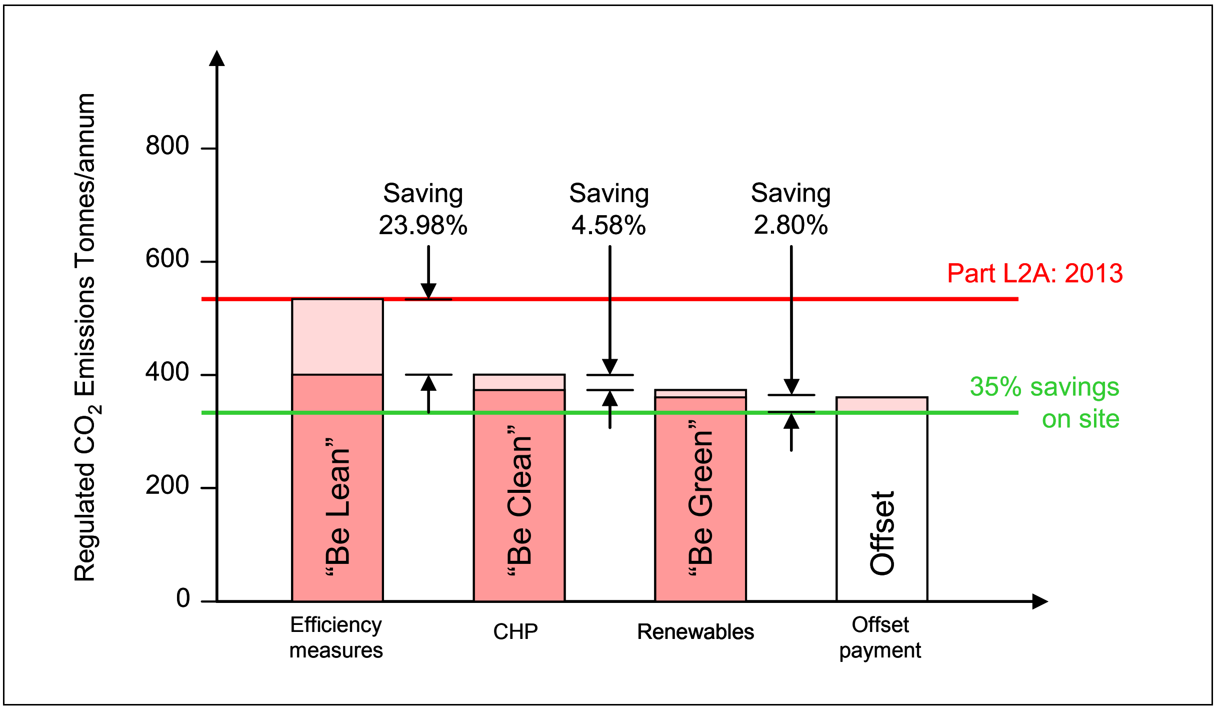
Table 5: Site wide regulated carbon dioxide emissions and savings

Combined results for domestic and non-domestic buildings	*Site wide*		
	Regulated (T CO_2/yr)	*Savings (T CO_2/yr)*	*Percentage*
Building Regulations compliant (2013)	***1144.20***		
Be lean (efficiency)	***982.59***	***161.61***	***14.12%***
Be clean (CHP)	***807.88***	***174.71***	***15.27%***
Be green (renewables)	***741.74***	***66.14***	***5.78%***
Cumulative on-site results		***402.47***	***35.17%***
Total 30-year savings from offset payment	***11,981 Tonnes***		

Graph 1: Domestic energy hierarchy and targets



Graph 2: Non-domestic energy hierarchy and targets



2.3 Key energy-efficient design measures

The development proposals include the provision of the following energy efficiency measures:

- Optimally sized windows that achieve good daylight levels but avoid excessive solar gain in summer and heat loss in winter;
- Insulation in walls, floors and roofs that exceeds the performance levels listed for the reference case in SAP2012 Table R1;
- A design air leakage rate of 4 m^3/m^2hr which is just 40% of the regulatory limit;
- Careful design to reduce the effect of non-repeating thermal bridges including the use of high-performance thermal breaks where appropriate;
- In both residential communal areas and in non-residential units, all lighting will use very low energy lamps with a luminous efficacy of up to 90 lamp-lumens/watt;
- Residential common area lighting will have automatic controls with occupancy and daylight sensors;
- Any white goods that are supplied (fridges, freezers, washer dryers and dishwashers) will be models that are “best practice” for energy consumption;
- Mechanical ventilation systems with heat recovery will be installed in every apartment and the systems used will exceed Energy Savings Trust (EST) “best practice” guidelines.
- Power factor correction in the larger non-residential units;
- Occupant sensors and automatic dimming of lighting in commercial buildings in spaces where there is also natural light;
- In larger non-residential units, all services separately metered, with warning for “out of range values” in accordance with BRREAM guidance; and
- In larger non-residential units, ventilation will be controlled by sensors that detect occupancy density and adjust the ventilation rate accordingly.

These measures will enable the both the dwellings and the non-residential buildings to achieve compliance with the current Building Regulations, Part L1A/L2A: 2013 prior to the addition of low and zero carbon technologies.

2.4 Summary of proposed heating and ventilation systems

The whole of the supermarket site will be heated by a communal heating system, with the main heating plant located in a dedicated Energy Centre located in the undercroft of Block A. The lead heat source will be a gas-fired CHP unit, and supplementary heat will be provided by condensing gas boilers. The flues from the plant room will be routed to the top of Block A, which rises to a height of 14 storeys. Heat will be distributed across the site using pre-insulated heat mains that connect to each building, using local heating sub-stations as necessary.

Each dwelling will be equipped with a high-performance heat recovery ventilation system. It will also have a Heat Interface Unit (HIU) with remote metering which will allow the management company to bill the residents for the heat used. The commercial spaces on this site (supermarket, community, sports, office, and retail units) will also be provided with heat for space heating and hot water from the communal heating system. The proposed comfort cooling that is to be provided to a proportion of the residential units, and where necessary, to the commercial units, will be provided by stand-alone systems with chillers located on the roof of the building concerned.

The new retail and office building on the PFS Site will require both heating and cooling, and have minimal demand for hot water. Therefore, all the space heating and cooling will be provided by Air Source Heat Pumps (ASHPs). The only heat requirement that cannot be wholly met from this system is that for sanitary hot water, and modest demands from any café kitchens. The connection distance to the communal heating network is such that suppling the hot water over this distance would result in disproportionate losses and circulation energy, so no link is proposed. Instead, the carbon emissions from this hot water use will be minimised by using small electric water heaters fed with water pre-heated by the ASHP system, a common arrangement in this scenario.

2.5 Choice and impact of low-carbon energy technologies

The efficiency measures and the ASHPs will deliver a saving of 14.12%. The CHP-based communal heating will deliver sufficient low carbon heat to reduce the predicted carbon dioxide emissions from the development by a further 15.27%. Photovoltaic (PV) panel arrays are proposed for the roofs of all the buildings where the roof form and height makes this a practicable proposition, and will deliver a predicted further saving of 5.78%. These savings will together result in the development achieving an overall reduction in regulated emissions of 35.17% with reference to the 2013 Building Regulations in accordance with March 2016 GLA Guidance. Full details of all calculations and an outline description of the proposed systems are contained within this report.

The CHP unit will be fitted with a catalytic converter to reduce the NO_x emissions to 50 mg/Nm^3 and the boilers are fitted with low NOx burners with maximum emissions of 40 mg/kWh. The impact of the heating plant emissions has been assessed in an Air Quality Impact Assessment that has been prepared to accompany the application, and was found to be negligible. A buildings Air Quality Neutral

Assessment has also been completed in support of the application, in accordance with the London Plan 2016, and the GLA Sustainable Design and Construction SPG (April 2014). This is being submitted as a separate appendix to the Sustainable Design and Construction Statement.

The CHP unit will be supplied with an acoustic enclosure, and acoustic ventilators will be provided to the Energy Centre as necessary to eliminate any material noise impact.

The proposed ASHPs to be used to provide heating and cooling to the new building on the PFS Site will be mounted inside a visually and acoustically screened enclosure on the building roof. The photovoltaic panel arrays of the roofs of the apartment buildings will in some cases be screened from view by the parapet walls. In other cases, and especially where the buildings have pitched roofs, they will be visible. Either way, they will not detract from the appearance of the buildings at street level. Some of the arrays on the lower roofs will be visible from the upper levels of the site but care will be taken to ensure that these arrays have a uniform and tidy appearance.

The proposed low carbon technologies will therefore have no material adverse impact in terms of air quality, noise, or appearance on either the proposed development or the locality.

3. Planning policy context

3.1 Regional and local energy and emissions policies

There are a range of energy-related planning policies that impact upon the design of new residential and commercial developments. The regional policy, *The London Plan 2016*, sets out a requirement to assess energy demand, adopt efficiency measures and renewable energy systems, avoid overheating, and implement distributed energy networks where these are feasible. The London Borough of Camden Local Development Framework Core Strategy, contains essentially identical requirements.

This part of the statement therefore identifies the energy policies that apply to this development namely The London Plan 2016: *Policy 5.2: Minimising carbon dioxide emissions; Policy 5.6: Decentralised energy in development proposals; Policy 5.7: Renewable energy;* and *Policy 5.9: Overheating and cooling*. It also identifies the relevant policies in the LDF Core Strategy: *London Borough of Camden Local Development Framework Core Strategy (November 2010)* so far as they apply to energy issues.

Policy 5.2: Minimising carbon dioxide emission requires that major developments meet specific targets for carbon dioxide emissions reduction. These targets are set in the context of the 2010 Building Regulations and since October 2016, a 100% reduction in the *regulated emissions* (i.e. “zero carbon”) has been required. The *unregulated emissions* are excluded from the assessment in line with the Government policy although they are required to be reported. To demonstrate compliance with the policy it is necessary to assess the energy demand and emissions in detail, and to demonstrate how the “Be lean”; “Be clean” and “Be green” energy hierarchy is being followed and how the emissions targets will be met using efficiency measures, decentralised energy systems and renewable energy technologies as appropriate. It is also acknowledged that it may not be possible to achieve a 100% reduction on site, and that where this is the case any shortfall may be provided by means of a cash in lieu contribution to the borough concerned.

The situation with regard to the on-site targets and offset payments has been further clarified in the *GLA guidance on preparing energy assessments, GLA (March 2016).* This stipulates that subject to the 2013 Regulations being used to determine the baseline and target calculations, a minimum on-site reduction of 35% should be achieved, and that the remaining emissions should be fully offset by means of a carbon offset payment at a rate of £60/Tonne/year for a 30-year period. This assessment therefore follows the March 2016 GLA guidance, and presents all the results in terms of the 2013 regulations notwithstanding the fact that the London Plan 2016 cites the 2010 Regulations.

Policy 5.6: Decentralised energy in development proposals requires that major schemes use communal heating and cooling networks and where possible incorporate CHP and connect to district heating networks or facilitate a future connection should this become available.

Policy 5.7: Renewable energy requires that where feasible, renewable energy systems should be utilised, subject to the system selected being compatible with any proposed communal or district heating system, and there being no adverse impact on local air quality.

Policy 5.9: Overheating and cooling requires that the overheating risk of new developments is considered, and that appropriate mitigation measures are incorporated into the proposals.

The current adopted local energy policy in the London Borough of Camden LDF Core Strategy is *Core Strategy Policy CS13* as supported by *Development Policy DP22 Promoting sustainable design and construction*. The specific targets in these documents have been superseded for major development proposals by *The London Plan 2016.* The emerging local policy is *Policy CC1 Climate change mitigation* in the submission draft of the *Camden Local Plan (2016).* This requires that major developments demonstrate how they meet the regional requirements for carbon dioxide emissions. Further local guidance is provided in the supplementary planning document *CPG3 Sustainability (July 2015).*

3.2 Changes to national planning policy

An amendment to *National Planning Policy* was issued in the form of a *Written Ministerial Statement* (WMS) on 25th March 2015. The WMS announced the abolition of the CSH and a general prohibition on local planning authorities requiring CSH compliance with immediate effect. This is reflected in The London Borough of Camden supplementary planning document *CPG3 Sustainability (July 2015).*

The WMS also announced the introduction of new *National Technical Standards* (NTS) including specifically a new standard on energy and emissions that can be applied by local planning authorities that have in place an existing policy requirement for CSH Level 4 compliance. The new standard was described as being equivalent to compliance with the mandatory requirements of CSH Level 4, section Ene1 which requires a 19% reduction in emissions referenced to Part L1A: 2013. This is significantly less onerous than the March 2016 GLA guidance, which requires an on-site reduction of 35%, so compliance with this NTS is assured. The WMS also announced the creation of National Technical Standards dealing with certain other matters that had previously been covered by the CSH. However, as these are not related to energy they are not considered further in this report.

4. Calculation methodology

The main section of this Energy Statement follows the detailed methodology set out in the GLA guidance issued in March 2016, and accordingly all results are based on the 2013 Part L1A/L2A methodologies. It uses these calculations to calculate the regulated residential energy demand for an extensive range of 122 individual dwelling types that are fully representative of all the dwellings within the proposed development, and the related version of Bredem-12(4) to estimate the unregulated residential energy demand. The energy demand for the non-residential buildings including the supermarket, and the commercial, leisure, and small retail units on the Main Site, and the whole of the PFS Site was similarly estimated using iSBEM version 5. The final totals for the whole development were derived from the individual calculated results by combining the results to represent the total number of dwellings and total floor area of the development.

The SAP2012 compliance calculations were completed with software which implements SAP version 9.92 (June 2014), and the iSBEM calculations were carried out using the approved IES software suite. In all cases the calculations, both with and without CHP, use community heating for all dwellings.

The baseline “compliant” case for emissions was determined by using the Target Emissions Rates (TER) from the compliance calculations. These figures provide an emissions rate, and hence a figure for total regulated emissions from a building. The emissions saving from the efficiency measures (“Be Lean”) was determined by comparing the total emissions based on the TER figures with the predicted emissions based on the actual proposed specification as defined in the Dwelling (or Building) Emissions Rate (DER/BER) from the compliance calculations. Where comfort cooling is proposed the cooling systems were included in all the results determined for the “Be Lean” stage.

The calculation used to determine the potential benefit from CHP for the apartments (“Be Clean”) is defined in SAP Appendix C. The compliance calculations were adjusted to include the CHP unit as a heat source, and the resulting revised DER/BER figures were used to determine the impact on the emissions.

Note 4: *SAP2012 version 9.92, Appendix L,* DECC (June 2014)

5. Energy demand and efficiency

5.1 Baseline emissions

The total regulated energy demand has been calculated taking full account of energy demands for space heating and hot water, and electricity for pumps, fans, and lighting. The baseline emissions were established by reference to the TER figures for each dwelling type and non-residential unit. The TER is the maximum permitted emissions rate for a building, and is expressed in $kgCO_2/m^2$. Thus the total emissions for a building is the product of the TER and the building floor area.

The unregulated emissions for the dwellings were estimated using Bredem-12 as defined in Appendix L of SAP2012, and the unregulated emissions from the non-residential buildings were taken from the iSBEM results. However, since in a residential / non-residential shell and core context the developer has no control over this aspect of energy use, no energy saving measures have been proposed or assessed, so the same figures are used at each stage in the hierarchy.

Table 6: Baseline carbon dioxide emissions

Stage	*Carbon dioxide emissions (Tonnes CO_2/yr) Part L1A/L2A: 2013*	
	Regulated	*Unregulated*
Dwellings	*617.47*	*733.17*
Non-residential areas	*526.73*	*401.42*
Total emissions	***1,144.20***	***1,134.59***

A summary of the results for energy demand for the residential units is provided in Appendix 6, together with a selection of sample SAP worksheets. Full copies of all worksheets have been submitted as Appendix 7, but in electronic .pdf format only as they run to thousands of pages.

5.2 Fabric energy efficiency performance

The 2013 revision to Part L1A included some significant amendments: not only were the emissions targets revised downwards, but a new compliance requirement, the Fabric Energy Efficiency rate (FEE rate) was introduced together with a revision to the way the related “reference” dwelling was specified.

To explain further, the new FEE rate fabric compliance target creates a specific requirement for the thermal performance of the dwelling fabric. This performance measure focuses on the U-values, the thermal bridges at the junctions, the air leakage and the solar gains and excludes the effects of mechanical services such as ventilation systems and heating plant by setting the performance parameters of these systems to standard values.

The FEE rate for the dwelling is the annual energy required for heating and cooling per m2 of floor area (note that cooling is included even if no cooling plant is specified). The actual calculation used is the SAP calculation as this calculates the energy demand as a means of calculating the emissions. However, while such a measure is a very good measure of performance, and is akin to the Passiv Haus measure, in a compliance context the challenge is setting the target, as the result is very dependent on the building form and massing. This had become clear with section Ene2 of the CSH which was based on a virtually identical calculation but used a variety of fixed targets depending on the building type, but even then, was greatly affected by building orientation and the juxtaposition of other buildings. The problem of compliance target setting was solved by calculating a specific target for each dwelling. Hence there is now a Target FEE rate (TFEE) and a Dwelling FEE rate (DFEE) for each dwelling, and for compliance the DFEE rate must be lower than the TFEE rate. This approach is very similar to the TER and DER method used for emissions.

Furthermore, the TFEE rate is calculated using the same set of “reference” specifications as the TER and these are all listed in Appendix R of SAP2012. The TFEE rate for a dwelling is determined using a notional dwelling that is generally identical in all respects to the actual dwelling (i.e. size, shape, exposure, orientation etc.) other than that the “reference” specifications are used in place of the actual specifications. However, because this result is very sensitive to solar gains, and because of overheating concerns, in the notional dwelling the window (and door) sizes are limited to 25% of the dwelling floor area. This means that the energy demand created by any additional area of windows compared to having solid walls (lower heat loss in winter and additional cooling demand in summer) must be fully offset by other building fabric enhancements: it cannot be offset by more efficient heating or ventilation systems.

5.3 Façade design and glazing ratio

In practice, offsetting the additional heating and cooling demand from larger windows is very difficult, so the effect of this change to the compliance requirement has been to restrict the size of the windows that can reasonably be incorporated into new residential schemes. Such a restriction obviously reduces the risk of overheating as well, but has proved challenging to architects, and potentially controversial with Design Review Panels, although some have embraced the change(5).

In response to the new FEE rate compliance target the Design Team has taken great care to design a façade scheme that does not simply rely on large areas of glass but uses other materials and texture to create an attractive appearance while allowing the fenestration design to be optimised, and, in particular to ensure that none of the apartments demonstrate more than a “slight” risk of overheating. This aspect of the performance is covered in more depth in Section 6.

To this end the glazing ratio was evaluated as the design progressed and as required by the March 2016 GLA guidance. The ratios from a range of fully representative buildings including Blocks A, B, C, D, E1, E2 and F (calculated with reference to both the heat loss external façade and the dwelling floor area) are set out in the following table:

Table 7: Glazing ratios of example units

Dwelling Reference	*Glazing Area*	*Façade Area*	*Glazing to Façade ratio*	*Floor Area (TFA)*	*Glazing to TFA ratio*
A-1BST41-M-M	4.81	13.88	34.65%	41.0	34.65%
A-1BST41-M-R	4.81	13.88	34.65%	41.0	34.65%
A-1BST41-N-M	9.39	33.86	27.73%	41.0	27.73%
A-1B2P51-M-M	14.59	41.27	35.35%	51.0	35.35%
A-1B2P51-M-R	14.59	41.27	35.35%	51.0	35.35%
A-1B2P51-N-M	14.59	41.27	35.35%	51.0	35.35%
A-1B2P51-N-R	14.59	41.27	35.35%	51.0	35.35%
A-1B2P53-M-M	14.98	41.94	35.72%	53.0	35.72%

Note 5: Interview with Ken Shuttleworth, designer of 30 St Mary Axe, http://www.bbc.co.uk/news/magazine-27501938

A-1B2P53-M-R	14.98	41.94	35.72%	53.0	28.26%
A-1B2P53-N-M	14.98	41.94	35.72%	53.0	28.26%
A-1B2P53-N-R	14.98	41.94	35.72%	53.0	28.26%
A-2B4P77-M-M	20.18	55.22	36.54%	77.0	26.21%
A-2B4P77-M-R	20.18	55.22	36.54%	77.0	26.21%
A-2B4P77-N-M	20.18	55.22	36.54%	77.0	26.21%
A-2B4P77-N-R	20.18	55.22	36.54%	77.0	26.21%
A-3B5P86-M-M	22.09	54.2	40.76%	86.0	25.69%
A-3B5P86-M-R	22.09	54.2	40.76%	86.0	25.69%
A-3B5P100-M-M	22.09	58.1	38.02%	100.0	22.09%
A-3B5P100-M-R	22.09	58.1	38.02%	100.0	22.09%
B-1BST37-N-M	10.01	14.97	66.87%	37.0	27.05%
B-1BST37-S-M	10.01	14.97	66.87%	37.0	27.05%
B-1BST37-S-R	10.01	14.97	66.87%	37.0	27.05%
B-1B2P50-N-M	10.01	19.77	50.63%	50.0	20.02%
B-1B2P50-N-R	10.01	19.77	50.63%	50.0	20.02%
B-1B2P50-S-M	10.01	16.19	61.83%	50.0	20.02%
B-1B2P50-S-R	10.01	16.19	61.83%	50.0	20.02%
B-1B2P57-M-M	14.56	41.12	35.41%	57.0	25.54%
B-1B2P57-M-R	14.56	41.12	35.41%	57.0	25.54%
B-2B3P70-M-M	13.36	26.77	49.91%	70.0	19.09%
B-2B4P71-T-M	16.64	25.9	64.25%	71.0	23.44%
B-2B4P71-T-R	16.64	25.9	64.25%	71.0	23.44%
B-2B4P75-N-M	13.26	29.9	44.35%	75.0	17.68%

B-2B4P75-S-M	16.64	29.9	55.65%	75.0	22.19%
B-2B4P75-S-R	16.64	29.9	55.65%	75.0	22.19%
B-2B4P75-M-M	13.26	23.81	55.69%	75.0	17.68%
B-2B4P75-M-R	13.26	23.81	55.69%	75.0	17.68%
B-2B4P75-A-M	20.02	45.21	44.28%	75.0	26.69%
B-2B4P75-A-R	20.02	45.21	44.28%	75.0	26.69%
B-2B4P75-P-M	20.02	45.21	44.28%	75.0	26.69%
B-2B4P75-P-R	20.02	45.21	44.28%	75.0	26.69%
B-3B5P91-N-M	26.52	52.16	50.84%	91.0	29.14%
B-3B5P91-S-M	26.52	52.16	50.84%	91.0	29.14%
B-3B5P93-T-M	16.64	50.36	33.04%	93.0	17.89%
B-3B5P93-T-R	16.64	50.36	33.04%	93.0	17.89%
B-2B4P94-D-G	13.32	86.97	15.32%	95.0	14.02%
B-3B5P101-N-M	26.52	62.92	42.15%	101.0	26.26%
B-3B5P101-N-R	26.52	62.92	42.15%	101.0	26.26%
C-1B2P52-M-M	11.94	23.27	51.31%	52.0	22.96%
C-1B2P52-M-R	11.94	23.27	51.31%	52.0	22.96%
C-1B2P53-M-M	14.23	40.9	34.79%	53.0	26.85%
C-1B2P53-M-R	14.23	40.9	34.79%	53.0	26.85%
C-1B2P53-N-M	14.23	40.9	34.79%	53.0	26.85%
C-1B2P53-N-R	14.23	40.9	34.79%	53.0	26.85%
C-2B3P73-M-M	22.67	50.36	45.02%	73.0	31.05%
C-2B3P73-M-R	22.67	50.36	45.02%	73.0	31.05%
C-2B3P73-N-M	22.67	50.36	45.02%	73.0	31.05%

C-2B3P73-N-R	22.67	50.36	45.02%	73.0	31.05%
C-2B4P85-M-M	24.63	43.29	56.90%	85.0	28.98%
C-2B4P85-M-R	24.63	43.29	56.90%	85.0	28.98%
C-2B4P85-N-M	24.63	43.29	56.90%	85.0	28.98%
C-2B4P85-N-R	24.63	43.29	56.90%	85.0	28.98%
C-2B4P88-M-M	21.23	53.4	39.76%	88.0	24.13%
C-2B4P88-M-R	21.23	53.4	39.76%	88.0	24.13%
C-2B4P88-N-M	21.23	53.4	39.76%	88.0	24.13%
C-2B4P88-N-R	21.23	53.4	39.76%	88.0	24.13%
D-1B2P51-N-M	14.31	47.42	30.18%	51.0	28.06%
D-1B2P51-N-R	14.31	47.42	30.18%	51.0	28.06%
D-1B2P52-T-M	9.83	40.76	24.12%	52.0	18.90%
D-1B2P52-T-R	9.83	40.76	24.12%	52.0	18.90%
D-1B2P58-S-M	12.14	53.79	22.57%	58.0	20.93%
D-1B2P58-S-R	12.14	53.79	22.57%	58.0	20.93%
D-2B3P66-M-M	17.63	69.84	25.24%	66.0	26.71%
D-2B3P66-M-R	15.39	69.84	22.04%	66.0	23.32%
D-3B5P105-D-G	19.81	60.33	32.84%	105.0	18.87%
D-3B5P115-D-G	23.81	130.19	18.29%	115.0	20.70%
E1-1BST42-M-M	3.50	14.46	24.20%	42.0	8.33%
E1-1BST42-M-R	3.50	14.46	24.20%	42.0	8.33%
E1-1B2P50-N-M	16.24	43.37	37.45%	50.0	32.48%
E1-1B2P50-N-R	16.24	43.37	37.45%	50.0	32.48%
E1-1B2P50-E-M	16.24	43.37	37.45%	50.0	32.48%

E1-1B2P50-E-R	16.24	43.37	37.45%	50.0	32.48%
E1-2B3P70-S-M	16.24	46.15	35.19%	70.0	23.20%
E1-2B3P70-S-R	16.24	46.15	34.30%	70.0	23.20%
E1-2B4P77-W-M	16.24	47.35	34.30%	77.0	21.09%
E1-2B4P77-W-R	16.24	47.35	34.30%	77.0	21.09%
E2-1B2P51-M-M	9.40	32.92	28.55%	51.0	18.43%
E2-2B4P88-D-R	17.74	64.05	27.70%	88.0	20.16%
E2-2B4P91-D-G	18.25	73.93	24.69%	91.0	20.05%
E2-3B5P104-D-G	22.25	82.25	27.05%	104.0	21.39%
E2-3B5P123-D-R	20.12	91.77	21.92%	123.0	16.36%
E2-4B6P127-H-T	30.34	310.24	9.78%	127.0	23.89%
F-1BST40-M-M	7.82	16.95	46.14%	40.0	19.55%
F-1BST40-M-R	7.82	16.95	46.14%	40.0	19.55%
F-1B2P52-M-M	8.20	21.45	38.23%	52.0	15.77%
F-1B2P52-M-R	8.20	21.45	38.23%	52.0	15.77%
F-1B2P52-N-M	8.20	21.45	38.23%	52.0	15.77%
F-1B2P52-N-R	8.20	21.45	38.23%	52.0	15.77%
F-2B3P69-M-M	14.60	28.14	51.88%	69.0	21.16%
F-2B3P69-M-R	14.60	28.14	51.88%	69.0	21.16%
F-2B3P69-N-M	14.60	28.14	51.88%	69.0	21.16%
F-2B3P69-N-R	14.60	28.14	51.88%	69.0	21.16%
F-2B4P70-M-M	14.88	30.5	48.79%	70.0	21.26%
F-2B4P70-M-R	14.88	30.5	48.79%	70.0	21.26%
F-2B4P70-S-M	14.88	30.5	48.79%	70.0	21.26%

F-2B4P70-S-R	14.88	30.5	48.79%	70.0	21.26%
F-2B4P78-T-M	17.15	44.75	38.32%	78.0	21.99%
F-2B4P78-T-R	17.15	44.75	38.32%	78.0	21.99%
F-2B4P78C-T-M	17.15	44.75	38.32%	78.0	21.99%
F-2B4P78C-T-R	17.15	44.75	38.32%	78.0	21.99%
F-2B4P80-D-R	18.94	54.42	34.80%	83.0	22.82%
F-2B4P83-D-G	13.52	60.07	22.51%	83.0	16.29%
F-3B5P87-M-M	25.72	71.79	35.83%	87.0	29.56%
F-3B5P87-M-R	25.72	71.79	35.83%	87.0	29.56%
F-3B5P87C-M-M	25.72	71.79	35.83%	87.0	29.56%
F-3B5P87C-M-R	25.72	71.79	35.83%	87.0	29.56%
F-3B5P87-S-M	20.99	55.22	38.01%	87.0	24.13%
F-3B5P87-S-R	20.99	55.22	38.01%	87.0	24.13%
F-3B5P87-N-M	20.99	55.22	38.01%	87.0	24.13%
F-2B4P95-D-R	14.88	55.17	26.97%	95.0	15.66%
F-3B5P102-T-M	21.58	35.31	61.12%	102.0	21.16%
F-3B5P102-T-R	21.58	35.31	61.12%	102.0	21.16%
F-3B6P106-D-G	24.61	135.7	18.14%	106.0	23.22%
F-3B5P103-D-R	30.78	118.83	25.90%	103.0	29.88%

5.4 Energy efficiency measures and savings (“Be Lean”)

During the design process the Design Team has explored a range of energy efficiency measures including enhanced U-values, specific construction details to reduce the effect of non-repeating thermal bridges, and the use of heat recovery ventilation. The specific target for the dwellings was to exceed the requirements of Part L1A: 2013 using these measures alone in accordance with the GLA policy guidance. A range of options was evaluated, and those presented below represent one way of delivering the required result: they are not finalised, but there is a commitment to achieve the resulting level of emissions, by this or another combination of specifications. The proposed specifications (indicative) for the building fabric are as follows:

Heat loss floors (including exposed upper floors etc.):	0.12 W/m^2K
External walls:	0.15 W/m^2K
Main roofs:	0.12 W/m^2K
Doors and windows:	1.40 W/m^2K
Air leakage rate (maximum):	4 m^3/hrm^2

In addition to the above, a variety of improvements are proposed to the building services and fit-out specifications. These include:

- Residential lighting: 100% of light fittings to lamp that are >45 Lm/W;
- Hot water cylinders: high performance cylinders with a loss factor of < 0.01 kWh/L/day;
- Heating controls: full zone control with delayed start to be installed in larger units; and
- Ventilation: all dwellings to have EST “best practice” heat recovery ventilation systems;

Care will also be taken to reduce where possible the unregulated emissions by providing “best in class” (“A” rated or equivalent) white goods and energy display devices that show electricity use to encourage residents to save energy. The benefits are not included in the results for *unregulated energy use* as there is no established method for calculating the savings that might result.

The commercial units across the scheme will all utilise an appropriate range of efficiency measures relating to optimising control and management of building services. These include:

- Power factor correction;
- Occupant sensors and automatic dimming of lighting where there is also natural light;
- All services separately metered, with warning for “out of range values”; and
- Ventilation speed controlled by occupancy density.

The emissions from the efficiency calculations *include* all the emissions from the proposed cooling plant, for both the residential and commercial units. And where ASHPs are proposed for heating (on the PFS Site) these are included as well – no attempt has been made to extract an arbitrary ASHP “renewable” element and report this separately.

The final results for all the building within the proposed development with all the identified efficiency measures are shown in the following table:

Table 8: Carbon dioxide emissions with efficiency savings

Stage "Be Lean"	*Carbon dioxide emissions (Tonnes CO_2/yr) Part L1A: 2013*
Dwellings	*582.16*
Non-residential buildings	*400.43*
Total emissions	***982.59***
Baseline emissions	*1144.20*
Savings at this stage	*161.61*
Percentage savings	***14.12%***

6. Summer overheating and cooling

6.1 Compliance with the "cooling hierarchy"

The London Plan 2016 states in *Policy 5.9* that the risk of summer overheating should be reduced as far as practicable by adhering to a hierarchy of measures known as the "cooling hierarchy" which contains the following elements:

- Minimise internal heat generation through energy efficient design:

  In this case, within the dwellings the unwanted summer heat gains under the control of the Applicant are the gains from lighting, fixed white goods and hot water systems. In this respect, all of the lighting will be low energy, all white goods will be nominally "A-rated" (as previously required to gain full credits in the CSH) and hot water systems will use high performance cylinders with a standing loss of < 0.01 kWh/L/day. All other gains such as those from unregulated appliances such as large-screen TVs and the metabolic gains from the occupants are outside the control of the Applicant.

- Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls:

  As far as possible the buildings have been aligned to limit the amount of westerly glazing as large west-facing windows that allow deep penetration of afternoon solar heat are one of the principal contributors to residential overheating. In addition, window sizes have been optimised across the scheme, and the extensive use of recessed balconies and deep reveals provide a worthwhile degree of external shading over the windows.

  Albedo (diffuse reflectance coefficient) is a measure of how a building surface reflects or absorbs the sun's radiant energy. It is often assumed to be analogous to colour, (e.g. dark colours absorb heat) but in fact it is determined by the surface structure of the materials. In practice, most opaque building materials (other than polished metals) have a low albedo and absorb around 80% of the incident energy and this is not directly dependent on colour. Standing seam metal pitched roofs with increased albedo are proposed for several buildings including parts of Blocks D, E2 and F which will therefore all benefit from this technique.

Inverted roofs are being proposed for most of the other buildings. In these structures the thermal insulation, typically 250 mm thick, is located between the surface layer (either paving for trafficked areas or a planting substrate for other areas) and the concrete roof slab. This means that the solar heat is largely prevented from reaching the building roof structure so avoiding long-term build-up of summer temperatures in the thermal mass of the roof. Block B will benefit from a related effect – namely the presence of the glass houses which will similarly limit the transfer of solar heat to the building structure.

While some of the inverted roofs are to be utilised as amenity spaces or for necessary plant, wherever possible, the roof ballast layer will be specified as a growing medium and be completed as a bio-diverse roof. This will serve to provide some limited additional cooling as heat is removed in conjunction with the transpiration of moisture from the plants. It has not been possible to quantify this effect in this case although reductions in summer cooling loads of over 25% have been claimed. Green (living) walls are not appropriate taking account of the style of architecture proposed for the scheme.

Glazing with a reduced g-value (glazing co-efficient of permeability of total solar radiation) of 0.40 is proposed for a very small number of apartments where necessary. In simple terms, the g-value is a percentage measure of the amount of transmitted solar heat. This is achieved by adding a "solar control" coating to a "low-e" glazing unit. In summer a low g-value reduces summer gains – a g-value of 0.40 means that only 40% of the solar heat is transmitted through the glass. But it has an adverse effect in winter reducing the desirable winter solar gains as well. It is therefore only used where necessary and majority of the apartments do not overheat and can use standard "low-e" glass with a g-value of 0.60.

- Manage the heat within the building through exposed internal thermal mass and high ceilings:

  The frame of each of the larger apartment buildings, including floors, shear walls and stair and lift cores will necessarily be constructed of concrete and will therefore have significant thermal mass. However, it is not possible to directly expose the concrete slab of the floors or ceilings within the dwellings because this would result in unacceptable acoustic performance, and ceiling voids are essential to provide space for services. Some thermal mass benefit will arise from the use of a cement or gypsum-based screed for the floors, and a further benefit will arise from the ceilings as heat will be transmitted through the ceilings and into the slab above, although the effect will be limited.

The dwellings have been found to have a thermal mass parameter of approximately 180 kJ/m²K which is considered to be a mid-range value. The internal height of 2.6 m exceeds the more common 2.4 m so the dwelling volume and resulting ventilation cooling will be enhanced slightly.

- Utilise passive ventilation:

  The windows are designed to have openable areas that are in accordance with Part F: 2013 of the Building Regulations. These areas will ensure that for dwellings without cross ventilation the natural ventilation rate will be at least 4 ach (air changes per hour), and for dwellings with cross ventilation the rate will be 6 ach. This will provide the principal summer cooling mechanism.

- Utilise mechanical ventilation:

  Mechanical ventilation units with heat recovery and a summer bypass setting are being installed to provide background ventilation to habitable rooms, plus kitchen and bathroom extract ventilation. Purge ventilation will be provided by means of conventional openable windows in accordance with Part F: 2010 of the Building Regulations.

- Select active cooling systems which achieve the lowest possible emissions:

  All cooling systems proposed including those for a proportion of the residential units, will have the highest possible energy efficiency. The system selected are multi-split vapour-compression heat pumps with refrigerant cooling loops, and roof mounted chillers. These systems achieve the highest available system efficiencies, and a minimum EER of 3.5 will be specified.

In developing these proposals, the Applicant has closely followed the “cooling hierarchy” as set out in Policy 5.9 of the London Plan 2016. Further details of the cooling systems and the results for both residential and no-residential cooling energy demand, that show that this has been successfully minimised, are contained in the following sections.

6.2 Regulatory requirements

The Building Regulations Approved Document Part L1A: 2013 (in common with previous editions) has as one of the five criteria for compliance a requirement that adequate measures are implemented to ensure that summer solar gains are limited and that a dwelling does not overheat in the summer. The Approved Document cites a methodology contained in SAP2012 Appendix P which determines overheating risk for a dwelling as one of four classes: “not significant”, “slight”, “medium” and “high”, and requires that using this methodology a dwelling should be shown to have a risk of overheating no worse than “medium”. The methodology takes account of the differing solar irradiation levels and average temperatures through each month of the summer and all other relevant factors including window size, orientation, shading, glazing g-value, ventilation rate, thermal capacity, fabric insulation and the mean summer temperature of the dwelling location. It has been developed in a “compliance” context and has the major advantage that the principal parameters used are fully defined, and not, as with the alternative methods, subject to many areas of adjustment and interpretation.

The results from the Appendix P assessment, presented in the following paragraph, show that the highest risk of overheating in any apartment is “slight” and that therefore on this measure of performance, none of the dwellings present an unacceptable risk of summer overheating.

6.3 Summer overheating risk and cooling energy requirements

The results from the Appendix P calculations for each dwelling type assessed are provided in the table that follows. All of the results fall in the lowest two categories “not significant” or “slight”: this indicates that the approach adopted has been successful.

Table 9: Summer overheating risk results

Dwelling Reference	*“Not significant” (<20.5 °C)*	*“Slight” (<22.0 °C)*	*“Medium” (<23.5 °C)*	*July Cooling (kWh/m^2)*
A-1BST41-M-M	-	21.12	-	-
A-1BST41-M-R	-	20.97	-	-
A-1BST41-N-M	-	21.21	-	-
A-1B2P51-M-M	-	21.60	-	-
A-1B2P51-M-R	-	21.48	-	-
A-1B2P51-N-M	-	21.67	-	-
A-1B2P51-N-R	-	21.55	-	-
A-1B2P53-M-M	-	21.52	-	-
A-1B2P53-M-R	-	21.40	-	-

A-1B2P53-N-M	-	21.47	-	-
A-1B2P53-N-R	-	21.36	-	-
A-2B4P77-M-M	-	21.41	-	1.2692
A-2B4P77-M-R	-	21.29	-	1.1375
A-2B4P77-N-M	-	21.34	-	1.1319
A-2B4P77-N-R	-	21.22	-	1.0013
A-3B5P86-M-M	-	21.36	-	1.2553
A-3B5P86-M-R	-	21.02	-	1.1199
A-3B5P100-M-M	-	20.92	-	0.9975
A-3B5P100-M-R	-	20.81	-	0.8516
B-1BST37-N-M	-	21.86	-	-
B-1BST37-S-M	-	21.76	-	-
B-1BST37-S-R	-	21.64	-	-
B-1B2P50-N-M	-	21.26	-	-
B-1B2P50-N-R	-	21.13	-	-
B-1B2P50-S-M	-	21.19	-	-
B-1B2P50-S-R	-	21.08	-	-
B-1B2P57-M-M	-	21.22	-	-
B-1B2P57-M-R	-	21.13	-	-
B-2B3P70-M-M	-	21.08	-	0.8031
B-2B4P71-T-M	-	21.16	-	-
B-2B4P71-T-R	-	21.04	-	-
B-2B4P75-N-M	-	20.91	-	0.6801
B-2B4P75-S-M	-	21.10	-	-

B-2B4P75-S-R	-	21.00	-	-
B-2B4P75-M-M	-	20.94	-	-
B-2B4P75-M-R	-	20.84	-	-
B-2B4P75-A-M	-	21.67	-	-
B-2B4P75-A-R	-	21.54	-	-
B-2B4P75-P-M	-	21.56	-	1.0635
B-2B4P75-P-R	-	21.43	-	0.9573
B-3B5P91-N-M	-	20.52	-	0.9047
B-3B5P91-S-M	-	20.55	-	1.0537
B-3B5P93-T-M	20.12	-	-	0.8459
B-3B5P93-T-R	20.06	-	-	0.7224
B-2B4P94-D-G	19.42	-	-	-
B-3B5P101-N-M	20.21	-	-	0.7444
B-3B5P101-N-R	20.16	-	-	0.6682
C-1B2P53-N-M	-	21.62	-	-
C-1B2P53-N-R	-	21.50	-	-
C-2B3P73-M-M	-	21.94	-	1.6226
C-2B3P73-M-R	-	21.82	-	1.4982
C-2B3P73-N-M	-	21.85	-	1.5371
C-2B3P73-N-R	-	21.74	-	1.4132
C-2B4P85-M-M	-	20.60	-	1.6042
C-2B4P85-M-R	-	20.53	-	1.4509
C-2B4P85-N-M	20.40	-	-	1.3849
C-2B4P85-N-R	20.34	-	-	1.2326

C-2B4P88-M-M	20.34	-	-	1.4560
C-2B4P88-M-R	20.28	-	-	1.2998
C-2B4P88-N-M	20.32	-	-	1.3047
C-2B4P88-N-R	20.26	-	-	1.1492
D-1B2P51-N-M	-	21.65	-	-
D-1B2P51-N-R	-	21.56	-	-
D-1B2P52-T-M	-	21.58	-	-
D-1B2P52-T-R	-	21.46	-	-
D-1B2P58-S-M	-	21.13	-	-
D-1B2P58-S-R	-	21.05	-	-
D-2B3P66-M-M	-	21.63	-	-
D-2B3P66-M-R	-	21.53	-	-
D-3B5P105-D-G	19.49	-	-	-
D-3B5P115-D-G	19.52	-	-	-
E1-1BST42-M-M	-	20.87	-	-
E1-1BST42-M-R	-	20.74	-	-
E1-1B2P50-N-M	-	20.87	-	-
E1-1B2P50-N-R	-	20.80	-	-
E1-1B2P50-E-M	-	20.98	-	-
E1-1B2P50-E-R	-	20.92	-	-
E1-2B3P70-S-M	20.39	-	-	1.3351
E1-2B3P70-S-R	20.33	-	-	1.1973
E1-2B4P77-W-M	20.18	-	-	1.1756
E1-2B4P77-W-R	20.12	-	-	1.0314

E2-1B2P51-M-M	20.23	-	-	-
E2-2B4P88-D-R	19.61	-	-	-
E2-2B4P91-D-G	19.58	-	-	-
E2-3B5P104-D-G	19.62	-	-	-
E2-3B5P123-D-R	19.37	-	-	-
E2-4B6P127-H-T	19.55	-	-	-
F-1BST40-M-M	-	21.39	-	-
F-1BST40-M-R	-	21.45	-	-
F-1B2P52-M-M	-	20.96	-	-
F-1B2P52-M-R	-	20.84	-	-
F-1B2P52-N-M	-	20.97	-	-
F-1B2P52-N-R	-	20.85	-	-
F-2B3P69-M-M	-	21.16	-	1.2738
F-2B3P69-M-R	-	21.03	-	1.1058
F-2B3P69-N-M	-	21.11	-	1.0314
F-2B3P69-N-R	-	20.98	-	0.8670
F-2B4P70-M-M	-	21.14	-	-
F-2B4P70-M-R	-	21.00	-	-
F-2B4P70-S-M	-	21.19	-	-
F-2B4P70-S-R	-	21.05	-	-
F-2B4P78-T-M	-	21.19	-	-
F-2B4P78-T-R	-	21.05	-	-
F-2B4P78C-T-M	-	21.19	-	1.1168
F-2B4P78C-T-R	-	21.05	-	0.9572

F-2B4P80-D-R	19.62	-	-	-
F-2B4P83-D-G	19.97	-	-	-
F-3B5P87-M-M	-	20.59	-	-
F-3B5P87-M-R	-	20.52	-	-
F-3B5P87C-M-M	-	20.59	-	1.1489
F-3B5P87C-M-R	-	20.52	-	1.0123
F-3B5P87-S-M	20.43	-	-	-
F-3B5P87-S-R	20.36	-	-	-
F-3B5P87-N-M	20.35	-	-	-
F-2B4P95-D-R	19.41	-	-	-
F-3B5P102-T-M	-	20.89	-	-
F-3B5P102-T-R	-	20.75	-	-
F-3B6P106-D-G	19.57	-	-	-
F-3B5P103-D-R	19.79	-	-	-
Average July space cooling requirement kWh/m^2 (all cooled apartment types)				1.1289
Maximum July space cooling requirement kWh/m^2				1.6226

The value in the final column in the above table is taken from the DER worksheet Box 107(July) for each apartment type assessed ***divided by the apartment area to give a result in kWh/m^2****. The GLA guidance incorrectly states that the values in box 107 are in units of kWh/m^2, whereas in fact they are in units of kWh (i.e. the actual space cooling requirement for the dwelling).*

6.4 Results from Dynamic Simulation Modelling

In addition, modelling in accordance with “CIBSE TM52: The limits of thermal comfort” using the appropriate weather data set referenced in “CIBSE TM49: Design Summer Years for London” has been carried out for the whole of Block F. This block was selected as it contains a variety of different apartment type and sizes, and is located on the western edge of the site, so does not benefit from solar shading from other buildings within the scheme. The details of the modelling are contained in a separate report which is being submitted as Appendix B to the Sustainable Design and Construction Statement. The results show that all the dwellings will comply with the recommendations in CIBSE TM52 without reliance on comfort cooling, and that comfort cooling is not therefore necessary. This finding supports the results reported in the preceding Section 6.3 from the SAP Appendix P assessment.

6.5 Residential comfort cooling policy

Comfort cooling is proposed to 227 of the higher-value private-sale tenure apartments for purely commercial reasons, and to maximise the sales value of the development. As has already been shown, cooling is *not required*. However, there is a specific market segment which is willing to pay extra for certain luxuries, and expects cooling to be provided. If it is not part of the specification, the people concerned will simply look elsewhere, either in neighbouring boroughs, or where existing buildings are being refurbished by the replacement of mechanical plant and where planning permission is simply not required to incorporate cooling as part of the works being carried out. It should be noted in this regard, that the Building Regulations Part L1B, which may apply to such works, would not in any way restrict the provision of cooling in such cases since it is concerned only with plant efficiency, controls and interlocks *(Domestic Building Services Compliance Guide 2013: Section 10).*

It is acknowledged that when comfort cooling plant is provided it is likely to be used, and that this will result in additional emissions that would not have occurred without it. However, these emissions, as determined by the NCM, have been factored into all the results along with all the other emissions, and are therefore fully accounted for in all the calculations, and in the proposed carbon offset payment necessary to achieve a notional *zero-carbon* residential development. In such circumstances, the question of whether comfort cooling should be permitted becomes more one of *principle and policy* rather than a concern with its actual material impact.

In addition to the matter of *principle and policy* it is also absolutely necessary for the LPA to consider the *materiality* of the issue when reaching a decision. In other words, it might be reasonable for the LPA to refuse permission for comfort cooling if it has a real material impact on the overall emissions from the development and if the effect of including it means that a specific policy target is not met. However, if the impact is negligible in the context of the overall scheme, and if for example, the other emissions saving efficiency measures incorporated within the proposals are such that the development, with comfort cooling, falls within the range of acceptable emissions as achieved by other similar consented developments without cooling, then the impact is clearly *not material* and consent should not be withheld on these grounds.

It is important to note in the regard that both national and regional policy requires the LPA to accept at face value the results of the calculations as presented. This is because they have been prepared using SAP2012, which is the Government's National Calculation Method (NCM) for dwellings.

6.6 Residential cooling plant proposal

Type

The proposed plant type selected is multi-split vapour-compression heat pumps with refrigerant cooling loops, and roof mounted chillers. Each chiller unit will serve a number of apartments, and deliver the cooling via fan coil units mounted in ceiling bulkheads.

Performance

The system type selected achieves the highest available system efficiencies for cooling of this type, and a minimum EER of 3.5 will be specified.

Controls

The cooling controls will be integrated with the heating controls so that it will not be possible to run the heating and cooling simultaneously. This is in accordance with the *Domestic Building Services Compliance Guide 2013: Section 10.*

Location

The air-cooled chiller units will be located on the roof of the building served. This results in a higher system efficiency than is possible with a chilled water system, and means that no storage of chilled water is required, and there does not have to be any separate heat rejection plant. The roof-top location of the chillers also means that all heat is rejected at a high level away from any amenity space, and there will therefore be no material effect on local air temperatures. The chiller units will be co-located with other mechanical plant near the top of risers to facilitate connection to the dwellings below. The roof space thus occupied is unlikely to have otherwise been suitable for PV panels, but the possible impact of such substitution is explored in Section 8.

Metering

Delivered cooling will be metered and each resident will be billed according to usage.

Other impacts

The chillers will constitute a fixed noise source within the development. A Noise Impact Assessment (NIA) has been carried out to determine the likely impact of this noise on the new dwellings and appropriate technical measures will be implemented to ensure that it is acceptable. This is addressed in more detail in the Environmental Statement.

6.7 Residential comfort cooling materiality

As noted in Section 6.5, all cooling is included in the efficient case "Be Lean" results. However, to determine the materiality of the proposed residential cooling an alternative set of results was prepared that had no cooling. The emissions are compared in the following table:

Table 10: Comparison between the residential emissions with and without cooling

Stage – "Be Lean"	*Carbon dioxide emissions (Tonnes CO_2/yr)* *Part L1A: 2013*
Dwellings without cooling	*575.94*
Dwellings with cooling	*582.16*
Emissions from cooling	***6.22***
Baseline residential emissions	*617.47*
Cooling emissions (residential baseline)	*1.01%*
Baseline whole scheme emissions	*1144.20*
Cooling emissions (whole scheme baseline)	***0.54%***

6.8 Non-residential comfort cooling

As noted in the previous sections, comfort cooling will be provided to the larger commercial units in accordance with the normal practice for units of this type and specification. This has duly been included in the specifications used for the SBEM calculations and the cooling energy demand for the actual and notional buildings are as listed in Table 11, overleaf.

Table 11: Comparison between the national and actual cooling demand figures

Non-residential cooling	*Conditioned Area (m^2)*	*Cooling Demand (kWh)*	
		Notional	*Actual*
Main site buildings	*12,686*	*56.20*	*54.81*
PFS building	*8,044*	*38.00*	*30.00*

The above figures are taken directly from the BRUKL Reports included in Appendix 7.

At this stage, it is not feasible to provide a breakdown per building zone of the actual and notional cooling demand figures since the internal arrangements of the commercial spaces are at present indicative only, and will in fact only be determined on fitout, and are likely to change during the life of the building.

Furthermore, the SBEM methodology does not provide for a logical or realistic assessment of this issue since the application of the templates is often dictated by matters such as the servicing arrangements, and this can result in the arbitrary dividing of spaces for assessment purposes that have no actual physical divisions. This can result in anomalous situations where small local areas have very high cooling demand simply because all of the solar gain from the adjoining windows is allocated to that specific "zone", and none is allocated to another "zone" that is physically connected to it. It follows that the only way to evaluate whether the solar gain and resulting cooling energy demand and emissions are excessive, is to use the average figures for the whole of the building.

The results listed above show that in both cases the cooling demand for the actual buildings is lower than the cooling demand for the notional buildings. The buildings therefore satisfy the GLA guidance on this issue.

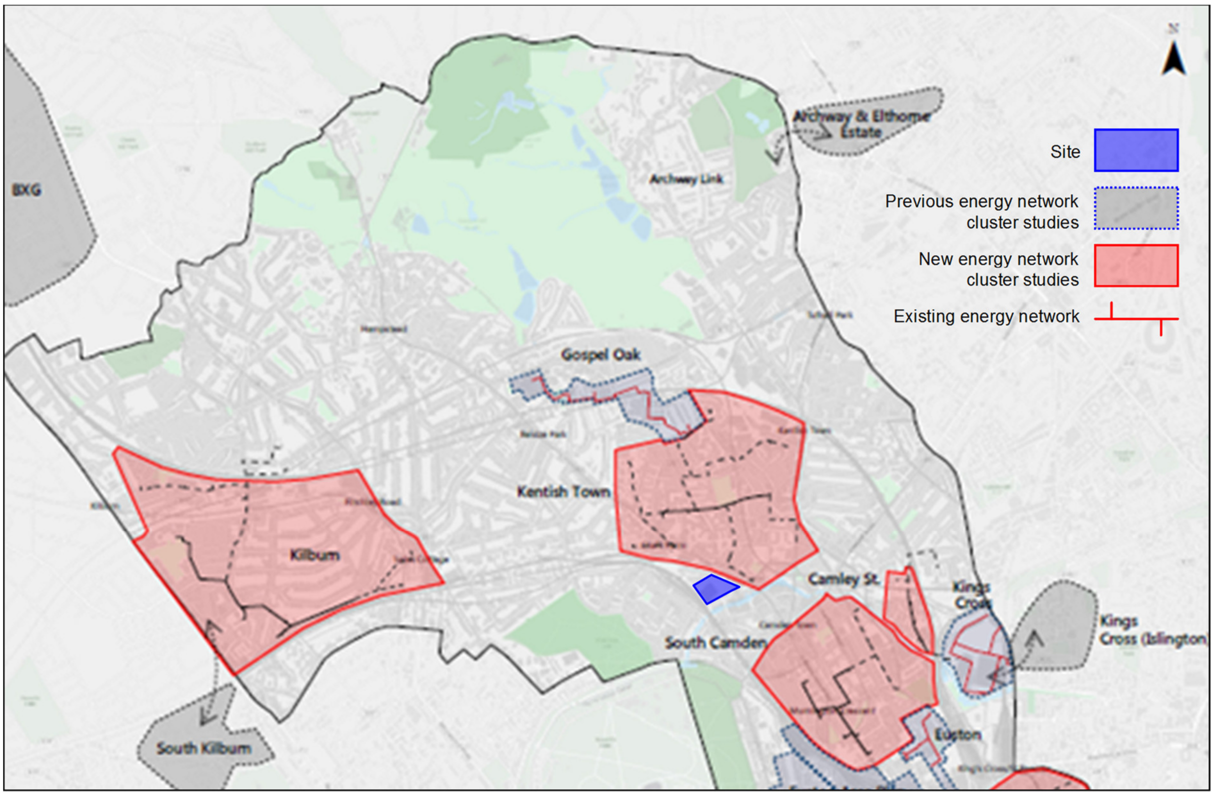
7. CHP and decentralised energy

7.1 Overview of decentralised energy

The London Plan 2016, in *Policy 5.6: Decentralised energy in development proposals* clearly sets out a requirement that new developments must connect to an existing district or community heating network if one is available.

There are a growing number of expanding heat networks within Camden, and these have been strongly encouraged by the Council. A Heat Mapping Study, completed by the Council in 2015, identified five existing decentralised energy clusters, and six areas for future potential clusters, part of which are shown on the map below in Figure 1. The nearest current network is the new Gospel Oak network that provides approximately 50% of the heat and electricity needed for 1,449 homes across six estates, using waste heat from the Royal Free Hospital's CHP units.

Figure 1: A map showing the site, the existing network, and the local cluster



To the south-east of the existing Gospel Oak network, the 2015 Heat Mapping Study identified the Kentish Town cluster, an area with sufficient heat demand density to be potentially feasible for an expansion of the Gospel Oak network. The application site falls just outside the area identified for this cluster, and while it is not adjacent to the anticipated initial network corridor, it is apparent that a future connection would be desirable, should this network be developed. It is also possible that the development of the site may make a material contribution to the commercial feasibility of this network, and the Applicant is keen to work with the Council to understand how the proposal could to contribute to making this network a reality.

As a minimum, an appropriate provision for a connection will be made within the Energy Centre that would allow the site to draw heat from the external network. It may also be possible for the Energy Centre plant (primarily the boilers, but also to a limited extent, the CHP unit) to deliver some heat for off-site use within the network by operating for an extended number of daily hours, beyond that needed to meet the on-site demand.

It will not be possible, however, to accommodate any additional heating plant within the on-site Energy Centre because the plant space is too limited. The Energy Centre, for sound engineering and economic reasons is located in the basement under Block A. The size is sufficient for the plant needed to supply the site with heat, but no greater. This is because such space, under a building, is always at a premium, being required for other plant, cycle stores, bin stores etc., and because it is very expensive to construct. So, making extra space available for future plant that may or may not be required in this location, is not commercially feasible and is therefore not proposed.

The Applicant recognises that the practical development of heat networks is a priority for the Council, and indeed is fully supportive of this as a corporate policy, however at present, the network proposals and plan are not sufficiently advanced for any firm commitments or predictions to be possible. Notwithstanding this fact, the Applicant is willing to support such a network should the plans materialise during the engineering design timeframes that will apply to the project if consent is granted.

In the absence of a currently operating district heating scheme, and given the fact that there is no certainty that one will be developed locally within the necessary timeframe, it is of course essential for the development to incorporate the necessary local gas heating plant, and, in this regard, achieve reductions in carbon dioxide emissions by utilising a local heat-lead gas CHP unit. As noted previously this will be sized to power this development only in the first instance. Heat will be distributed across the development using “heat mains” that connect to each block or core, and from there distribute heat to the supermarket, and each dwelling, office, small retail unit etc. Within each unit there will be a heat exchanger and metering system that allows heat to be transferred into a local heating system that serves the unit, and the amount of heat energy taken by the occupant to be measured so that they can be billed accordingly. The local heating system for the residential units will provide space heating and hot water and can incorporate a hot water storage cylinder.

The energy centre plant will be designed with a substantial degree of redundancy, in accordance with CIBSE best practice – for example the proposed boilers comprise six units each containing three modules, so eighteen modules in total, and the system will continue to be fully operational in the event that a module fails. Similarly, there will be redundant pumps and other equipment to allow the system to continue to operate in the event that an item of equipment fails or has to be taken off-line for maintenance.

However, it should be noted that community heating systems such as that proposed provide no intrinsic reduction in energy demand or carbon dioxide emissions, and indeed, due to the need to distribute hot water over substantial distances they can incur significant system losses and pumping energy requirements(6), and although the systems are design to operate with a nominal return temperature of 40 °C, at times of low load the boilers will sometimes operate in a non-condensing mode. To achieve any benefit (other than "future proofing"), they must therefore incorporate low carbon heat sources.

7.2 Combined heat and power systems

Combined Heat and Power (CHP) systems are regarded by current policy as a desirable way of reducing energy wastage and resulting carbon dioxide emissions. While generally operating on fossil fuel, mainly natural gas, and using reciprocating engines (or, on large scale units, gas turbines) to drive electrical generators, their advantage is that the waste heat produced by the engine (the reason for the familiar "cooling towers" at power stations) is collected and put to good use providing space heating and hot water. This means that the overall fuel efficiency can be increased significantly – typically to above 75% compared to 30 – 40% for grid electricity. It is important to note that the carbon dioxide emissions reduction is due to the utilisation of the waste heat, and that the use to which the electricity is put is not significant, and is not included in any of the assessment calculations. Furthermore, the overall "energy efficiency" of the CHP units (the total useful energy produced as the sum of the heat and electricity) is lower than that of a boiler. So any direct comparison of total *energy efficiency* will produce a meaningless result. It is for this reason that all calculations involving CHP always use a carbon emissions basis alone.

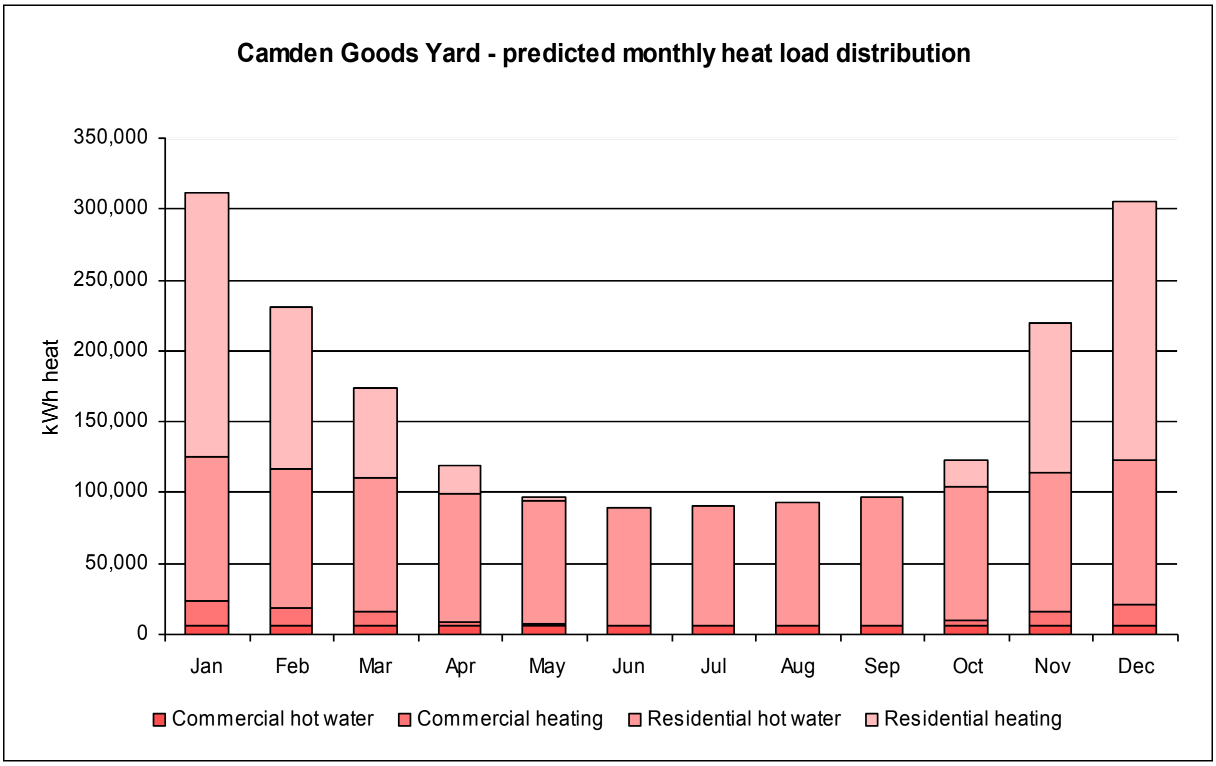
Note 6: Deborah Morgan and John Henderson: *How operational data is used to test assumptions in the SAP methodology* (CIBSE Technical Symposium, Edinburgh, UK 14-15 April 2016), 4-6. This paper reports that measured data demonstrates that the current 5% allowance for the *Distribution Loss Factor (DLF)* in SAP 2012 seriously underestimates the actual losses and proposes a minimum DLF of 50%. If adopted this would mean that the use of CHP-based communal heating as a way of reducing carbon dioxide emissions would need to be re-considered as it is likely that no savings would be demonstrated.

However, CHP, although desirable, does have practical limitations. The principle requirement is that, to be effective, all of the energy produced must be utilised. This means that all the electricity must be used in a financially sound manner and all the waste heat must be put to good use – preferably to meet a heat demand – and not dumped. This means that a workable operating strategy must be developed taking full account of the electrical and heat loads. Such a strategy has been prepared for this development and this is described more fully in the following sections.

7.3 CHP sizing and heat output

As stated in the preceding section the size of the CHP unit is limited by the requirement to ensure efficient operation throughout the year. Detailed design has not yet been completed, but for a heat-led CHP scheme such as this the size of the unit is limited by the summer heat load – which equates to the combined hot water load of the apartments and the commercial space. The heat load information from the energy assessment (including the monthly data from the SAP and SBEM outputs) has been utilised to assess the monthly, and hence daily loads. This is shown in the graph below.

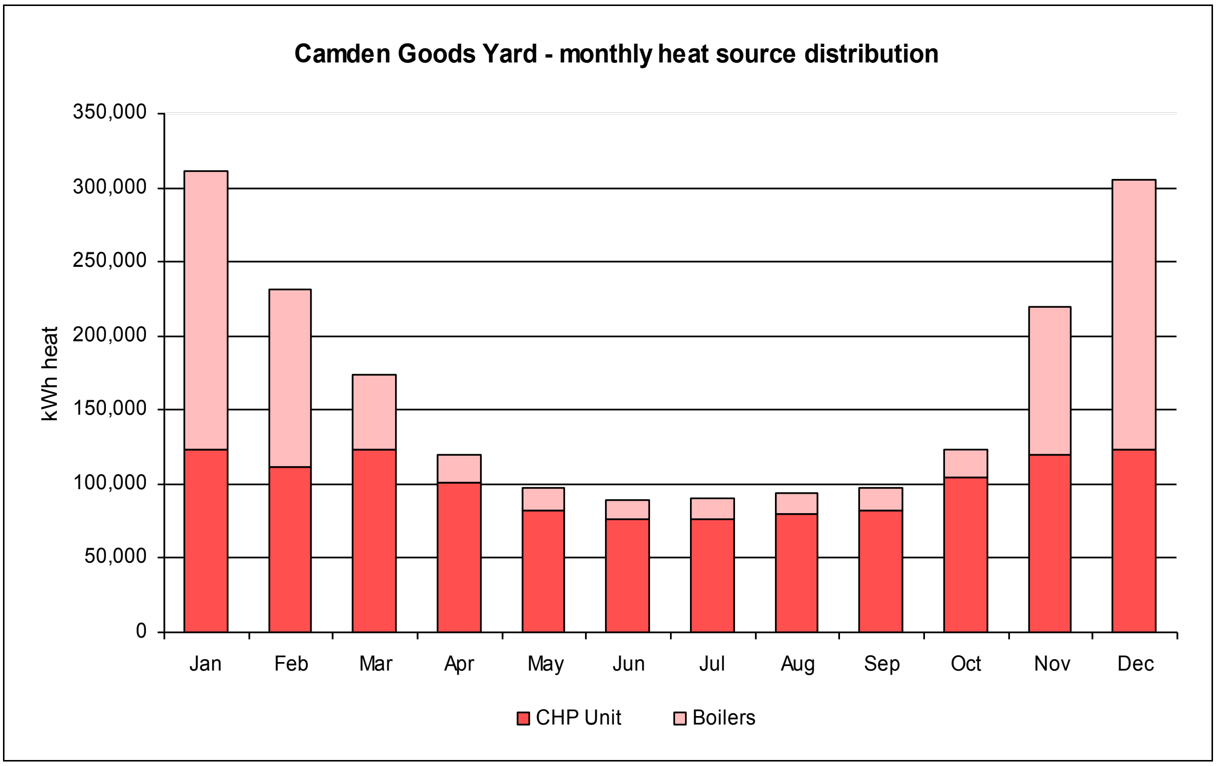
Graph 3: Predicted monthly heat load distribution



The results show that the lowest daily summer heat load (July) is predicted to be 2,903 kWh which would permit 10 hours/day operation of a nominal 234 kWth unit through the summer months, 17 hours/day during the heating season and over 5,000 running hours per year. Further analysis of the demand shows that the annual proportion of the total system heat that could be delivered by such a unit would be at least 60%. The specification details from a typical unit of this capacity, the Ener-g E150, and a 60% annual CHP heat proportion have therefore been used for the remainder of this report.

The communal heating plant will be located in an Energy Centre located in the undercroft below Block A, that has been specifically sized to accommodate all the required plant including boilers, CHP unit, buffer vessels, pump sets and heat exchangers. The buffer vessels will be sized to allow optimum operation of the CHP unit, and a total capacity of circa. 25,000 L is likely. Heat mains will route heat to all the dwellings and commercial areas throughout the supermarket site. The Energy Centre will also have space for the necessary heat exchangers for connection to a future district heating scheme.

Graph 4: Predicted monthly heat source distribution (234 kWth CHP unit)



7.4 Extent and phasing of the communal network

An indicative layout for the site heat mains is included in Appendix 4.

As stated in the preceding section, all the apartments and all the non-residential spaces throughout the supermarket site will be connected to the network. It will not however be extended to serve the new retail and office building on the PFS Site. This is because the building will require both heating and cooling, and have minimal demand for hot water. Therefore, all the space heating and cooling will be provided by Air Source Heat Pumps (ASHPs). The only heat requirement that cannot be wholly met from this system is that for domestic hot water, and modest demands from any café kitchens. The connection distance to the communal heating network is such that suppling the hot water over this distance would result in disproportionate losses and circulation energy, so no link is proposed. Instead, the carbon emissions from this hot water use will be minimised by using small electric water heaters fed with water pre-heated by the ASHP system, a common arrangement in this scenario.

We do not consider it necessary to justify this on “emissions” grounds simply because it would be wholly impracticable in an office building to provide space heating from a distant communal network and integrate this with local refrigerant loop chillers that provide cooling, when those same chillers are technically cable of providing low-carbon heating as well.

However, when the emissions are considered, the conclusions fully justify the approach proposed. This is because the office building will have no significant summer heat demand (it uses minimal domestic hot water). So the additional load on the network would be a winter load only. Since the CHP unit is sized based on the summer load, the CHP unit size could not be increased, and the CHP unit winter hours are already at the 17 hours per day commercial limit. Hence the additional winter load to supply the office building would have to be delivered by the boilers. This would therefore have the effect of increasing the average annual carbon factor for the communal system heat, and thus negate any apparent saving, and the resulting total emissions would be higher than they are for the proposed ASHPs. The nominal figures for the alternative approaches are provided in the following table – the communal heating emissions assume the extra heat is provided by the boilers, and the ASHP emissions figure is taken directly from the SBEM BRUKL Report:

Table 12: Comparison between the commercial emissions from boilers and ASHPs

Stage – “Be Clean”	*Annual space heating demand (kWh)*	*Carbon dioxide emissions (Tonnes CO_2/yr) Part L2A: 2013*
PFS building with communal heating	*127,980*	*29.33*
PFS building with ASHP heating		*14.19*

A further material consideration on a large and complex site such as this is the need to demonstrate that the planned construction phasing has taken account of the need to ensure that the site heat mains are installed and the Energy Centre is built and commissioned before the first occupations will take place. This has been taken fully into account and the Heat Mains Layout Plan, included in Appendix 4, shows how this will work.

The Energy Centre, in the undercroft below Block A, is part of the earliest phase of the works. This means that it can be constructed and the plant and flues installed and commissioned to coincide with the initial completions. The site heat mains, routed along the basement soffit, will be installed as work proceeds, and connected to valve sets at each riser or substation, or temporarily capped as necessary so that heat can be connected to each building as required.

7.5 Communal heating plant operation and management

The Applicant proposes to develop the detailed design of the communal plant, and then subsequently operate the systems in conjunction with an ESCo partner: they have a proven track record in this regard and already have some 10,000 apartments that are part of existing completed residential and mixed-use schemes ranging in size from 200 to over 700 apartments that are serviced in this way.

In common with virtually all CHP schemes, a residential Private Wire Network (PWN) will not be used. Under the ESCo contract the ESCo takes responsibility for operating the CHP unit and dealing with any excess electricity which, after local plant room and Landlord’s demands are satisfied, is normally exported to the grid. In this case, the presence of the supermarket, which will have a substantial 24/7 electricity demand, means that it is possible that agreement may be reached for excess electricity to be supplied to the supermarket. However, this is far from straightforward technically, since the maximum electrical output of the CHP unit, at 150 kWe, is modest, and as the system is “heat led” the operating hours of the CHP unit will vary with the season. This means that in practice it is likely that the CHP output will connect to the grid rather than directly to the supermarket. It should be noted that in all current assessment methods the use of the electricity is irrelevant as all the emissions savings are attributed to the low carbon heat produced by the CHP unit.

The ESCo contract will stipulate the terms under which the plant must be operated, including the minimum annual proportion of the heat that must be delivered by the CHP unit, as necessary to achieve the network heat carbon factor necessary to deliver the predicted emissions saving.

7.6 Emissions savings from CHP ("Be Clean")

As noted in Section 4, the convention for calculating the saving in carbon dioxide emissions achieved by a CHP unit is set out in SAP Appendix C. The approach adopted in the compliance methodologies is to first attribute carbon dioxide emissions at the "displaced grid electricity" emission rate to the electricity produced, and to attribute any remaining emissions to the heat output.

In this case the performance figures for a typical 150 kWe / 234 kWth CHP unit (data from Ener-g E150) are as follows (efficiencies quoted are based on the fuel GCV):

Electrical efficiency (with reference to gross fuel input):	31.58%
Thermal efficiency (with reference to gross fuel input):	49.26%
Electrical output:	150 kW
Thermal output:	234 kW

The results for the nominal CHP heat emissions factor can be calculated using this data and the respective emissions factors from the 2013 regulations. The CHP heat emissions factor applies to the proportion of the heat supplied by the CHP unit. When this heat is factored into the performance of the community heating system as a whole, and allowing for the remaining heat component (40%) that is produced by 92% efficient communal gas boilers, the overall effective heat emissions factor can then be calculated. The result is as follows:

CHP unit heat emissions factor (E150):	0.1058 $kgCO_2/kWh$
Gas boiler heat emissions factor (92% efficient):	0.2374 $kgCO_2/kWh$
Overall system heat emissions factor:	0.1584 $kgCO_2/kWh$

The saving per kWh delivered is calculated by subtracting the emissions factor for the Energy Centre heat from the emissions factor for normal boiler heat. The results demonstrate that the proposed CHP-based communal heating will deliver savings of 0.0790 $kgCO_2$ per kWh of heat delivered compared to the case where heat was provided from a communal system with just gas boilers alone. The final results for the development with all the identified efficiency measures and the CHP-based communal heating are shown in the Table 13, overleaf.

Table 13: Carbon dioxide emissions with efficiency and CHP unit savings

Stage – "Be Clean"	*Carbon dioxide emissions (Tonnes CO_2/yr) Part L1A: 2013*
Dwellings	*431.55*
Non-residential units	*376.33*
Total emissions	***807.88***

With efficiency savings only	*982.59*
Savings at this stage	*174.71*
Percentage savings	***15.27%***

8. Renewable energy options

8.1 Overview of renewable energy

Renewable energy is defined as energy derived from energy flows that occur naturally and repeatedly in the environment. It may be contrasted with energy sources that can be depleted such as fossil fuels or uranium-238-based nuclear power. Renewable energy technologies, with a couple of exceptions, all utilise energy from the sun – either directly or indirectly, the exceptions being true geothermal(7), which uses heat from the earth's mantle, and tidal / marine current electricity generation which uses the gravitational forces between the earth and the moon, (although some marine currents are also greatly affected by solar energy). Insofar as this study is only concerned with practical options for *on-site* renewable energy, these options are not considered further. The remaining range of "solar" technologies are however vast, and some would not even appear to be solar on superficial inspection. They can be summarised as follows:

- Solar thermal – direct heating of water for space heating or domestic hot water;
- Photovoltaic – direct generation of electricity from sunlight;
- Hydroelectricity – electricity generation by solar (water cycle) driven(8) water flows;
- Wind turbines – use of solar driven air movement to generate electricity;
- Heat pumps – extraction of solar heat from the earth, atmosphere or water bodies;
- Bio-fuels – combustion of solid or liquid bio-fuels to produce heat or electricity;

The technologies, and their potential application to this site are discussed in more detail the following sections. However, one further pertinent point must be made. The reason for adopting renewable energy technologies is to reduce greenhouse gas emissions – mainly carbon dioxide, and none of the technologies are wholly "zero carbon". This is because when the whole life cycle is taken into account energy has to be put into every system to manufacture, maintain, operate and replace the equipment (which has a finite life), and generally at present, this energy is derived from non-renewable sources. Examples include the energy needed to process the silicon used to manufacture photovoltaic panels, and the fuel used to process and transport wood pellets or manufacture fertilisers.

Note 7: Ground source heat pumps are sometimes described as "geothermal", however most simply extract solar energy stored near the Earth's surface. True geothermal heat is heat from deep in the earth, which is believed to arise mainly from the decay of radioactive isotopes in the earth's mantle.

Note 8: This may be compared with "pumped storage" systems such as Dinorwig in North Wales where water is pumped to an upper storage lake during periods of low electricity demand and released to generate electricity when needed during times of peak demand.

8.2 Renewable energy roposals

Taking account of the foregoing section of this report, it is apparent that the wide range of efficiency measures plus the community heating system with substantial CHP unit that have been incorporated within the design of the scheme will achieve significant reductions in emissions compared to the regulatory baseline. It is also accepted that on a scheme such as this, the only feasible renewable energy systems would be roof mounted photovoltaic (PV) panels. The option to use façade mounted panels was discounted at an early stage due to the fact that it would be wholly incompatible with the architectural design, and because the efficiency of the panels is greatly reduced.

However, the design of the scheme and the fact that some of the blocks have pitched roofs, and significant areas of roof on some of the blocks are used as amenity spaces, and of course the proposal to use the roof of Block B for a food and plant growing and production facility, means that only limited areas of roof are available for use for PV panel arrays. The usable area on some of the buildings with pitched roofs is further limited by the orientation of the roof slopes, as the panels need to be mounted facing east through south to west, so generally only one of the slopes can be used on these roofs.

When planning the PV array roof layouts, it is also necessary to ensure allowance is made for ventilation fans and ducts and other plant, access hatches, and smaller elements such as soil and vent pipes. It is also essential that on flat roofs a clear margin is maintained around the perimeter of the roof so that safe access equipment can be installed as necessary, and that access can be gained to the parapet wall or roof eaves structures for future maintenance. It is equally essential that PV panels are only mounted on pitched roofs in positions and at heights that can be reached using portable or transportable access equipment, e.g. “cherry pickers” as annual visual safety checks have to be carried out, and it would not be viable to do this if access could only be gained by erecting scaffolding.

Taking all of the foregoing constraints into account, and at the same time accepting that there is a policy imperative to absolutely maximise the PV provision on this scheme, the following arrays of panels are proposed on the various buildings:

Block A	24.75 kWp
Block B	(none, due to the use of the roof for glasshouses)
Block C	17.60 kWp
Block D	22.00 kWp
Block E1	13.75 kWp
Block E2	26.95 kWp

Block F	22.55 kWp
PFS Site	37.40 kWp

The total size of the arrays proposed is therefore 165 kWp.

As noted above, PV arrays are not proposed for Blocks B, as the roof space will be used for the glasshouses, and it is not possible to mount the panels on the roofs of the glasshouses as they would create too much shade to the growing area below.

The arrays will be connected to a bank of inverters located in a suitable riser on an upper level in each block, or in a weatherproof enclosure and co-located with other plant externally on the roof. In the case of the residential buildings, the electricity produced will be connected to the Landlords intake where it will provide electricity for the common area lighting and other similar uses, and the panel area per core in each case is less than the 30 kWp simplified metering limit for small-scale PV installations, which ensures that connection and ongoing metering costs are minimised.

The PFS Site office building has space for a larger array, of 37 kWp, and this will be connected to the building system where it will contribute directly towards meeting the electricity demand from the proposed ASHP heating and cooling plant.

Access to the flat roofs for maintenance and cleaning will by means of access hatches in the stair cores, so the routine annual maintenance can be carried out without requiring specialist access equipment or access via a private roof terrace. Most flat-roofed blocks have low parapet walls which will serve to largely hide the panels from view from ground level, and man-safe systems will be installed as necessary to permit safe access. In the case of the pitched roofs on Blocks E2 and F, access can be gained by using a “cherry picker” located at ground level. PV arrays are not proposed on the high-level pitched roofs on Block F simply because routine safe access is not possible.

The Architects’ drawings show the general location of the proposed panels and the available areas but the numbers of panels are not shown. This is because the sizes and shape of the panels is subject to continuous improvement by manufacturers and the Applicant will utilise the technology available at the date of installation. However, as a guide, a typical current panel with an output of 0.275 kWp would be 1000 mm x 1600 mm. The proposed arrays would have 600 of these panels.

The panels on some of the lower level flat roofs, such as the roofs of Blocks E2 and D will be visible from the upper floors of the taller blocks. However, these roofs have to have access hatches and other items such as ventilation units and soil and vent pipe terminals, so cannot be free of access equipment and mechanical and electrical plant. The PV panels will be arranged in neat rectangular arrays and it is considered that the appearance will not be unacceptable, and indeed for some observers, they will enhance the site by reinforcing its environmental credentials.

An assessment has also been completed to determine the amount of roof space that has been set aside for residential cooling plant, and that as a result cannot be used for PV panels. The areas occupied by the cooling plant are generally co-located with other mechanical plant, and it would not necessarily be feasible to use them for PV panels. The areas are nominally as follows:

Block A	40 m^2
Block C	60 m^2
Block E1	40 m^2
Block F	20 m^2
Total	160 m^2

Assuming that 50% of the space would have been suitable for use for PV and a typical space utilisation factor of 33%, the maximum area of PV panels that might be displaced would be 27 m^2. This equates to 4.6 kWp, or just 0.16% of the total emissions from the scheme.

8.3 Emissions savings from renewables (“Be Green”)

The standard methodology for calculating the reduction in carbon dioxide emissions that can be achieved by photovoltaic panels is set out in SAP2012 Appendices M and U.

The calculation is as follows:

Nominal total peak power of combined flat roof arrays:	132.55 kWp
Orientation:	Horizontal
Proposed angle of elevation:	<10 º
Shading:	None
SAP2012 output per kWp (horizontal):	760 kWh/kWp/yr
Annual electricity produced:	100,738 kWh

Nominal total peak power of combined pitched roof arrays:	32.45 kWp
Orientation:	South-west

Proposed angle of elevation:	30
Shading:	None
SAP2012 output per kWp (south-west, 30 º):	823 kWh/kWp/yr
Annual electricity produced:	26,706 kWh
Total electricity produced:	127,444 kWh
SAP2012 emissions factor for grid-displaced electricity:	0.519 $kgCO_2/kWh$
Annual emissions saving from PV arrays:	**66,143 $kgCO_2$**

Table 14: Carbon dioxide emissions with efficiency, and CHP unit and renewables savings

Stage – "Be Green"	*Carbon dioxide emissions (Tonnes CO_2/yr) Part L1A: 2013*
Dwellings	*380.16*
Non-residential units	*361.58*
Total emissions	***741.74***

With efficiency/CHP savings	*807.88*
Savings at this stage	*66.14*
Percentage savings	***5.78%***

Baseline emissions	*1144.20*
Total cumulative savings	*402.47*
Percentage savings	***35.17%***

The areas of roof proposed to be occupied by the PV panels are shown on the Architect's drawings.

8.4 Heat pumps – explanation of approach

As noted in the overview to this chapter (please see also Appendix 3), heat pumps are a recognised means of utilising renewable energy. They use a vapour compression cycle to *move* heat from a location of lower temperature to one of higher temperature. In terms of building services, they perform two roles: they can use electricity to deliver space (or domestic hot water) heating as an alternative to using gas as the primary fuel; and they also provide the most common method to deliver cooling, (a chiller is simply a heating heat pump working “backwards” removing unwanted heat and usually rejecting it to the atmospheric air).

Hence it is technically valid in an Energy Statement to determine the “renewable energy” component in the heat pump operation (in both heating and cooling variants) and cite this in the results as part of the headline “renewables” figure. This has commonly been done, and was particularly prevelent when policy focused overtly (and unhelpfully) on the “percentage renewables”.

However, while valid, it is not necessarily helpful. This is because it becomes virtually impossible to present the result in a meaningful way, especially when cooling is required, or where heat pumps are the most appropriate technology. This is because the “baseline” case must always have a “renewables” component, and this makes it impossible to establish what proportion of the renewables is “baseline” and what proportion contributes to “renewables” policy compliance.

In this assessment, BBS Environmental has taken a different approach. In the PFS building where they are used as the main heat source, the heat pumps are treated as contributing only to the “efficiency” savings. Hence the baseline is derived from the TER figures, and for the efficient, ”Be Lean” case, the proposed heat pumps (for both heating and cooling) are included in the assessment and hence in the BER (and DER where applicable) figures.

This means that the figures for renewables relate only those systems which collect on-site solar or wind energy (in this case only the PV systems). It means that the percentages quoted are smaller, but it is a straightforward and easily understood approach, and one that conveys the trues facts about the scheme in a way that will be easily understood by all the stakeholders.

9. Conclusions

The foregoing projected results show that this development proposal meets the applicable planning policies that relate to energy conservation, decentralised energy networks, renewable energy systems, and avoiding overheating, so far as this is technically feasible.

In developing these proposals, the Design Team has taken account of the nature of the site and its inner-London location on a boundary between low-rise residential and the more intensively developed locale along the Regents Canal, and on a highly accessible site that has historically seen industrial and transport hub use. In this regard, matters of relating to the design of the building roofscapes were particularly important, and this has necessarily reduced the PV panel provision compared to the norm for a flat-roofed scheme of this size. Notwithstanding this constraint, by focussing instead on efficient fabric and optimal fenestration, impressive efficiency savings have been achieved, and this has also ensured that the cooling energy demand was minimised, which has in turn meant that the emissions from the proposed residential cooling are only 1% of the total residential emissions, and less than 0.6% of the total emissions from the site.

In common with many schemes of this type, a CHP-based community heating system, with plant located in a purpose-built undercroft, is proposed to provide space heating for the Main Site. The flues are routed to the top of the apartment building above, Block A, from where they discharge without any local adverse effects on air quality. The PFS Site will not be connected to this system as it contains only commercial space, and the most appropriate strategy is to use ASHPs to provide both cooling and heating.

Extensive PV panel arrays are proposed for all the suitable roof space that is not required for other purposes, and a total array capacity of 165 kWp is proposed spread across Blocks A, C, D, E1, E2, F and the PFS building.

In terms of results for *regulated* energy and emissions savings, and compared to the “compliant case” baseline referenced to the 2013 Building Regulations, the development proposals include passive energy savings and energy efficiency measures (including the use of ASHP heating and cooling on the PFS building) that reduce the residential carbon dioxide emissions by 5.72%, and the non-residential emissions by 23.98%, and 14.12% for the whole scheme. The saving achieved by the provision of a CHP-based communal heating network as a percentage of the baseline emissions, is 24.39% and 4.58% for the residential and non-residential units respectively, and 15.27% for the whole scheme.

Finally, the options for renewable energy systems were considered. The roof design allows for the installation of PV panels arrays with a total nominal rating of 165 kWp across seven of the eight buildings. This will achieve a further reduction, as a percentage of the baseline emissions, of 5.78%.

The total saving from all the measures combined is therefore 35.17%. This satisfies the on-site target set in the *GLA guidance on preparing energy assessments (March 2016).* Therefore, subject to the payment of the carbon offset charge, the scheme will be deemed to fully meet the requirements of The London Plan 2016: *Policy 5.2: Minimising carbon dioxide emissions.*

In addition, the inclusion of a local energy centre, with CHP-based communal heating, and the facility to connect to a future district heating network, and the proposals for renewable energy systems in the form of PV panel arrays, means that the scheme satisfies *Policy 5.6: Decentralised energy in development proposals;* and *Policy 5.7: Renewable energy*. Finally, the assessments of summer overheating risk and cooling energy demand, demonstrate that the “cooling hierarchy” has been followed successfully, and that therefore the scheme satisfies *Policy 5.9: Overheating and cooling.*

The compliance with the London Plan 2016 energy policies, that has been clearly demonstrated, means that the scheme also fully satisfies the equivalent local energy policies in the London Borough of Camden LDF Core Strategy (November 2010) and the emerging Camden Local Plan.

Appendix 1

Carbon dioxide emission factors 2013

These factors are taken from SAP2012 version 9.92, Table 12 and are used in Part L1A/L2A: 2013 of the Building Regulations. They have superseded the factors used in Part L1A: 2010, and due to significant differences, can result in different level of emissions reduction, particularly with CHP systems and PV panels where grid displaced electricity is taken into account.

Fuel	CO_2 emission factor $kgCO_2/kWh$
Natural gas	0.216
LPG	0.241
Biogas	0.098
Heating oil	0.298
Biodiesel from any biomass source	0.123
House coal	0.394
Anthracite	0.394
Manufactured smokeless fuel	0.433
Dual fuel appliances (mineral + wood)	0.226
Wood pellets	0.039
Wood chips	0.016
Grid supplied electricity	0.519
Grid displaced electricity(9)	0.519

Note 9: Unlike in earlier editions of SAP the carbon emissions factors for grid-supplied electricity and grid-displaced electricity are now identical. This reduces the calculated emissions savings from local electricity sources such as PV panels, wind turbines and CHP units.

Appendix 2

Renewable energy systems data

The predicted renewable energy outputs quoted in this report are based on the following manufacturers' and other data. This is typical for these products although subject to constant improvement as manufacturers develop better technologies.

Photovoltaic panels: Usable output (SAP2012)[(10)]: 760 kWh/kWp/year

Note 10: Data from SAP2012 Appendices M and U. Nominal output for a panel inclined at 10º and orientated due south.

Appendix 3

Background information on renewable energy systems

The following sections contain a summary of each alternative possibly-applicable technology, a comparison of the advantages and disadvantages of technologies relevant to this development, and the reasons it was not proposed.

A3.1 Solar thermal panels

A typical solar thermal (hot water) panel can provide 400 kWh of *useable* hot water per year for every square metre of panel. Under normal circumstances this energy will replace gas, and because the emissions factor for gas is only 0.216 $kgCO_2/kWh$ the reduction in carbon dioxide emissions, allowing for the boiler efficiency, is modest at approximately 86 $kgCO_2/m^2$. However, in this case the additional heat source, which would be available mainly in the summer, is incompatible with the use of CHP as it would make control of the CHP unit substantially more difficult and further limit the CHP unit operating hours. Furthermore, the available roof on Block A is being used for photovoltaic panels. It was not therefore considered.

A3.2 Wind turbines

Micro wind turbines produce electricity and can be grid-connected in the same way as photovoltaic panels. There are two main concerns with wind turbines – aesthetic considerations, and the limited output in an urban environment. It was considered that while in this location the visual impact of a modest-sized unit could be unacceptable, the presence of the tall buildings, including Block A at 14 storeys, on a dense site would create wholly unsatisfactory wind conditions, so this technology was not considered further.

A3.3 Bio-fuels

In the UK at present the commercial bio-fuels that can be used in the context of emissions reduction in the built environment are confined to either wood pellets or wood chips (biomass) or in special cases glycerine for CHP. Bio-diesel is not an acceptable fuel as it is easily replaced by petro-diesel so does not qualify under the applicable regulations. A small 300 kW automated pellet boiler could have been installed in the plant room to provide additional low carbon winter heat. However, it would have greatly increased the emissions of NO_x and have resulted in significant emissions of particulates which were judged to be unacceptable in this location. It has not therefore been proposed. Glycerine CHP is an emerging technology which has very low emissions and uses the fuel that is a waste product from the bio-diesel manufacturing process. However, the commercial availability is very limited (there is a single small-scale supplier) and it was unclear whether plant of a suitable type and size would be available for this development. It has not therefore been proposed.

A3.4 Heat pumps

Heat pumps collect low temperature heat from renewable sources and “concentrate” it to a usable temperature. Fossil fuel based (grid) electricity is generally required to operate the pumps and the renewable component of the output is therefore by convention taken as the difference between the output energy and the input energy. A typical heat pump will deliver 3 kWh of useful energy for every 1 kWh of input energy. A heat pump operating in this way would therefore be deemed to have delivered 2 kWh of renewable energy.

There are two common types of heat pump – ground source and air source. In urban locations ground source heat pumps collect heat from boreholes. These are typically up to 100m deep and have to be spaced at least 6m apart to avoid over-cooling the ground. A typical borehole can deliver a maximum output of 4kW of heat. Air source heat pumps collect heat from the ambient air using air-heat-exchanger units and are frequently mounted on the roofs of commercial buildings.

With communal heating systems, the heat pump is used to supply heat for space heating, but can only be used to pre-heat the domestic hot water. This is because the heat pump will not operate effectively at the temperatures needed for domestic hot water. As a result, the heat pump is confined to meeting only a proportion of the heat demand and this limits its ability to deliver a reduction in carbon dioxide emissions. Furthermore, their use of grid electricity to deliver heat means that the carbon emissions from a heat pump system can be higher than those from heat from the CHP system.

On this scheme, heat pumps, configured to provide both heating and cooling, are the most appropriate strategy for servicing the PFS building, and they are also used to provide local cooling on the Main Site, where heating is supplied from the CHP-based communal heating network.

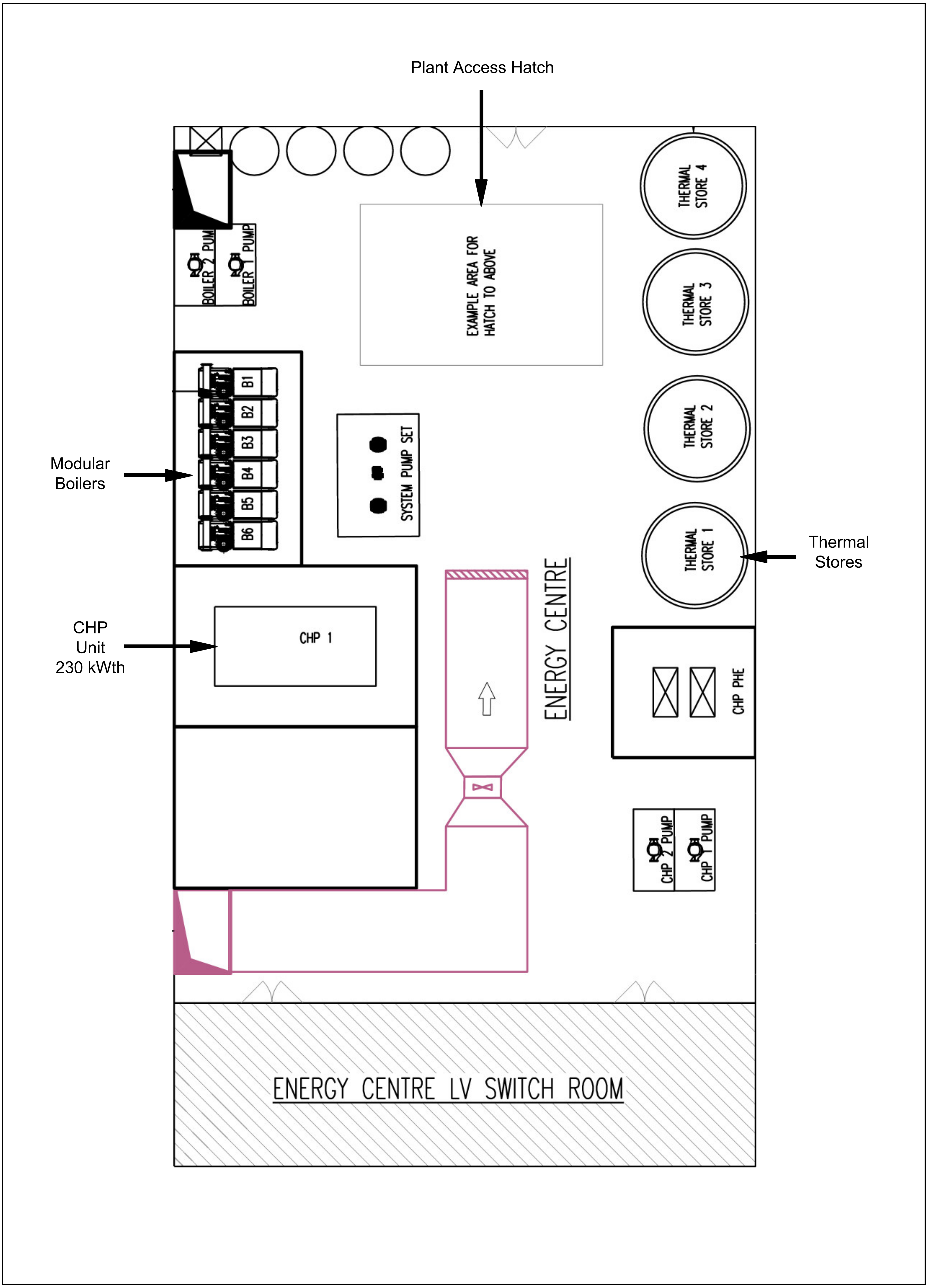
Appendix 4

Indicative drawings

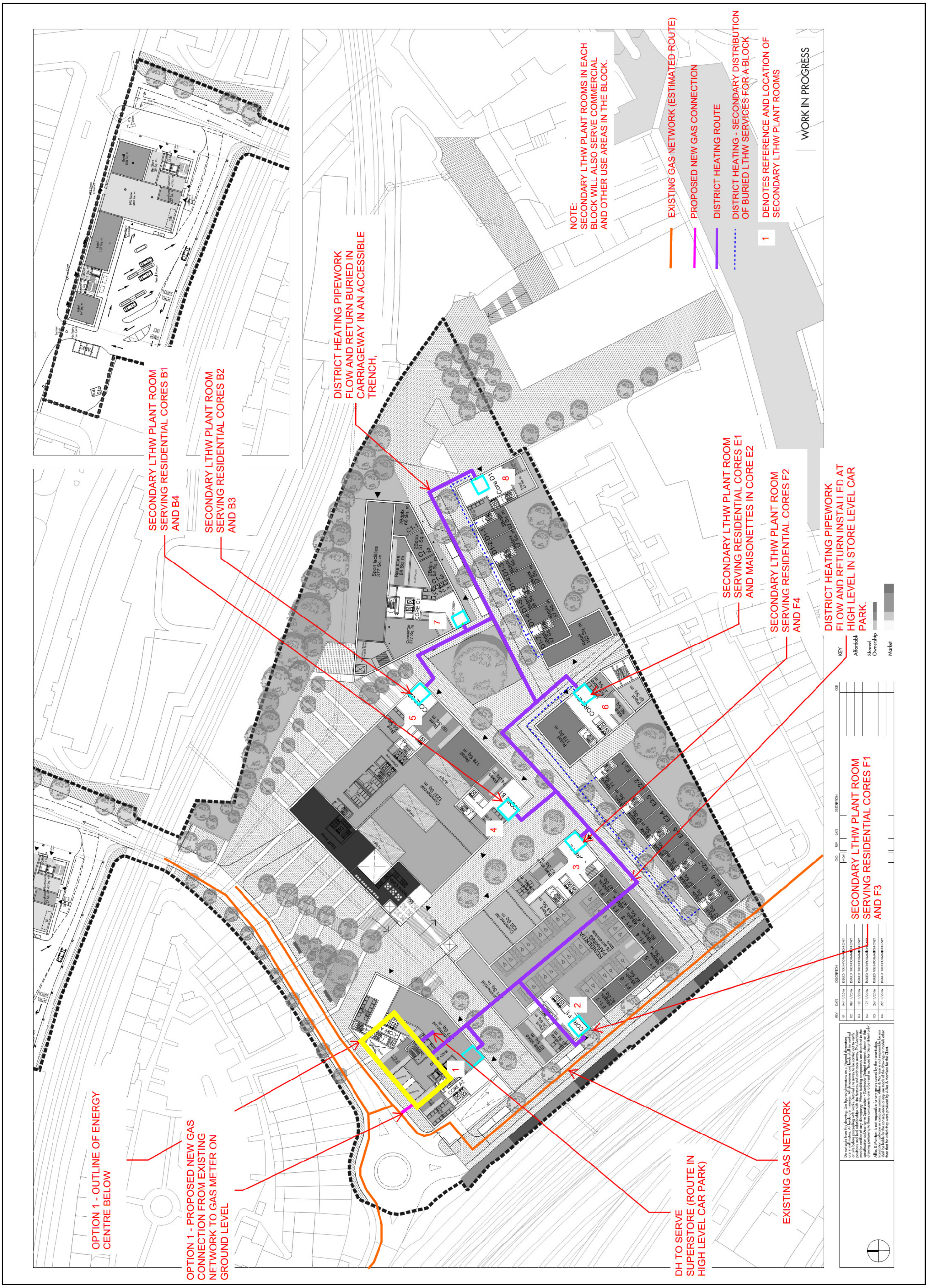
Energy Centre General Arrangement

Site Heat Mains Layout

Indicative Phasing Plan



Energy Centre General Arrangement



Site Heat mains Layout

Indicative Phasing Plan