South West London & St George's Mental Health NHS Trust

Barnes Hospital

Outline Planning Energy Strategy

Issue2 | 25 October 2018

Job number 226594

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Document Verification

ARUP

Job title	Barnes Hospital	**Job number** 226594	
Document title	Outline Planning Energy Strategy	**File reference**	
Document ref			

Revision	**Date**	**Filename**	Outline Planning Energy Strategy Draft 1.docx		
Draft 1	18 Oct 2017	**Description**	First draft		
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Issue	9 Nov 2017	**Filename**	Outline Planning Energy Strategy Draft 1.docx		
		Description	Report amended in accordance to Anthony Brogan comments		
			Prepared by	Checked by	Approved by
		Name	Hans Chao	Jenny Bousfield	Mike Booth
		Signature			
Issue2	25 Oct 2018	**Filename**	New Outline Planning Energy Strategy ISSUE2.docx		
		Description			
			Prepared by	Checked by	Approved by
		Name	Joe Carthy Hans Chao	Jenny Bousfield	Mike Booth
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ✓

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Appendix A

Typical Flood

1 Introduction

The South West London and St. Georges Mental Health Trust (SWLStG) are intending to redevelop land at the Barnes Hospital site, in the London Borough of Richmond-Upon-Thames.

This report provides a review of the relevant National, London and Borough level legislative and regulatory drivers, a high level technical feasibility of low and zero carbon energy supply technologies is also presented in support for the outline planning application for the Barnes Hospital redevelopment scheme.

1.1 Site and Surrounding Area

Barnes Hospital is located on the south side of the South Worple Way, East Sheen, London SW14, in the London Borough of Richmond upon Thames. The hospital site is bounded to the north by South Worple Way and the railway line which is located to the north of the South Worple Way, to the east by housing located along Buxton Road, to the south by housing located along Grosvenor Avenue, and to the west by Mortlake Cemetery.

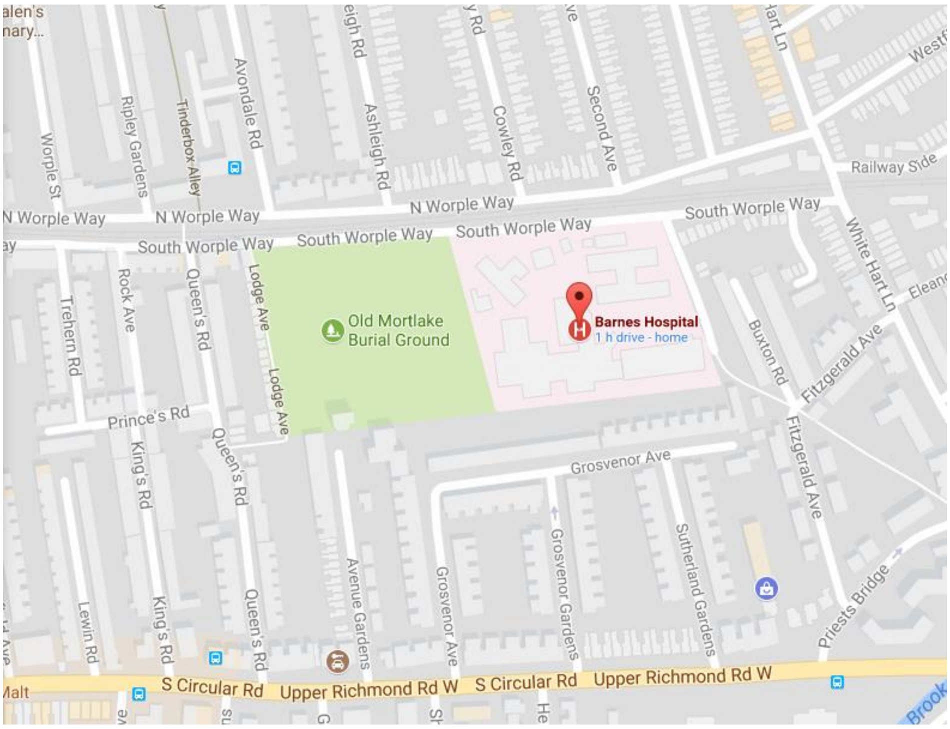


Figure 1: Hospital site location

Barnes Hospital provides community outpatient and therapy services, the majority of the existing hospital buildings are one story in height, and approximately 6,950 sqm Gross Internal Area (GIA).

The existing hospital comprises Block A – Riverside Lodge, Block B – Kingfisher Suite, Block C – Main Building, kitchen/Dining, Laundry House, Porters' Lodge, Mortuary, Generator House, Elizabeth Lodge, Recreational Hall/Workshop, Doctors' Residence, Fleming Dining Area, Fleming Lodge, Ballard Room, and Beatrice Lodge. The site is owned by South West London and St. George's Mental Health NHS Trust.

1.2 Description of the proposed development

The proposed scheme consists of a mixed-use accommodation schedule – including a Health Hub, Residential accommodation and a Special Educational Needs School:

- Residential [Class C3] accommodation:
    - Total GIA of approx. 6,918 sqm distributed between 3 pavilions
    - The proposal aims to provide on-site affordable accommodation, percentage to be agreed
    - Total of up to 83 units with a mixture of 1, 2 and 3 beds (including the conversion of two of the retained BTMs for use for up to 3 no. of residential units)
    - A maximum of 2.5 storeys for each block, with the third story accommodated within the roof space
    - 44 private car parking spaces with cycle parking provision
- Health Hub [Class D1]:
    - A healthcare facility of approx. 2,500 sqm GIA
    - Provision of 26 car parking spaces
- SEN School
    - A Special Education Needs school of approx. 2,402 sqm GIA
    - Provisions for car and cycle parking

The residential accommodation is set to be developed first, followed by the Health Hub and SEN school.

Figure 2: Proposed Ground Floor area plan

The table below summaries the development area of the proposed masterplan:

Block	Function	Gross Internal Floor Area (sqm)
Residential Block A	Residential use	2,108 sqm
Residential Block B	Residential use	2,230 sqm
Residential Block C	Residential use	2,580 sqm
Residential BTMS	Residential use	238 sqm
Residential Basement	Plants, parking and bin stores	1,944 sqm
Health Hub	Health clinic	2,500 sqm
SEN School	Special education need school	2,402 sqm
Total		**14,002 sqm (incl basement)** **12,058 sqm (excl basement)**

Based on the definition from the current London Plan, the proposed scheme is classed as a Major Development.

1.3 Methodology

The energy assessment conducted has been carried out following the Mayor of London's energy hierarchy assessment approach, as outlined in the London Plan 2016, which states that development proposals should make the fullest contribution to minimising carbon dioxide emissions in accordance with the following:

- Be Lean – Use less energy
- Be Clean – Supply energy efficiently
- Be Green – Use renewable energy

Details of the energy assessment carried out following the Energy Hierarchy approach are documented in Section 5 of this report.

2 Context

This section provides a brief review of national and local governmental legislation, regulatory drivers and climate initiatives.

2.1 National Policy

Under the Kyoto Protocol, the UK aims to reduce a basket of greenhouse gases to 80% below 1990 levels by 2050 with an interim target of 34% reduction by 2020.

This reduction may be achieved through a combination of strategies including reducing the need to use energy, using it more efficiently and increasing the proportion of energy from renewable sources.

The Energy White Paper 2007 sets out the Government's aspiration to supply 20% of its electricity from renewables by 2020 and put the UK on a path to delivering carbon dioxide reductions of around 60% by 2050.

The Climate Change Bill passed into law in November 2008 puts in place a framework to achieve a mandatory 80% cut in the UK's carbon emissions by 2050 (compared to 1990 levels), with an intermediate target of between 26% and 32% by 2020.

In summary, the government's proposed policy involves 5 components:

1) Establishing an international framework to tackle climate change, including the stabilisation of atmospheric greenhouse gas concentrations and a stronger European Union Emissions Trading Scheme (EU ETS).
2) Providing legally binding carbon targets for the whole UK economy, reducing emissions through the implementation of the Climate Change Bill.
3) Making further progress in achieving fully competitive and transparent international markets, including further liberalisation of the European Union energy market.
4) Encouraging more energy saving through better information, incentives and regulation.
5) Providing more support for low carbon technologies, including increased international and domestic public-private sector collaboration in the areas of research, development,

demonstration and deployment – for example though the launch of the Energy Technologies Institute and the Environmental Transformation Fund.

The development of renewable energy resources on a commercial scale is a crucial element in meeting the UK Government's commitments on reducing emissions and combating climate change.

Given current renewable electricity production rates are around 3%, the scale of the challenge is clear. A 'step change' will be required if the targets are to be met, and this has been recognised by the Government in preparing:

National Planning Policy Framework

The National Planning Policy Framework sets out the Government's planning policies for England and how these are expected to be applied.

The NPPF states that to help increase the use and supply of renewable and low carbon energy, local planning authorities should recognise the responsibility on all communities to contribute to energy generation from renewable or low carbon sources:

- Positive strategy to promote energy from renewable and low carbon sources
- Design their policies to maximise renewable and low carbon energy development while ensuring that adverse impacts are addressed satisfactorily, including cumulative landscape and visual impacts;
- Consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure the development of such sources;
- Support community-led initiatives for renewable and low carbon energy, including developments outside such areas being taken forward through neighbourhood planning; and
- Identify opportunities where development can draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers.

2.2 The Current London Plan (March 2016)

The use of Decentralised energy (i.e. District Heating with combined heat and power) precedes Renewable Energy under the Major's Energy Hierarchy: paragraph 5.32 in the London Plan 2012 states – 'The Mayor supports the greater use of renewable and low carbon generation technologies and has set a target for London to generate 25% of its heat and power requirements through the use of local decentralised energy systems by 2025. These will potentially be based around the use of gas fired combined heat and power (CHP), district heating and cooling is the first preference'.

The key policies regarding energy efficiency and renewable energy in new developments are summarised below:

London Plan Policy 5.2 – Minimising CO_2 Emissions

Policy 5.2 of the London Plan sets out the methodology and targets for the journey towards zero carbon for both domestic and non-domestic buildings. Development proposals should meet the fullest contribution to minimising CO_2 emissions in accordance with the following energy hierarchy:

- Be Lean: use less energy

- Be Clean: supply energy efficiently
- Be Green: use renewable energy

The GLA provides guidance for developers and their advisers on preparing energy assessments to accompany strategic planning applications. In accordance with guidance document: GLA guidance on preparing energy assessments (March 2016 edition), the emission reduction targets the GLA will accept are currently defined as follow:

> ***Stage 1 schemes received by the Mayor on or after 1st October 2016** – Zero carbon for residential development and 35% below Part-L 2013 for commercial development*

The guidance document states that the Energy Strategy report must include the following for Outline Planning applications:

- Estimate site-wide 'Regulated' CO_2 emissions and reductions (broken down for the domestic and non-domestic elements of the development), expressed in tonnes per annum, after each stage of the energy hierarchy
- A clear commitment to 'Regulated' CO_2 emissions savings compared to a Part-L 2013 of the Building Regulations compliant development through energy demand reduction measures alone
- Clear evidence that the risk of overheating has been mitigated through passive design
- Evidence of investigation into existing or planned district heating networks that the development could be connected to, including relevant correspondence with local heat network operators
- Commitment to a site heat network served by a single energy centre linking all apartments with non-domestic building uses, if appropriate for the development
- Where applicable, investigations of the feasibility of installing CHP in the proposed development (if connection can't be made to an area wide network) before considering renewables
- The GLA expects all major development proposals to include on-site renewable energy generation, where feasible. This is regardless of whether a 35% target has already been reached through earlier stages of the energy hierarchy.
- Large-scale developments (e.g. mixed-use developments containing more than 1,000 homes) which may be the catalyst for an area wide network, must:
    - Investigate the feasibility of including additional space within the energy centre and capacity within the site heat network to supply heat to nearby developments and, where applicable, existing buildings
    - Provide a feasibility assessment to ensure that CHP is optimised to meet the domestic hot water and part of the space heating demand, thereby minimising CO_2 emissions
- An initial feasibility test for renewable energy technologies and, where appropriate, commitment to further reduce CO_2 emissions through the use of on-site renewable energy generation

- Consideration of the impact of development phasing (where relevant) to ensure the scheme can meet future, more stringent planning or regulatory targets
- Where the London Plan required CO_2 improvement on a development's Part-L 2013 of the Building Regulations compliant baseline is not met, the developer must provide a commitment to ensure the shortfall is met off-site using the provision established by the borough.

2.3 London Borough of Richmond upon Thames

London Borough of Richmond upon Thames's *Local Plan* (currently under consultation, expected to be adopted Spring 2018) set out policies and guidance for development of the borough over the next 15 years. The *Local Plan* forms part of the development plan for the borough, and the role of the development plan is to guide decision making on planning applications and inform investment in social and physical infrastructure.

Under *Local Plan Policy LP 22 – Sustainable Design and Construction*, the council require developments to make the fullest possible contribution to the mitigation of climate change by:

- Development that results in a new residential dwelling, including conversions, change of use, and extensions that result in a new dwelling unit, will be required to incorporate water conservation measures to achieve maximum water consumption of 110 litres per person per day for homes (including an allowance of 5 litres or less per person per day for external water consumption)
- New non-residential buildings over 100 sqm will be required to meet BREEAM 'Excellent' standard
- Proposals for change of use to residential will be required to meet BREEAM Domestic Refurbishment 'Excellent' standard (where feasible)
- Proposed developments are required to meet the following minimum reductions in carbon dioxide emissions[1]:
    - All new major residential development (10 units or more) should achieve zero carbon standards in line with London Plan policy
    - All other new residential buildings should achieve a 35% reduction
    - All major non-residential buildings should achieve a 35% reduction. From 2019 all major non-residential buildings should achieve zero carbon standards in line with London Plan policy

  Any shortfall in on-site reductions can exceptionally be met through a cash-in-lieu contribution to the Council's Carbon Offset Fund, agreed through a Section 106 legal agreement in line with the Planning Obligations SPD
- Energy assessment to be carried out following the Energy Hierarchy, the Energy Statement must demonstrate how the energy requirements will be met in line with the Energy Hierarchy.

[1] Targets are expressed as percentage improvement over the target emission rate (TER) based on Part-L of the 2013 Building Regulations

- All new development will be required to connect to existing decentralised energy (DE) networks where feasible
- Development proposals of 50 units or more, or new non-residential development of 1,000 sqm or more, will need to provide an assessment of the provision of non-site DE networks and combined heat and power (CHP) and where feasible, provide DE and CHP
- Where on-site provision is not feasible, provision should be made for future connection to a local DE network should one become available.
- Applicants are required to consider the installation of low, or preferably ultra-low NOx boilers to reduce the amount of NOx emitted in the borough

2.4 UK Building Regulations Part L

The current edition of Approved Document Part L of the UK Building Regulation has been enforceable since April 2013.

UK Building Regulations Part L are composed of 2 documents:

- Approved Documents L1A ‘Conservation of fuel and power in new dwellings’
- Approved Documents L2A ‘Conservation of fuel and power in new buildings other than dwellings’

Both documents are relevant for the Barnes Hospital development as it contains both residential as well as non-residential developments.

UK Building Regulations Approved Document L1A, ‘Conservation of fuel and power in new buildings dwellings’ 2010 edition with 2016 amendments, came into force in April 2016.

Part L1A 2010 (with 2016 amendments) outlines five criteria for demonstrating that a building complies with the L2A Regulations.

Criterion 1 – Achieving the TER (Target Emission Rate) and TFEE (Target Fabric Energy Efficiency) rate

Criterion 2 – Limit on design flexibility

Criterion 3 – Limiting effects of heat gains in summer

Criterion 4 – Building performance consistent with the DER (Dwelling Emission Rate) and DFEE (Dwelling Fabric Energy Efficiency) rate

Criterion 5 – Provisions for energy efficient operation of the dwelling

UK Building Regulations Approved Document L2A, ‘Conservation of fuel and power in new buildings other than dwellings’ 2013 edition with 2016 amendments, came into force in April 2016.

Part L2A 2013 (with 2016 amendments) outlines five criteria for demonstrating that a building complies with the L2A Regulations.

Criterion 1 – Achieving the TER (Target Emission Rate)

Criterion 2 – Limit on design flexibility

Criterion 3 – Limiting effects of solar gains in summer

Criterion 4 – Building performance consistent with the BER (Building Emission Rate)

Criterion 5 – Provisions for energy efficient operation of the building

It is expected that government approved compliance software are used to produce an output documentation to BCBs (Building Control Bodies) for regulation compliance. In general, compliance involves demonstrating that:

1. The building/dwelling CO_2 performance target and dwelling fabric energy performance target have been met
2. Elements of the design do not fall outside energy efficiency limits unless there are exceptional circumstances
3. The building will not suffer from excessive solar gain
4. The building, as constructed matches the design intent
5. Information is provided to enable the building to be operated efficiently

When carrying out compliance check with Part L, energy and subsequent CO_2 emission from process-related activities should be excluded from the total when calculating the percentage reduction in CO_2 emissions, i.e. 'Regulated' CO_2 emissions only.

Non-exempt buildings with low energy demand

AD L2A defines non-exempt buildings with low energy demand are taken to be those buildings or parts thereof where:

a. Fixed building services for heating and/or cooling are either not provided, or are provided only to heat or cool a localised area rather than the entire enclosed volume of the space concerned (e.g. localised radiant heaters at a workstation in a generally unheated space); or
b. Fixed building are used to heat space in the building to temperatures substantially less than those normally provided for human comfort.

In the situations above, no TER/BER calculation is required, but reasonable provision would be for every fixed building service that is installed to meet the energy efficiency standards set out in the 2013 edition of the *DCLG Non-Domestic Building Services Compliance Guide*.

2.5 BREEAM New Construction 2018

London Borough of Richmond upon Thames *Local Plan Policy LP 22 – Sustainable Design and Construction* requires new non-residential buildings over 100 sqm to meet BREEAM 'Excellent' standard.

The latest BREEAM scheme is BREEAM New Construction 2018. The relevant BREEAM issue for this Energy Strategy is ENE01 'Reduction of energy use and carbon emissions', the minimum requirement under this Issue for achieving 'Excellent' level is:

- To achieve a minimum of 4 credits under *ENE 01 Reduction of energy use and carbon emissions*
- To achieve 1 credit under *ENE 02 Energy monitoring*

2.6 Code for Sustainable Homes

The Code for Sustainable Homes was introduced in 2007, and became a mandatory requirement for new homes in some London boroughs.

In March 2015, following a fundamental review of technical housing standards, the UK government withdrew the Code, aside from the management of legacy cases.

In a written ministerial statement on 25 March 2015, the Secretary of State for Communities and Local Government confirmed that local authorities in England could no longer require code level 3, 4 5 or 6, as part of conditions imposed on planning applications.

Instead, energy requirements for dwellings would be set by the Building Regulations, which were changed to be equivalent to Code Level 4.

3 Energy Hierarchy

The performance of the redevelopment has been assessed following the procedure laid out by the document titled "*Energy Planning – Greater London Authority guidance on preparing energy assessments (March 2016)*", following the Mayor's Energy hierarchy:

- **Priority 1 – Energy Conservation & Energy Efficiency (Be Lean)**
- **Priority 2 – Exploitation of Low Carbon Technologies (Be Clean)**
- **Priority 3 – Exploitation of renewables, sustainable sources of energy (Be Green)**

The Energy Hierarchy offers an effective framework to guide energy policy and decision making. By prioritising demand-side activities to reduce wastage and improve efficiency, the hierarchy links closely to the principles of sustainable development and offers an integrated, easy to use approach to the management of energy demand and supply.

Priority 1 – Energy Conservation & Energy Efficiency (Be Lean)

Energy conservation is often achieved through behavioural changes such as switching appliances off when they are not being used, or the introduction of passive design features, an example of which would be to implement shading devices in order to reduce the need for cooling in summer etc.

Energy efficiency improvements are usually achieved through the application of engineering principles.

Priority 2 – Exploitation of low carbon technologies (Be Clean)

Finite natural resources such as oil, coal, gas and uranium provide the vast majority of global and UK energy supply. The current transport systems, buildings and power generation infrastructure have been built such that they are all largely dependent on the continued supply of these resources. Examples of low carbon technologies are Heat Pumps, Combined Heat & Power and District Heating/Cooling. However, Heat Pumps are considered Renewable technologies when their efficiency is above certain limits.

Priority 3 – Exploitation of Renewables, Sustainable Sources of Energy (Be Green)

Having taken all reasonable steps to minimise energy demand and improve efficiency, this next priority is to supply that demand from clean energy sources that are effectively infinite. Effective, sustainable energy provision, though, is not just about resource availability: it must also embrace wider issues such as affordability, societal acceptability and environmental impact.

4 Methodology

Following the guidance set out in the document "*Energy Planning – Greater London Authority guidance on preparing energy assessments (March 2016)*", GLA's requires reporting of development CO_2 emissions that arise from *Regulated Energy* use.

The definition of *Regulated Energy* and *Regulated CO_2 Emissions* are as follow:

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

Regulated CO_2 Emissions – the CO_2 emissions arising from *Regulated Energy*, as defined above.

4.1 Regulated Energy & CO_2 Emissions Benchmark

Regulated Energy and *Regulated Emissions* are typically derived through a compliance modelling process via a government approved compliance modelling software. However, at this stage it is not possible to carry out a full compliance modelling process and thus benchmark figures are utilised to give a high-level estimate of the energy and carbon performance for the proposal scheme.

Carbon Compliance figures published under the report: "*Zero Carbon Strategies for tomorrow's new homes"* by Zero Carbon Hub have been used as guidance, below is an excerpt from the report showing the theoretical emissions intensity limit achievable with modern home design and construction, the report suggest that the limit is 14 $kgCO_2/m^2$/year for typical apartment blocks, prior to the application of any low carbon and/or renewable energy technologies.

Built form	Fabric Standard (FEES) (max. energy demand for space heating & cooling)	Carbon Compliance (max. on-site carbon emissions from the home's design & construction)
Detached houses	46 kWh/m^2/year	10 $kgCO_2/m^2$/year
Semi-detached houses	46 kWh/m^2/year	11 $kgCO_2/m^2$/year
End of terrace houses	46 kWh/m^2/year	11 $kgCO_2/m^2$/year
Mid terrace houses	39 kWh/m^2/year	11 $kgCO_2/m^2$/year
Apartment blocks	39 kWh/m^2/year	14 $kgCO_2/m^2$/year (up to 4 storeys)

Figure 3: Minimum dwellings *Regulated Emissions* Intensity achievable, taken from *Zero Carbon Hub* report titled *"Zero Carbon Strategies For tomorrow's new homes"* – Feb 2013

Combined with Arup past projects experience, the benchmark figures below are chosen as this more realistically reflect the baseline for the residential development at Barnes Hospital as a starting point.

Block	**Benchmark chosen for residential baseline emissions**
Apartment Blocks	15.14 $kgCO_2/m^2$/year

For the new healthcare centre, the *Regulated Energy* and *Regulated Emissions* intensity benchmark figures applied in this energy assessment are based on new primary healthcare buildings energy performance data found on the UK government's *Energy Performance of Buildings Database England and Wales.*

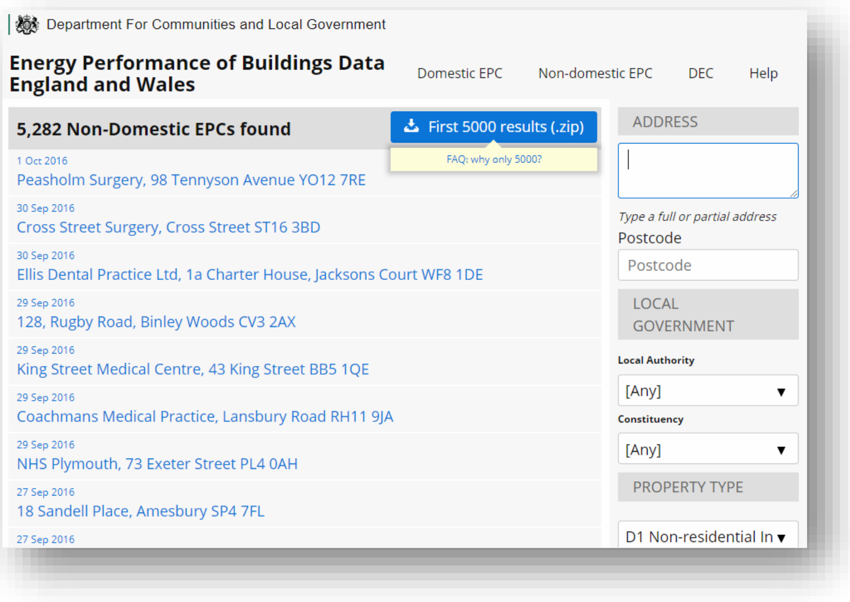


Figure 4: UK Government Energy Performance of Buildings Data England and Wales

Energy Performance Certificate (EPC) data from 49 new build healthcare buildings (since 2011) and 373 new build schools in the South-East region of England have been compiled and analysed. The figures below illustrate the median Target Emission Rate (TER) in $kgCO_2/m^2$/annum.

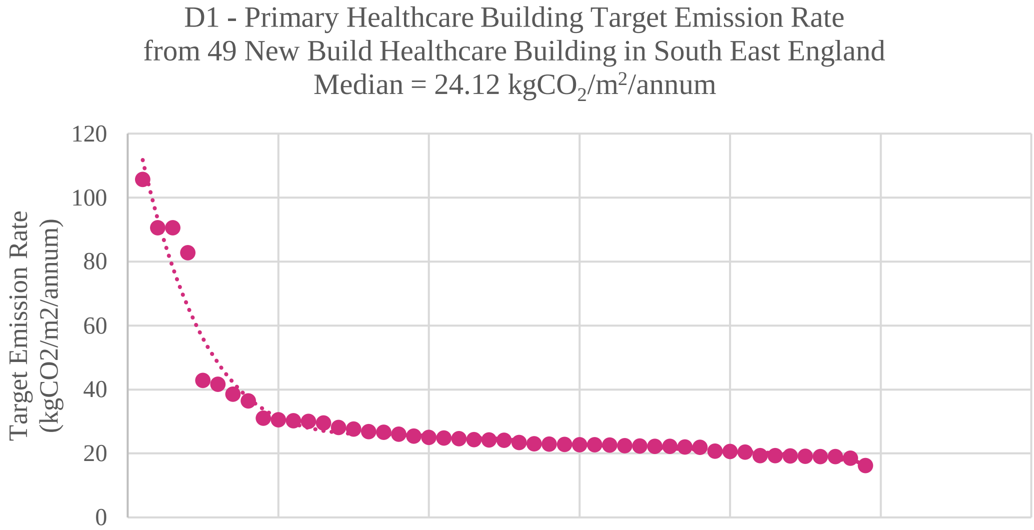
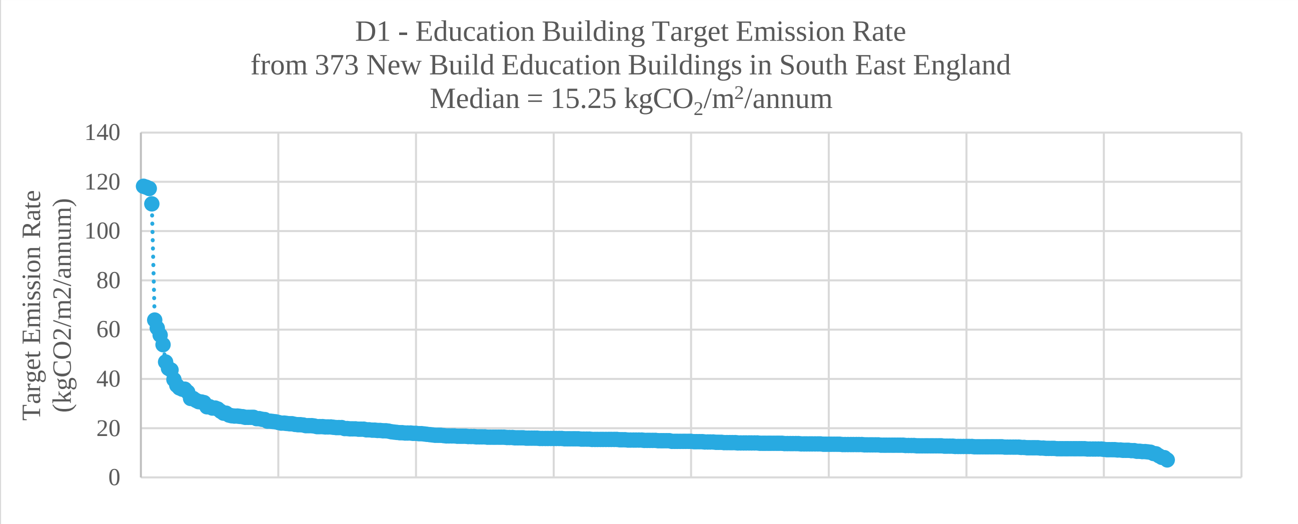


Figure 5: TERs of 49 new build D1 – Primary Healthcare Building since 2011

The TER figure above represents the baseline *Regulated Emissions* for a new build health care building, and from the EPC data being processed, the median TER was found to be at 24.12 $kgCO_2/m^2$/annum and this has been used as the Baseline emission rate for the new health centre.



The TER figure above represents the baseline Regulated Emissions for a new build education building, and from the EPC data being processed, the median TER was found to be at 15.25 $kgCO_2/m^2$/annum and this has been used as the Baseline emission rate for the new Special Education Need school.

5 Energy Assessment

The performance of the building design has been assessed following the Energy Hierarchy (Be Lean – Be Clean – Be Green).

5.1 Notional Baseline

According to the methods set out by the Energy Hierarchy approach under Section 3 of this report, the first step is to establish an energy consumption and associated carbon dioxide emission baseline for the scheme, this is termed the *Notional Baseline*.

The *Notional Baseline* represents the baseline energy consumption and carbon dioxide emissions associated with typical apartment blocks, terrace houses and health centre built to 2013 standards.

By utilising emission benchmark figures outlined in Section 4 of the report, the *Notional Baseline* for the entire scheme has been estimated to be 205.09 tCO_2/annum, shown in Table 1 below.

Table 1: Summary of scheme *Notional Baseline*

Block	Function	GIFA (sqm)	Part-L 2013 TER	Baseline Regulated Emissions
Block A	Residential use	2,108 m^2	15.14 $kgCO_2/m^2$/an	**31.92 tCO_2/annum**
Block B	Residential use	2,230 m^2	15.14 $kgCO_2/m^2$/an.	**33.76 tCO_2/annum**
Block C	Residential use	2,580 m^2	15.14 $kgCO_2/m^2$/an	**39.06 tCO_2/annum**
Residential BTMS	Residential use	238 m^2	15.14 $kgCO_2/m^2$/an	**3.42 tCO_2/annum**
Basement[2]	Plants, parking and bin stores	1,944 m^2	0 $kgCO_2/m^2$/an	**0 tCO_2/annum**
Health Hub	Health clinic	2,500 m2	24.12 kgCO2/m2/an	**60.30 tCO2/annum**
SEN School	Special education need school	2,402 m^2	15.25 $kgCO_2/m^2$/an	**36.63 tCO_2/annum**
Scheme Total Baseline Regulated Emissions (Notional Baseline):				**205.09 tCO_2/annum**
GLA emission reduction target for non-residential development:				**33.93 tCO_2/annum** (35% target)
GLA emission reduction target for residential development:				**108.16 tCO_2/annum** (100% target)
Combined total emission reduction target:				**142.1 tCO_2/annum**

London Borough of Richmond upon Thames requires developments carbon emission reduction targets to be in line with London Plan 2016 policy, current targets are 35% and 100% reduction for non-residential developments and residential developments respectively, thus the total emissions reduction target for the entire scheme has been calculated as 142.1 tCO_2/annum, as shown in Table 1 above.

[2] Assumed unconditioned thus classed as non-exempt buildings with low energy demand under UK Building Reg Part-L2A, refer to report section 2.4 for definition.

5.2 Energy conservation & energy efficiency - Efficient Baseline

The first stage of the London Mayor's Energy Hierarchy approach focusses on Energy Efficiency, to reduce energy losses and eliminate waste. Regulated Emission can be reduced by applying on-site energy efficiency and passive design measures.

All buildings shall be designed to use as little energy as economically possible. The energy demands of the scheme are therefore in need of careful management.

The following are typical measure that can be incorporated into the building design:

Passive design

The envelope of the new buildings can be designed so as to reduce heat losses and reduce energy consumption in both summer and winter season. Table 2 below shows typical U-values that can be achieved with modern construction:

Table 2: Building fabric design targets for the new buildings.

	Part L 2013 limiting parameters	Tpyically achievable
External Wall U-value	0.35 W/(m^2.K)	0.23 W/(m^2.K)
Roof U-value	0.25 W/(m^2.K)	0.16 W/(m^2.K)
Ground/Exposed Floors U value	0.25 W/(m^2.K)	0.18 W/(m^2.K)
Windows U-value	2.2 W/(m^2.K)	1.4 W/(m^2.K)
Building Air Tightness	10 m3/h.m2 @ 50Pa	3 m3/h.m2 @ 50Pa
Thermal Bridging	Standard	Approved construction details

Natural Ventilation design should be allowed for wherever possible to reduce energy consumption for pushing air through ductwork as well as cooling. Detailed analysis shall be carried out to understand the capability for residential plots and health centre to be naturally cooled in summer and overheating risk to be analysed in accordance with CIBSE TM52[3] and CIBSE TM59[4].

The design of buildings should also incorporate night time cooling wherever possible, to exploit exposed mass of high density building materials, this tends to help prevent the temperature of the building rising too much over a 24-hours cycle.

Efficient MEP Services

Minimising energy consumption can be accommodated by driving down energy consumption through energy efficient plant and controls

Therefore, a list of potential design considerations that can be implemented are:

- High seasonal efficiency condensing gas fired boilers;
- High efficiency cooling system SSEER => 4.0;

[3] CIBSE TM52: The Limits of Thermal Comfort: Avoiding Overheating in European Buildings

[4] CIBSE TM59: Design methodology for the assessment of overheating risk in homes

- Energy efficient Air handling units design with thermal energy recovery and low Specific Fan Power (SFP) air distribution system for the health hub and SEN school;
- Balanced Mechanical Ventilation with Heat Recovery for all new dwellings with high efficiency heat exchanger and ultra-low SFP;
- High efficacy low energy lighting i.e. LEDs for all buildings
- Presence detection lighting controls for health hub and SEN school
- Time and Temperature programmer control and TRVs on radiators for all buildings
- BMS system with automatic meter reading, energy monitoring and targeting facilities for health hub and SEN school
- Waste Water Heat Recovery System (WWHRS) for all new dwellings
- Insulation provided for all thermal storage vessels and pipework

Through passive design measures and energy efficient MEP services design, an Efficient Baseline for the development has been established. Table 3 below shows that the total Regulated Emissions of the development can be reduced from a baseline of 205.09 tCO_2/annum, down to 186.68 tCO_2/annum, an improvement of approximately 9.0% over the *Notional Baseline*.

Table 3: Summary of scheme *Efficient Baseline*

Block	**Function**	**GIFA (sqm)**	**BER with Energy Efficiency measures**	**Be Lean Regulated Emissions**
Block A	Residential use	2,108 m2	14.34 $kgCO_2/m^2$/an.	**30.23 tCO_2/annum**
Block B	Residential use	2,230 m2	14.34 $kgCO_2/m^2$/an.	**31.98 tCO_2/annum**
Block C	Residential use	2,580 m2	14.34 $kgCO_2/m^2$/an.	**37.00 tCO_2/annum**
Residential BTMS	Residential use	238 m2	14.34 $kgCO_2/m^2$/an.	**3.24 tCO_2/annum**
Basement[5]	Plants, parking and bin stores	1,944 m2	0 $kgCO_2/m^2$/an	**0 tCO_2/annum**
Health Hub	Health clinic	2,500 m2	20.95 $kgCO_2/m^2$/an.	**52.40 tCO_2/annum**
SEN School	Special education need school	2,402 m2	13.25 $kgCO_2/m^2$/an.	**31.83 tCO_2/annum**
Scheme Total Regulated Emissions (Efficient Baseline):				**186.68 tCO_2/annum**
Improvement over Notional Baseline:				**18.41 tCO_2/annum** (9.0% Improvement)

[5] Assumed unconditioned thus classed as non-exempt buildings with low energy demand under UK Building Reg Part-L2A, refer to report section 2.4 for definition.

5.3 Exploitation of low carbon technologies – Low Carbon Baseline

The successful integration of low carbon technologies with buildings depends on a number of technical, economic and social factors. This section explores the main low carbon technologies available for the site and presents results for the ones which are considered preferable.

5.3.1 Heat Demand Assessment

Energy profiling exercise carried out using UK government published *Building Energy Efficiency Survey (BEES)* report suggest that for typical health centres, most of the thermal energy demand is associated with space heating, approximately 37% and hot water accounts for approximately 63% of total thermal energy requirement.

The figure below illustrates the expected thermal demands of the scheme, blue colour indicates total thermal demand associated with the new Health Hub, purple indicate that associated with the residential development and green corresponds to the SEN School.

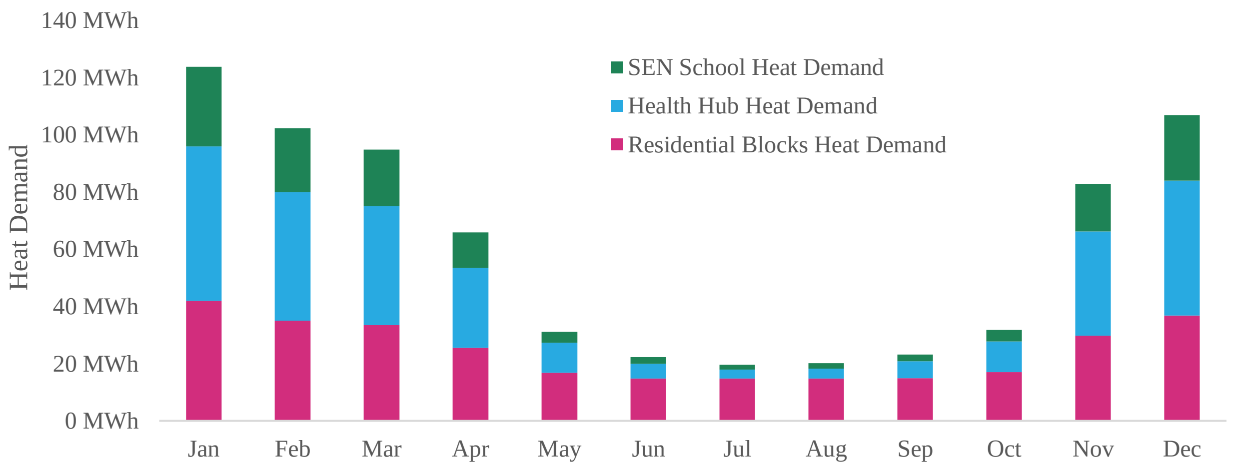


Figure 6: Figure showing the monthly thermal demand from the residential blocks, SEN school and health hub

5.3.2 Existing heat networks

According to the London Plan 2016, London has potential to increase its district energy capacity ten-fold. The Mayor is working to stimulate a major increase in investment in the necessary district energy infrastructure required to maximise the opportunities it can deliver.

The London Heat Map (source: https://maps.london.gov.uk/webmaps/heatmap/) in Figure 7 shows the position of the existing and proposed district heating network in proximity of Barnes Hospital.

It is clear in the figure that there are no major energy supply facilities or existing/proposed heat networks in the vicinity of the hospital site. Therefore, connecting into an existing heat network is shown to be an unviable option.

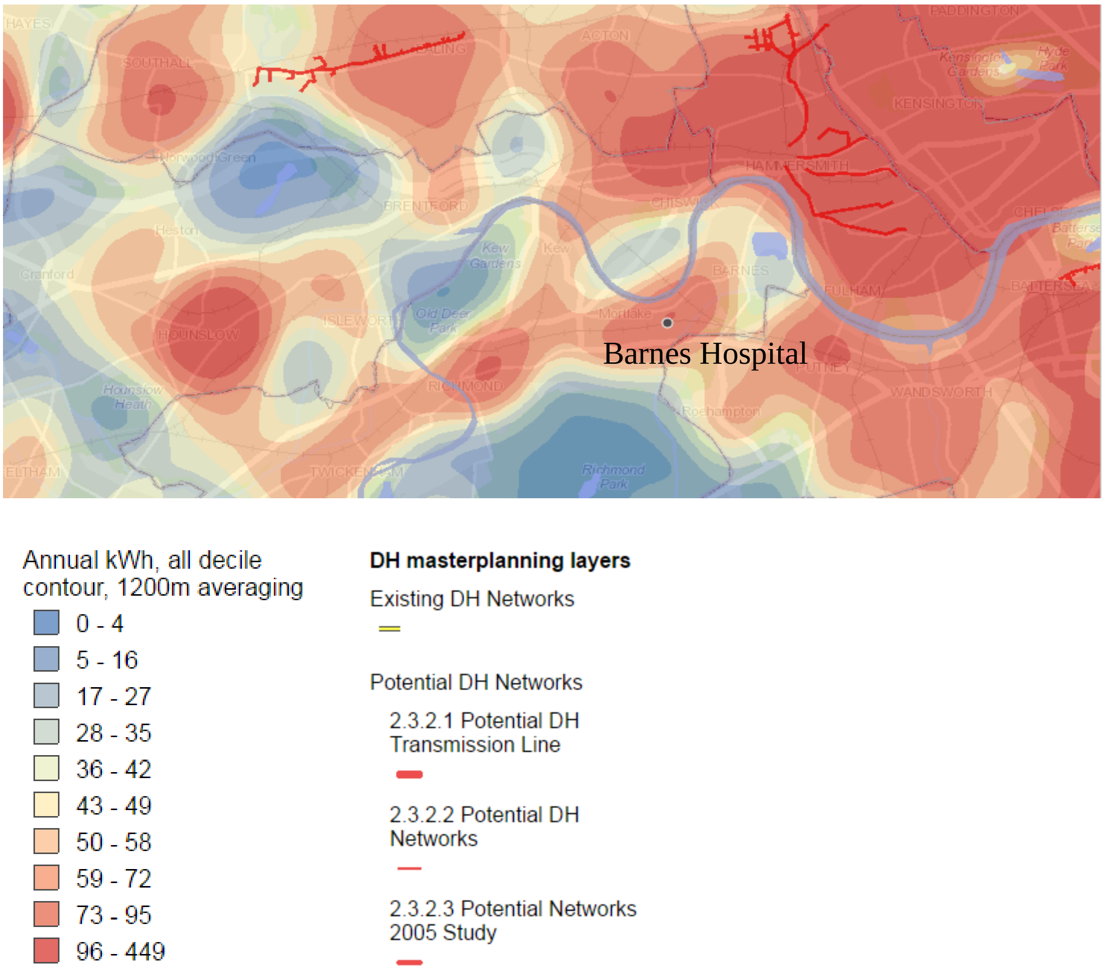


Figure 7: London Heat Map - Extract showing the area around Barnes Hospital Site

5.3.3 Combined Heat & Power

5.3.3.1 Combined Heat & Power Technology Assessment

Combined Heat & Power (CHP) plants, also known as cogeneration, use conventional stationary internal combustion engines or turbines to generate both electricity and heat. A generator is coupled directly to the output shaft of the engine in order to generate electricity. Heat is recovered from the engine via the water jacket, and from the exhaust gas. Assuming the CHP plant is well-designed and as such will be able to utilise large proportions of waste heat on an annual basis, this leads to an overall increase in the CHP plant efficiency to figures significantly greater than those of a conventional internal combustion engine, and is the basic advantage of a CHP plant.

CHP plants up to a peak electrical output of around 5MW are generally gas-fired, using conventional spark ignition engines. Above this range, gas turbines engines are more common, as they are capable of achieving more than 20 MW electrical output.

Although they can provide energy with very high efficiency, CHP plants rely on matched building electrical and heat demands. If these do not follow a similar trend over the course of the day, and throughout the year, then the CHP plant may frequently be generating large proportions of heat when it is not required. If there is no demand then this heat is essentially wasted, or ‘dumped’. This is a key factor which much be considered, as dumping heat will reduce the seasonal efficiency of a CHP system and in turn will reduce the reductions in carbon emissions that are achieved.

In addition, CHP plants are typically only economically feasible if they operate for at least 6,000 hours per annum. To ensure steady operation of the CHP plant, and to prevent heat being dumped, it is recommended that CHP plants are designed to meet the building's base heating demand, exporting electricity to the grid when electrical demand is lower than the CHP electrical output.

The figure below illustrates the thermal demand duration curve, which is often used for rule of thumb indicative sizing for CHP engines. The blue curve indicates the residential development, the pink curve indicates the new health centre and the grey line indicates the school. The purple line indicates the thermal demand duration curve of the combined total for the entire scheme.

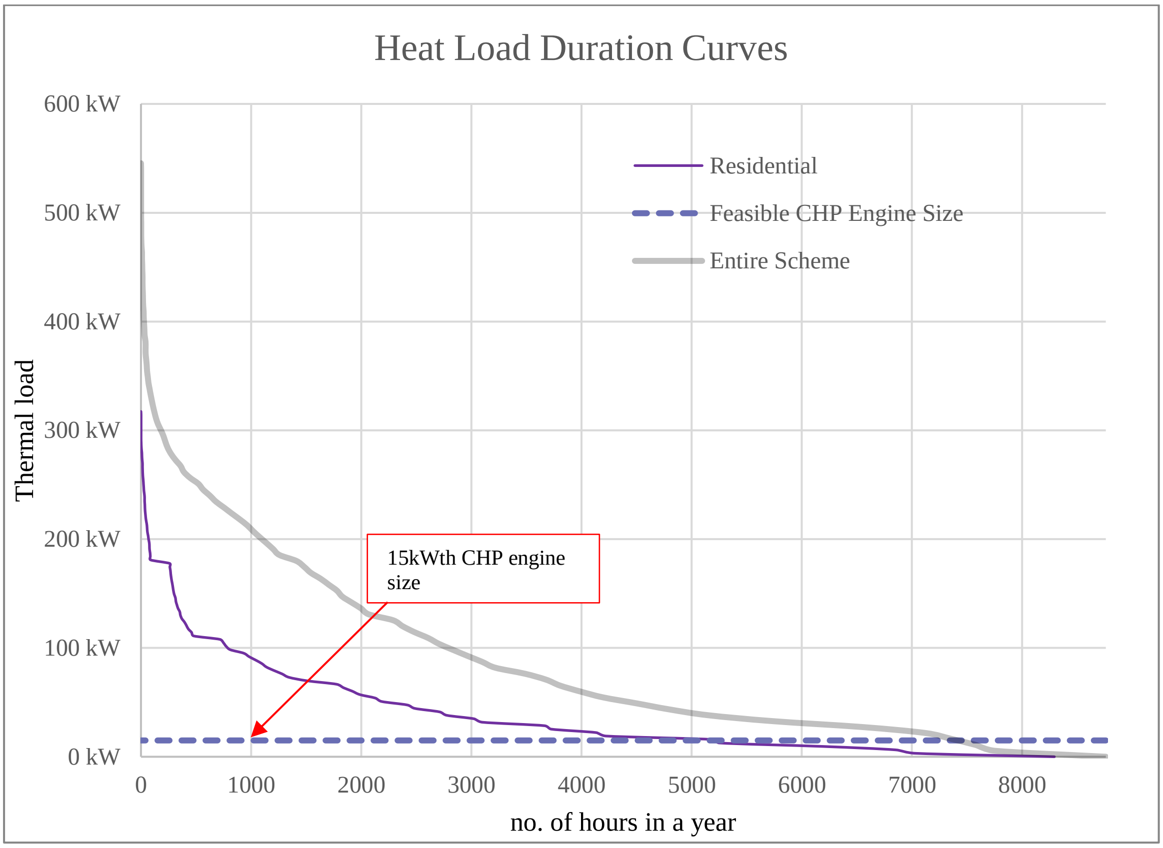


Figure 8: Thermal demand duration curve for the scheme

Looking at the entire scheme thermal demand duration curve, it can be seen a CHP engine thermal output size would be at around 35 kW_{th}, which correspond to around 6,000 – 7,000 hours of expected engine run time per annum.

However, it would be difficult to link up the entire scheme to a single energy supply point when considering ownership structure as well as phasing, in addition, there may not be sufficient plant space in the residential basement to allow a large enough plant for a joint up energy supply, due to constraint with car parking provision.

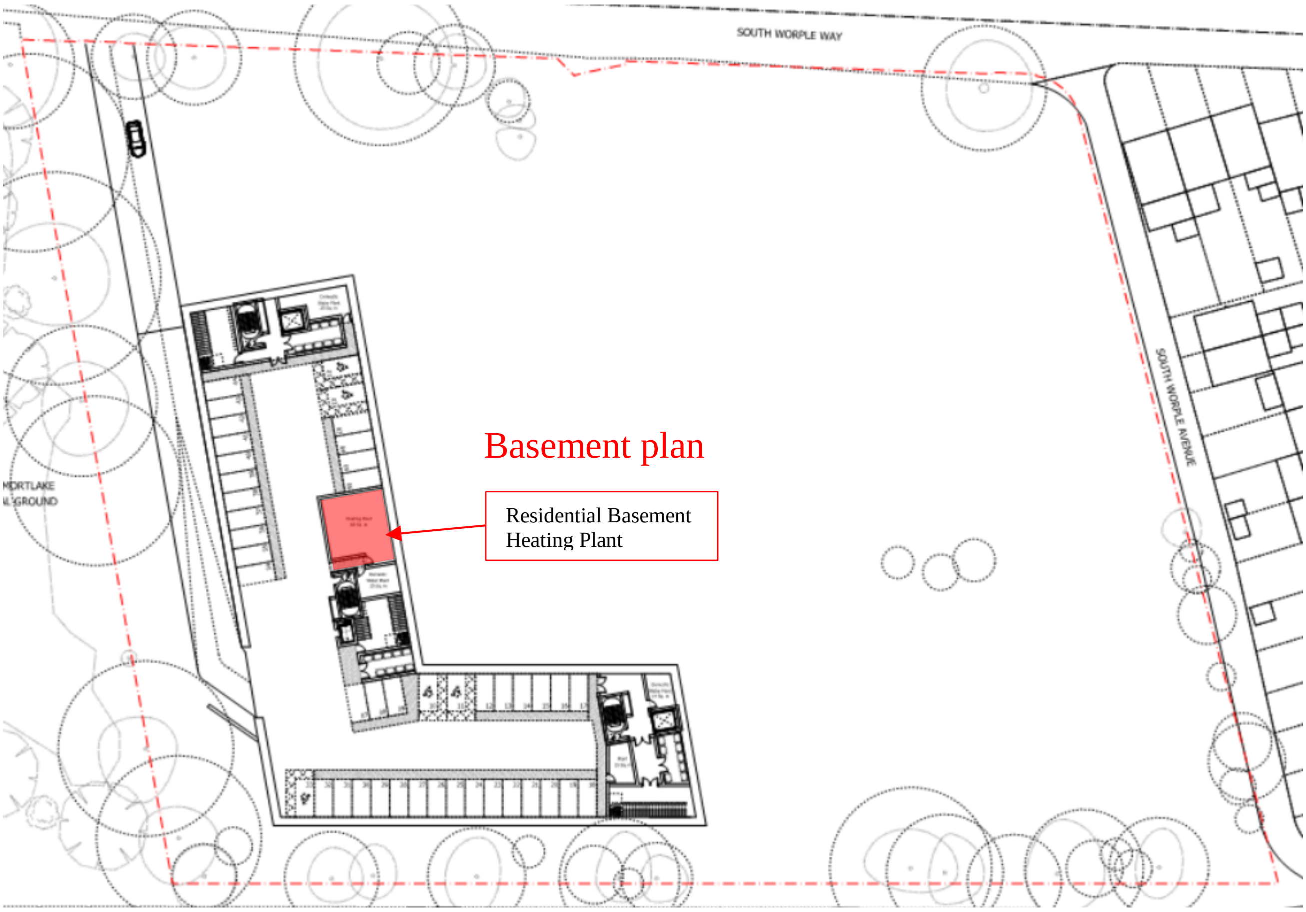


Figure 9: Basement plan showing location of communal heating plantroom

However, a single communal heating plant in the basement with a smaller CHP engine may prove to be a suitable solution for all residential blocks. And judging from heat load duration curve in Figure 8 above, a micro CHP engine size of ~15kWth may prove to be suitable. It is estimated that this size CHP engine can run throughout the day, operating for up to 6,000 hours per annum and it can charge up thermal buffer facilities overnights during summer period when demand for heat is minimal.

Figure 10: Summer time base thermal demand of the scheme (residential development only)

A typical micro-CHP engine of this scale (shown in figure below) would add approximately 6 m^2 to the heating plant space requirement, as shown in the figure below:

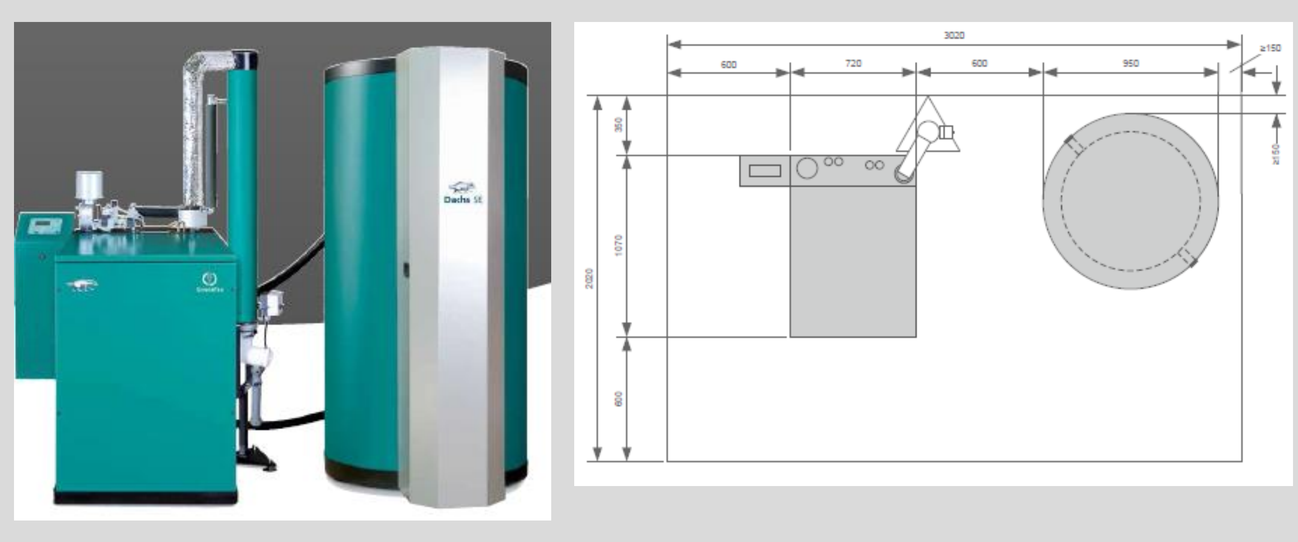


Figure 11: Typical plant space requirement for a micro-CHP engine of this scale (6 sqm)

Note that this does not account for further pipework, fittings and control unit requirement.

5.3.4 Residential blocks communal heating and independent systems for the rest of the scheme

Communal heating for residential blocks is a viable option, this involves placing a heating plant in the basement level and connect all the blocks via LTHW pipework. See Figure 12 and Figure 13 below for illustration.

Figure 12: Illustrative communal heating plant containing LTHW boilers and micro-CHP (for residential blocks)

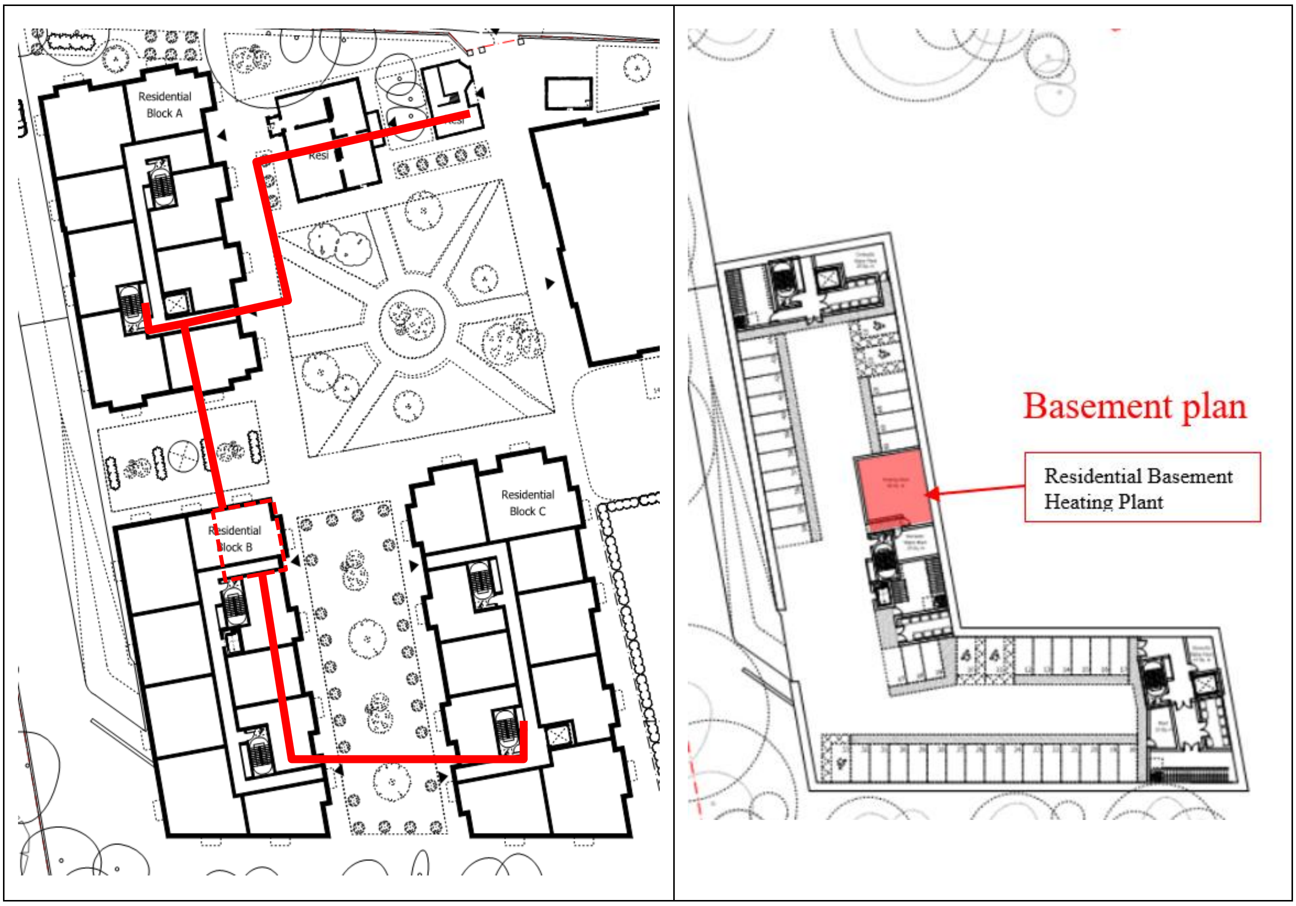
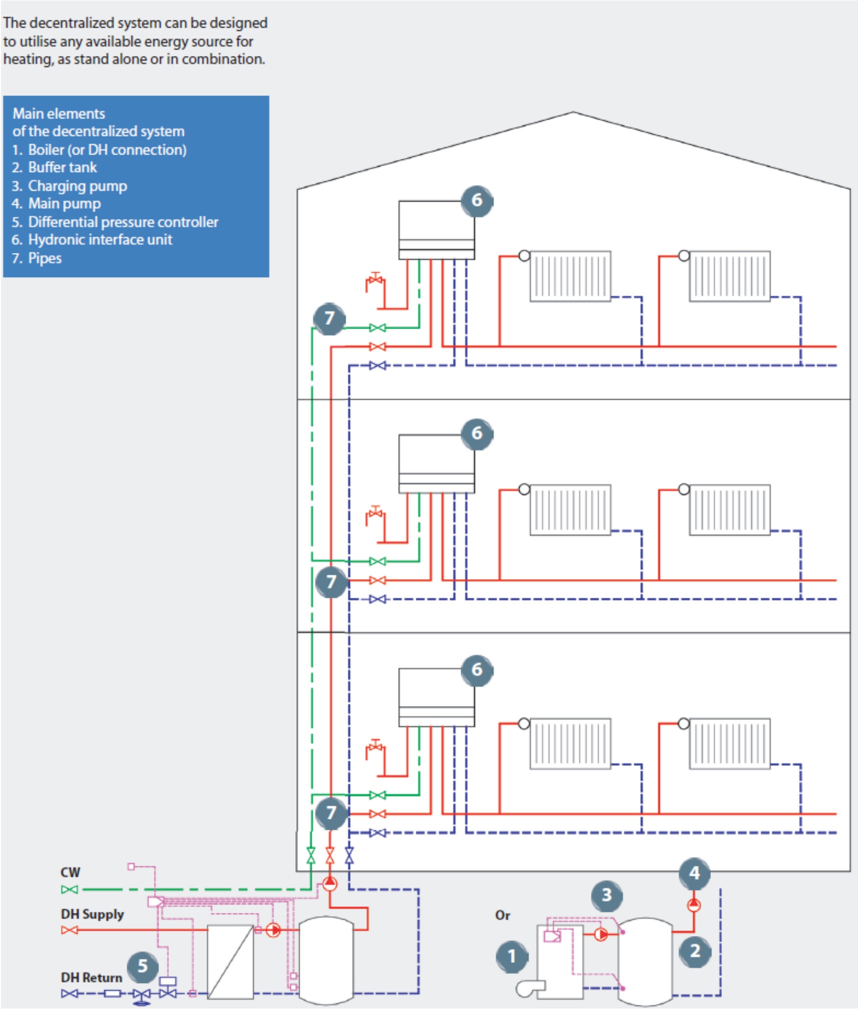


Figure 13: Apartment blocks with shared heating plantroom solution (in Basement)

Under this option, typical configuration of an apartment block heat supply is illustrated in the figure below.



Typical HIU in each apartment:

Figure 14: typical arrangement for an apartment block

A Hydronic Interface Unit (HIU) shall be installed in each apartment to tap into the communal heat supply, typical dimension 800mm (H) × 500mm (W) × 330mm (D).

The new healthcare hub and SEN school shall have their own separate heating system, independent to the rest of the scheme. This is a better solution for the owners of these developments as reliance on heat supply from another entity and plant ownership structure can be sensitive issues.

The table below gives a high-level estimate of the performance of the scheme:

Table 4: Summary of scheme *Low Carbon Baseline* with residential block CHP plant:

Block	**Function**	**GIFA (sqm)**	**BER with Low Carbon Technologies**	**Be Clean Regulated Emissions**
Block A	Residential use	2,108 m^2	12.17 $kgCO_2/m^2/an.$	**25.66 tCO_2/annum**
Block B	Residential use	2,230 m^2	12.17 $kgCO_2/m^2/an.$	**27.15 tCO_2/annum**
Block C	Residential use	2,580 m^2	12.17 $kgCO_2/m^2/an.$	**31.41 tCO_2/annum**

Residential BTMS	Residential use	238 m^2	12.17 $kgCO_2/m^2/an.$	**2.75 tCO_2/annum**
Basement	Plants, parking and bin stores	1,944 m^2	0 $kgCO_2/m^2/an$	**0 tCO_2/annum**
Health Centre Hub	Health Clinic	2,500 m^2	20.95 $kgCO_2/m^2/an.$	**52.40 tCO_2/annum**
SEN School	Special education need school	2,402 m^2	13.25 $kgCO_2/m^2/an.$	**31.83 tCO_2/annum**
Scheme Total Regulated Emissions (Low Carbon Baseline):				**171.21 tCO_2/annum**
Improvement over Notional Baseline:				**33.88 tCO_2/annum** (16.5% Improvement)

Communal heating with gas fired boilers for the residential blocks does not have it self any positive impacts on the building performance. However, by adding a micro-CHP engine to it can reduce the carbon intensity of the residential development.

Overall, the scheme *Regulated Emissions* can be reduced by up to 16.5% from the *Notional Baseline*.

5.4 Exploitation of renewable resources – Renewables Baseline

The GLA expects all major development proposals to include on-site renewable energy generation, where feasible. This is regardless of whether a 35% carbon reduction target has already been reached through earlier stages of the energy hierarchy.

Potential renewable technologies have been assessed and the findings are summarised in Table 5 below, showing the key figures for each technology. Details for each technology are given in the following paragraphs.

Table 5: Summary of Renewable Energy Technologies analysed.

Technology	Feasible?	Practical Solution?	Comments
Wind Turbines	✓	×	Insufficient contribution / urban environment, large scale deployment needed
Biomass (Boilers or CHP)	✓	×	High NOx emissions, delivery issues
Solar Water Heating	✓	×	Not effective if compared with other technologies
Air Source Heat Pumps (VRF-HR)	✓	✓	Preferred technology for health centre hub and SEN school
Ground Source Heat Pumps	✓	×	Expensive, not compatible when installed with VRF-HR
Photovoltaic	✓	✓	

5.4.1 Wind turbines

Figure 15: Typical wind turbine.

A wind turbine is a machine that converts kinetic energy (wind) into mechanical energy. Modern wind turbines are tough, durable machines and efficient at transferring the energy from a natural source. If the mechanical energy is used directly (i.e. to turn wheels), it would be known as a windmill; while if the kinetic energy is used to generate electricity, the system is known as a wind generator or wind turbine.

The issues related to wind turbines are mainly linked to two aspects: the site conditions and the costs. Wind turbines efficiency is strictly related to the very local conditions of the site: the air velocity must be over 5m/s and the site needs to be free of obstacles. Capital cost of the wind turbines are considerably high, being around £22,000 for a typical 6kW wind turbine producing about 11kWh/annum.

At the Barnes Hospital site, London weather data has been considered. This presents wind speeds higher than 5m/s only for 26%, considered insufficient to guarantee an effective investment. Figure 16 shows daily averaged wind speed for London weather file.

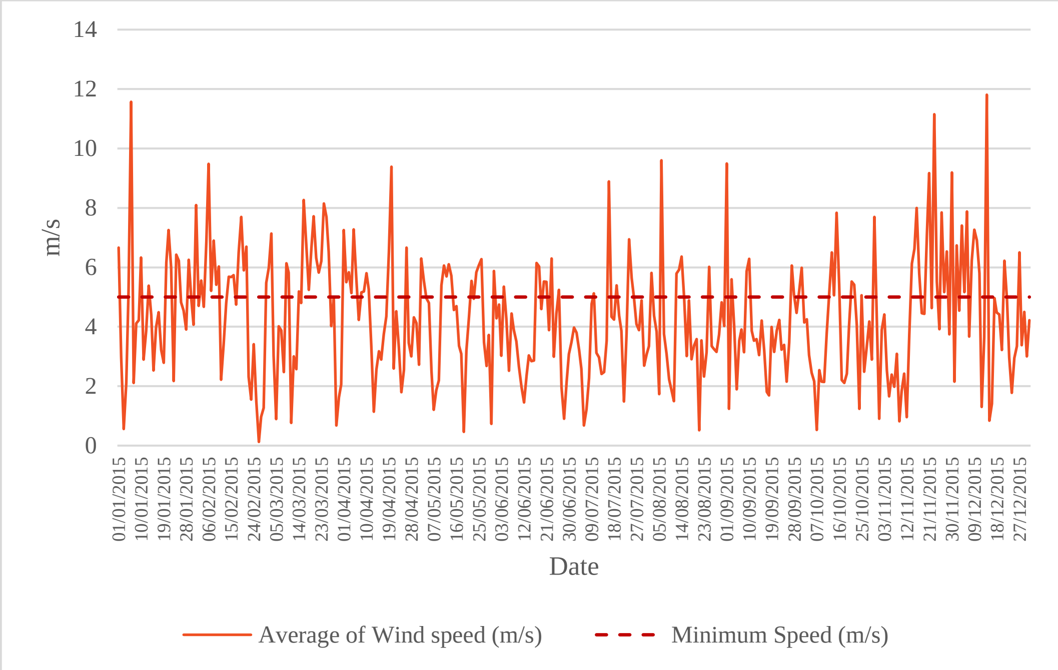


Figure 16: Daily averaged wind speed for London.

A more detailed analysis on the local conditions would be needed in order to argue consistently on the opportunity of this system. However, on the basis of the weather data available the **wind power is considered not viable due to the insufficient wind speed in the area.**

5.4.2 Biomass Heating

Figure 17: Typical Biomass Boiler and Auger © BSRIA.

Biomass boilers or CHPs could be used to provide hot water heating to the buildings. Carbon emissions associated with biomass boilers are low compared to a gas, oil or electric heating system. However, they present significant technical challenges and also require many additional components, such as a storage facility, handling, delivery access, ash removal, thermal storage etc.

Fuel can be delivered via trucks; the wood pellets can be pumped directly into the storage facility via blowers. Therefore, careful consideration must be given to space requirements on site, vehicle turning radius and location of fuel store.

In addition, wood chips/pellets are usually housed indoor in order to avoid decay due to humidity and rain; therefore, storage facilities would have to be built inside the energy centre, thereby increasing the cost and reducing the useful floor area.

Whilst Biomass Heating systems can result in a significant carbon mitigation, they can produce a large amount of NOx, typically around 200kg/kWh of delivered heating energy, and so they have a negative impact on the local air quality and may cause problems with obtaining planning consent. In addition to air quality issues, in an urban environment, logistics and security of fuel delivery can also be an issue, as well as fuel storage.

Due to the reasons listed above, it is determined that **Biomass Heating is not a practical solution** for the redevelopment at Barnes Hospital.

5.4.3 Solar Water Heating

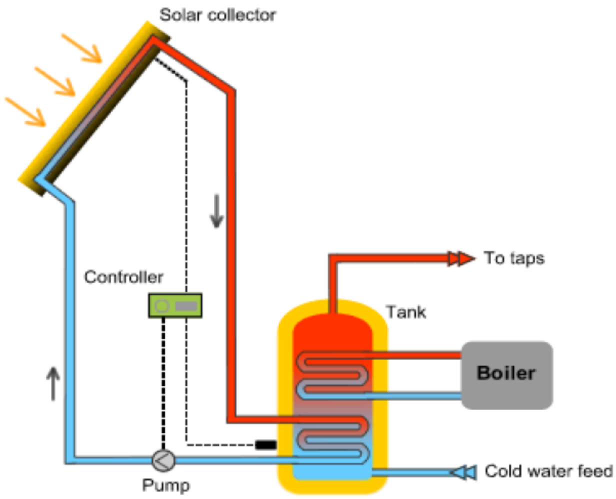


Figure 18: Example of a typical solar hot water system © Payless Solar System.

Solar Water Heating (SWH) can provide hot water to buildings by pumping incoming cold water supply through collectors, typically located on the building roof or façade.

Solar thermal technology is a proven technology, is silent in operation (does not cause any noise pollution) and does not require frequent access or maintenance. It is therefore considered to be a feasible option on technical and practical grounds.

It has been calculated that the carbon abatement potential per sqm of solar panel related to SWH is lower than the one for Photovoltaic panels and the relative implementation cost is higher. Therefore, the **solar thermal technology has been considered not effective** in this case.

5.4.4 Air Source Heat Pumps (Heat Recovery VRF System)

Variable refrigerant flow (VRF) systems are known for their high energy performance and thus can improve energy efficiency in commercial buildings. A typical VRF system consists of outdoor condensing unit(s) and multiple indoor evaporators.

VRF with Heat Recovery (VRF-HR) can operate simultaneously in heating and/or cooling mode, enabling heat to be used rather than rejected as it would be in traditional heat pump systems. VRF-HR systems are equipped with enhanced features like inverter drives, pulse modulating electronic expansion valves and distributed controls that allow system to operate in net heating or net cooling mode, as demanded by the space requirement.

VRF-HR mixed mode operation leads to energy savings as both ends of the thermodynamic cycle are delivering useful heat exchange. If a system has a cooling coefficient of performance (CoP) of 3, and a heating CoP of 4, then heat recovery operation could yield a CoP as high as 7.

VRF system can be 2-pipe or 3-pipe system based on manufacturer's own proprietary design. The figure below illustrates typical setup of VRF system:

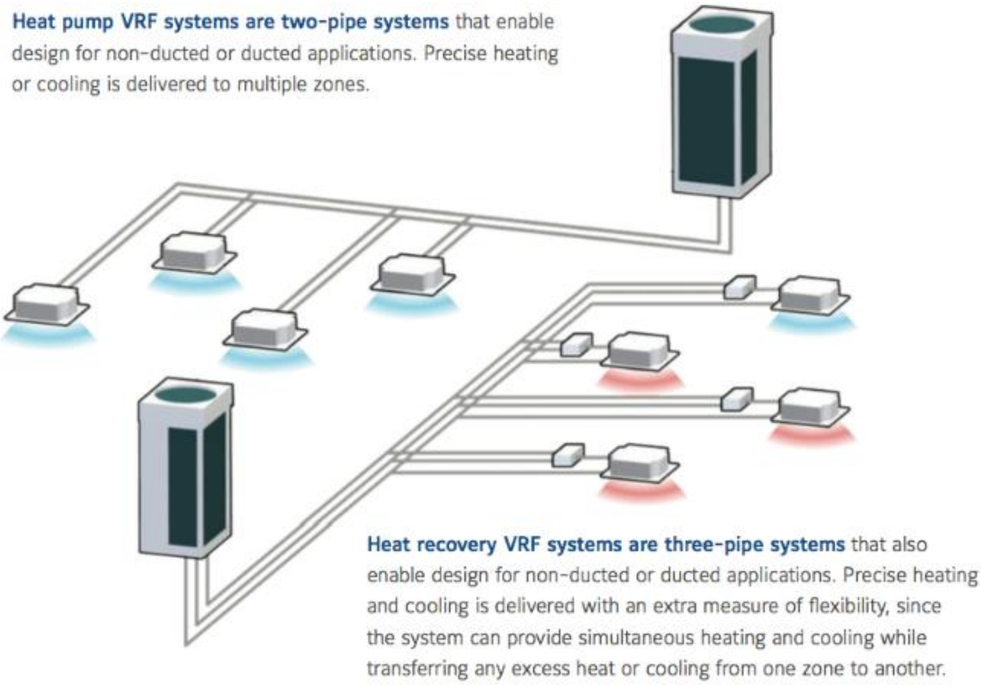


Figure 19: illustration of a typical VRF system setup

VRF-HR systems work best when there is a need for some of the spaces to be cooled and some of them to be heated during the same period. This often occurs in the winter in medium-sized to large sized buildings with a substantial core or in the areas on the north and south sides of a building.

External condensing units can be mounted on available flat spaces on the roof of buildings, or they can also be ground mounted open to atmosphere at concealed spaces, typical installation photos shown below:

Figure 20: Typical VRF installation showing external condensing units on roof and on ground level

It should be also noted that the UK's national electricity grid is being rapidly decarbonised, therefore it is expected that in the next iteration of UK Building Regulation Part-L, due out in 2019, in which electric heat pump technology will likely favoured in comparison to heat generation technologies using conventional fuel source like natural gas.

Therefore, at this outline planning stage, it is determined that Air Source Heat Pumps technology, in the form of Heat Recovery VRF system, is potentially a viable technology and is a preferred technology to be incorporated in the new health centre hub as well as SEN school.

5.4.5 Ground Source Heat Pump

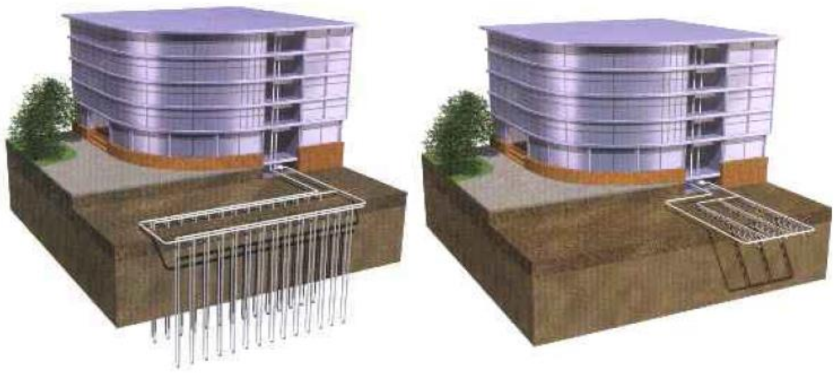


Figure 21: Typical GSHP installation types – vertical loop (left) and horizontal loop (right).

Ground Sourced Heat Pumps (GSHP) are generally used in conjunction with closed loop pipework systems installed either horizontally, approximately 2 metres below ground level, or vertically in bore holes with bore hole depths varying between 15 and 100 metres depending upon particular site ground conditions. Systems are available at present and vertical pipe loops can also be accommodated within pile foundations providing a more economical method of installation.

Ground-coupled heat pumps are not considered wholly renewable due to electrical energy required to generate heating/cooling, but when utilised can reduce building carbon emissions by between 30% and 35%.

The optimum use for GSHPs is in the generation of low temperature hot water to serve systems which are more suited to the use of lower flow temperatures (approximately 40°C), such as underfloor heating systems.

In addition, GSHPs can add significant cost to the construction. Problems can also arise with ground source heat pumps if the installation is poorly design or not matched to the heating needs of buildings.

As GSHPs are more expensive to install than Air Source options, as described in section 5.4.4 above. If implemented together, a GSHP system would compete with VRF-HR air source system for heat production, for these reasons, a GSHP system has been considered not practical and has not been selected as a preferred option.

5.4.6 Photovoltaic Panels

Figure 22: Example of solar photovoltaic panels.

Solar photovoltaic (PV) enables sunlight to be transformed directly into electrical power. The photovoltaic effect or interaction between radiating sunlight and the semiconductor material of the solar cell makes this transformation. This generates electrical charges that are conducted away by metal contacts. The direct current produced can be transformed into alternating current by connecting a DC/AC inverter. The main element of a photovoltaic generator is the solar photovoltaic cell. Several solar cells are combined in series or parallel into an electrical unit, called solar module.

A solar cell consists of a very thin layer of semiconductor material (usually silicon). This is doped with impurities (other elements) on both sides. As a result, one side acquires a negative charge (surplus of electrons) and the other a positive charge (electron deficiency). When sunlight falls on the material that has been changed in this way, electrons are forced from one side to the other by the sun's energy. This produces direct current at the terminals.

PV arrays should, where possible, be mounted to face between south east and south west at an inclination of between 30° and 40°. PV arrays can be designed to integrate with roofing and vertical glazing/cladding systems.

The system should ideally be connected to the mains electricity grid and should be capable of drawing energy from the grid and exporting energy produced by the PV cells to the grid.

The main advantages of PV systems are:

- Part of the electrical supply would be produced on site thus reducing the amount of electricity that would need to be imported;
- By connecting the system to the grid, the cost of storage can be avoided and security of supply is guaranteed.

The photovoltaic cell array size required is dependent upon the overall contribution to the electrical load, available budget and available area that can be utilised for installation.

Figure 23: Architect massing sketch

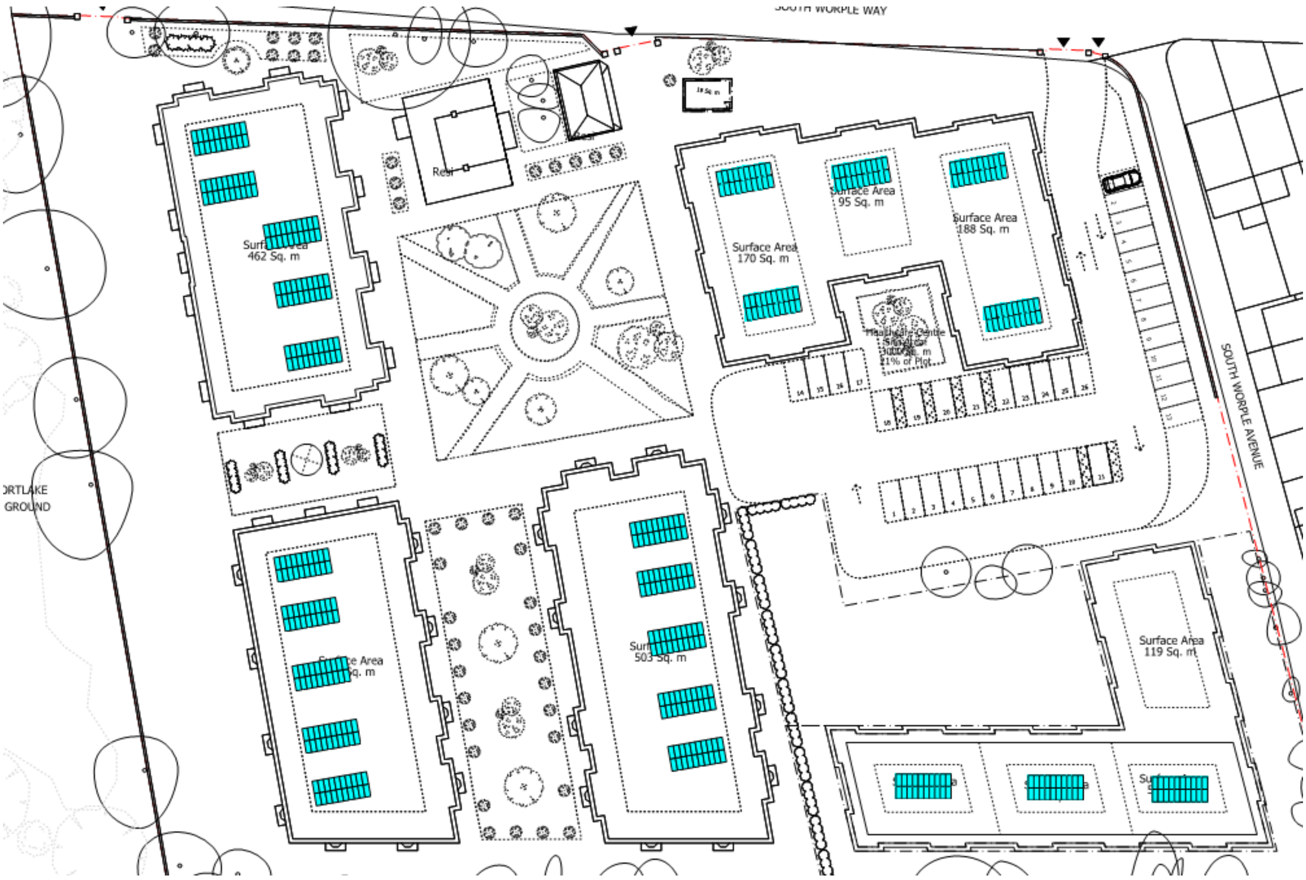


Figure 24: Indicative PV panels layout for the entire scheme

The figure illustrates an indicative photovoltaic panels layout for the development. The total array surface area amounts to 581 sqm, this is equivalent to a total system size of 87.4 kWp with typical 16% efficiency solar modules.

The table below shows the reduction in *Regulated Emissions* achievable for each plot in the scheme:

Plot	**No. of PV Panels**	**Array surface area**	**Orientation**	**System Size Peak kWp**	**Expected Energy Output**	**Regulated CO2 Offset**
Block A	100	126 sqm	South-East	19	-15,644 kWh	-8.12 tCO_2/an
Block B	100	126 sqm	South-East	19	-15,644 kWh	-8.12 tCO2/an
Block C	100	126 sqm	South-East	19	-15,644 kWh	-8.12 tCO2/an
Health Centre Hub	100	126 sqm	South-East	19	-15,644 kWh	-8.12 tCO2/an
SEN School	60	76 sqm	South-East	11.4	-9,386 kWh	-4.87 tCO2/an

With energy conservation & energy efficiency measures, low carbon technology in the form of a micro-CHP engine for the new health centre, and a total of 87.4 kWp of roof mounted photovoltaic panels, the table below gives a high-level estimate of the performance of the scheme:

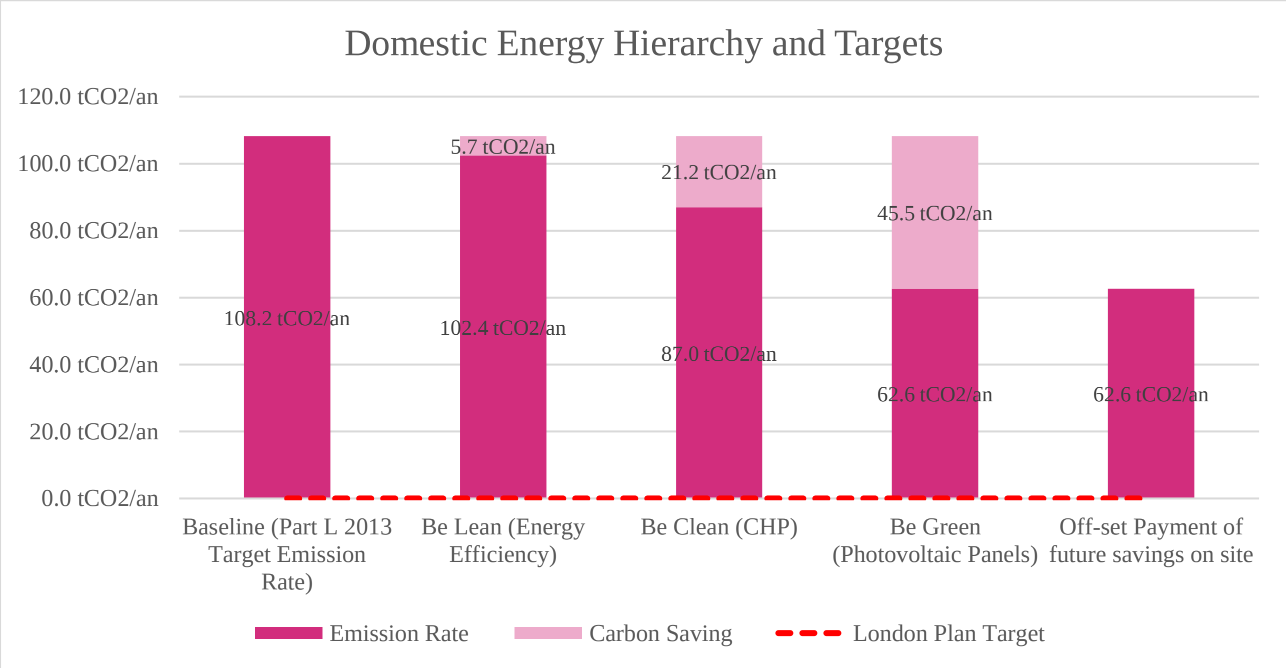
Table 6: Summary of scheme *Renewables Baseline*

Block	**Function**	**GIFA (sqm)**	**BER with Renewables**	**Be Green Regulated Emissions**
Block A	Residential use	2,108 m^2	8.32 $kgCO_2/m^2/an$	**17.55 tCO_2/annum**
Block B	Residential use	2,230 m^2	8.53 $kgCO_2/m^2/an$	**19.03 tCO_2/annum**
Block C	Residential use	2,580 m^2	9.03 $kgCO_2/m^2/an$	**23.29 tCO_2/annum**
Residential BTMS	Residential use	238 m^2	12.17 $kgCO_2/m^2/an$	**2.75 tCO_2/annum**
Basement	Plant, parking and bin stores	1,944 m^2	0 kgCO2/m2/an	**0 tCO2/annum**
Health Centre Hub	Health clinic	2,500 m^2	17.47 kgCO2/m2/an	**43.68 tCO2/annum**
SEN School	Special education need school	2,402 m^2	8.04 $kgCO_2/m^2/an$	**19.32 tCO_2/annum**
Scheme Total Regulated Emissions (Renewables Baseline):				**125.62 tCO_2/annum**
Improvement over Notional Baseline:				**79.47 tCO_2/annum** (38.7% Improvement)

Overall, the scheme *Regulated Emissions* can be reduced by 79.47 tCO_2/annum (38.7%) from the *Notional Baseline*.

6 Summary

The figures and table below illustrate the carbon abatement performance at each stage of the energy hierarchy. The figures are presented separately in accordance to GLA requirement. The carbon shortfall figures are also presented on the charts graphically as well as on the table for non-domestic development and domestic development.



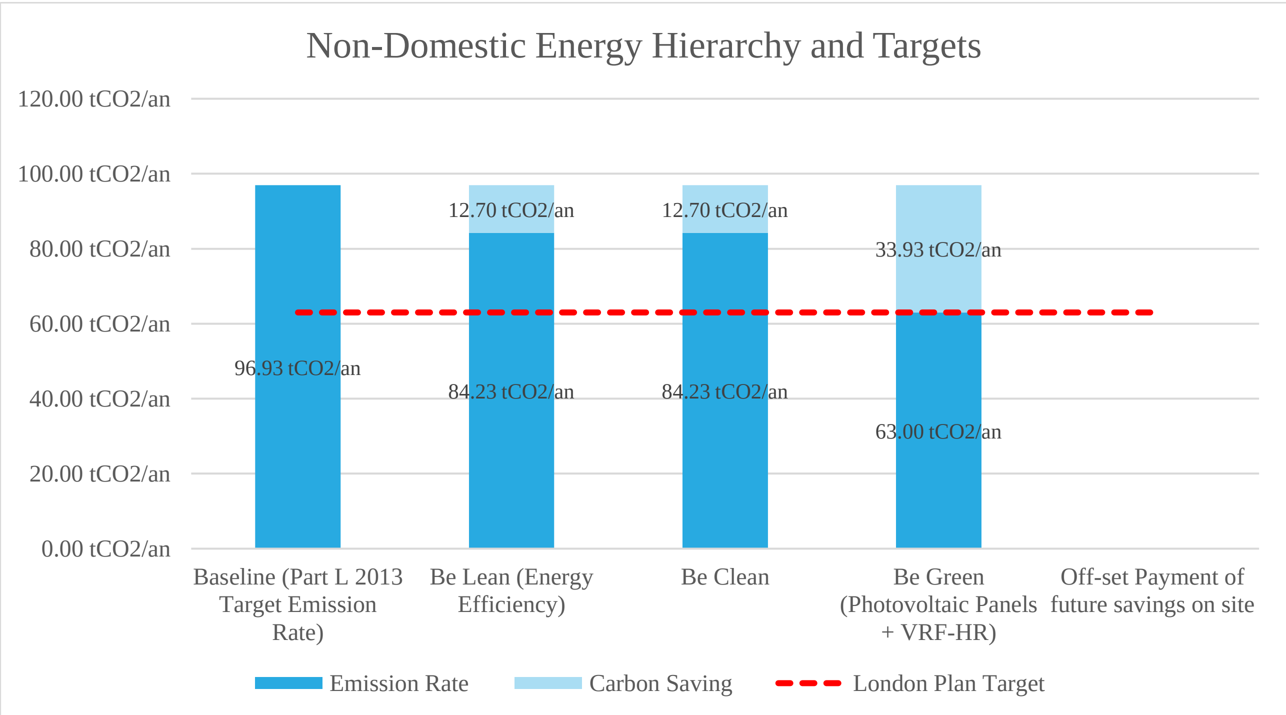


Figure 25: Domestic and non-domestic energy hierarchy performance for the scheme

Table 7: Scheme carbon shortfall calculation

	Regulated (Non-domestic Buildings)	Cumulative Saving	%	Regulated (domestic buildings)	Cumulative Saving	%	Regulated Scheme Total	Cumulative Saving
Baseline: Part-L 2013 of the Building Regulations Compliant Development	96.93 tCO_2/an	-	-	108.2 tCO_2/an	-	-	**205.1 tCO_2/an**	-
After energy demand reduction	84.23 tCO_2/an	12.70 tCO_2/an	13.1%	102.4 tCO_2/an	5.7 tCO_2/an	5.3%	**186.68 tCO_2/an**	**18.41 tCO_2/an**
After Low Carbon Heating Solution	84.23 tCO_2/an	12.70 tCO_2/an	13.1%	87.0 tCO_2/an	21.2 tCO_2/an	19.6%	**171.20 tCO_2/an**	**33.88 tCO_2/an**
After renewable energy	63.00 tCO_2/an	33.93 tCO_2/an	35.0%	62.6 tCO_2/an	45.5 tCO_2/an	42.1%	**125.62 tCO_2/an**	**79.47 tCO_2/an**
Target Savings	33.93 tCO_2/an		35%	108.2 tCO_2/an		100%	**142.1 tCO_2/an**	
Shortfall	0.0 tCO_2/an			62.6 tCO_2/an			**62.6 tCO_2/an**	

The assessment results indicate that it is unable to achieve the full GLA target of 35% *Regulated Emissions* reduction from non-residential development and 100% *Regulated Emissions* reduction from residential development. Therefore, cash in-lieu contribution or potential off-site solutions are likely required to meet the carbon shortfalls.

The table below summaries the annual carbon shortfall in relation to the GLA's carbon reduction target as well as cumulative shortfall for off-set payment calculation:

Table 8: Annual and cumulative carbon shortfall summary

	Hybrid scheme with Photovoltaic
Annual carbon shortfall for domestic development	62.6 tCO2/annum
30 years cumulative shortfall for off-set payment	1,878 tCO2

The above figures are derived from high level assessment using benchmarks figures at this outline planning stage. The energy assessment should be carried out again during detailed design stage using compliance modelling method in order to validate the carbon abatement potential of the scheme following the Energy Hierarchy approach.

Energy assessment conclusions as follow:

- High level baseline *Regulated Emissions* for the scheme is estimated at 205.1 tCO_2/annum
- Energy conservation & energy efficiency can potentially reduce Regulated Emission by approximately 18.41 tCO_2/annum, 9.0% improvement
- Communal heating is preferred option for the residential blocks with a single boiler plant with micro-CHP engine installed with thermal buffer facility

- VRF-HR air source heat pump system is preferred renewable energy technology for health centre hub and SEN school
- PV panels are found to be viable top-up renewable energy technology to meet the GLA's requirement for all major development proposals to include on-site renewable energy generation, where feasible, regardless of whether a 35% target has already been reached through earlier stages of the energy hierarchy.
- An overall *Regulated Emissions* reduction of 79.47 tCO_2/annum (38.7%) for the entire scheme from the baseline
- High level estimate indicates remaining carbon shortfall for the domestic development at 62.6 tCO_2/annum, which equates to a 30 years cumulative shortfall of 1,878 tCO_2
- Energy assessment to be carried out again in detailed design stage using compliance modelling method to validate carbon abatement potential of the scheme following the Energy Hierarchy approach

7 Domestic Overheating Checklist

GLA's guidance on preparing energy assessments: "*Greater London Authority guidance on preparing energy assessments (March 2016)*" states that an overheating checklist to be completed at pre-application and submission stage to assist designers to identify potential overheating risk in residential accommodation early in the design process and trigger the incorporation of passive measures within the building envelope and services design to mitigate overheating and reduce cooling demand in line with current *London Plan Policy 5.9.*

Table 9: Domestic Overheating Checklist

Site features affecting vulnerability to overheating		**Yes/No**
Site Location	Urban – within central London[6] or in a high-density conurbation	No
	Peri-urban[7] – on the suburban fringes of London	Yes
Air quality and/or Noise sensitivity – are any of the following in the vicinity of buildings?	Busy roads / A roads	No
	Railways / Overground / DLR	Yes
	Airport / Flight path	Yes
	Industrial uses / waste facility	No
Proposed building use	Will any buildings be occupied by vulnerable people (e.g. elderly, disabled, young children)?	Yes
	Are residents likely to be at home during the day (e.g. students)?	Yes
Dwelling aspect	Are there any single aspect units?	Yes
Glazing ratio	Is the glazing ratio (glazing: internal floor area) greater than 25%	No

[6] Urban – as defined in CIBSE Guide TM49. Broadly equivalent to Central Activities Zone and Inner London areas in Map 2.2 of the London Plan
[7] Peri-urban – as defined in CIBSE Guide TM49. Broadly equivalent to Outer London areas in Map 2.2 of the London Plan

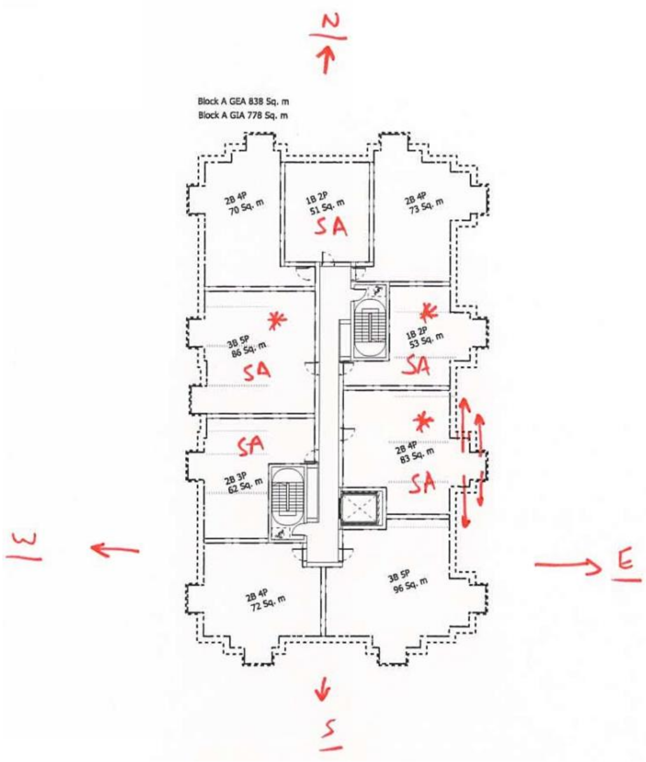
	If yes, is this to allow acceptable levels of daylighting?	N/A
Security – area there any security issues that could limit opening of windows for ventilation	Single storey ground floor units	Yes
	Vulnerable areas identified by the Police Architectural Liaison Officer	No
	Other	No
Section 2 – Design features implemented to mitigate overheating risk		Response
Landscaping	Will deciduous trees be provided for summer shading (to windows and pedestrian routes)?	Yes
	Will green roofs be provided?	Yes
	Will other green or blue infrastructure be provided around buildings for evaporative cooling?	Yes
Materials	Have high albedo (light colour) materials been specified?	* Subject to reserved matters
Dwelling aspect	% of total units that are single aspect	37%
	% single aspect with N / NE / NW orientation	1% (+ 18% west facing)
	% single aspect with E orientation	18%
	% single aspect with S / SE / SE orientation	-
Glazing ratio – what is the glazing ratio (glazing; internal floor area) on each façade?	N / NE / NW *Typical Block*	1 sqm: 0.02
	E *Typical Block*	1 sqm: 0.06
	S / SE / SW *Typical Block*	1 sqm: 0.02
	W *Typical Block*	1 sqm: 0.05
Daylighting	What is the average daylight factor range?	Unknown
Window opening	Are windows openable?	Yes
	What is the average percentage of openable area for the windows?	* Subject to reserved matters
Window opening – what is the extent of the opening?	Fully openable	* Subject to reserved matters
	Limited (e.g. for security, safety, wind loading reasons)	* Subject to reserved matters
Security	Where there are security issues (e.g. ground floor flats) has an alternative night time natural ventilation method been provided (e.g. ventilation grates)?	* Subject to reserved matters
Shading	Is there any external shading?	* Subject to reserved matters
	Is there any internal shading?	* Subject to reserved matters
Glazing specification	Is there any solar control glazing?	* Subject to reserved matters

Ventilation – what is the ventilation strategy?	Natural – background	Yes (in summer)
	Natural - purge	No
	Mechanical – background (e.g. MVHR)	MVHR likely
	Mechanical - purge	No
	What is the average design air change rate?	Unknown at this stage
Heating system	Is communal heating present?	Yes, It is the proposed energy strategy
	What is the flow/return temperature?	Typical 80°C/60°C
	Have horizontal pipe runs been minimised?	Shall be incorporated in design
	Do the specifications include insulation levels in line with the London Heat Network Manual[8]?	Shall be incorporated in design

[8] http://www.londonheatmap.org.uk/Content/uploaded/documents/LHNM_Manual2014Low.pdf

Appendix A

Internal Layout Sketch – First Floor



* SINGLE ASPECT FLATS
Excluded From CALC
AS THE PROJECTING BAYS
PROVIDE DUAL ASPECT.