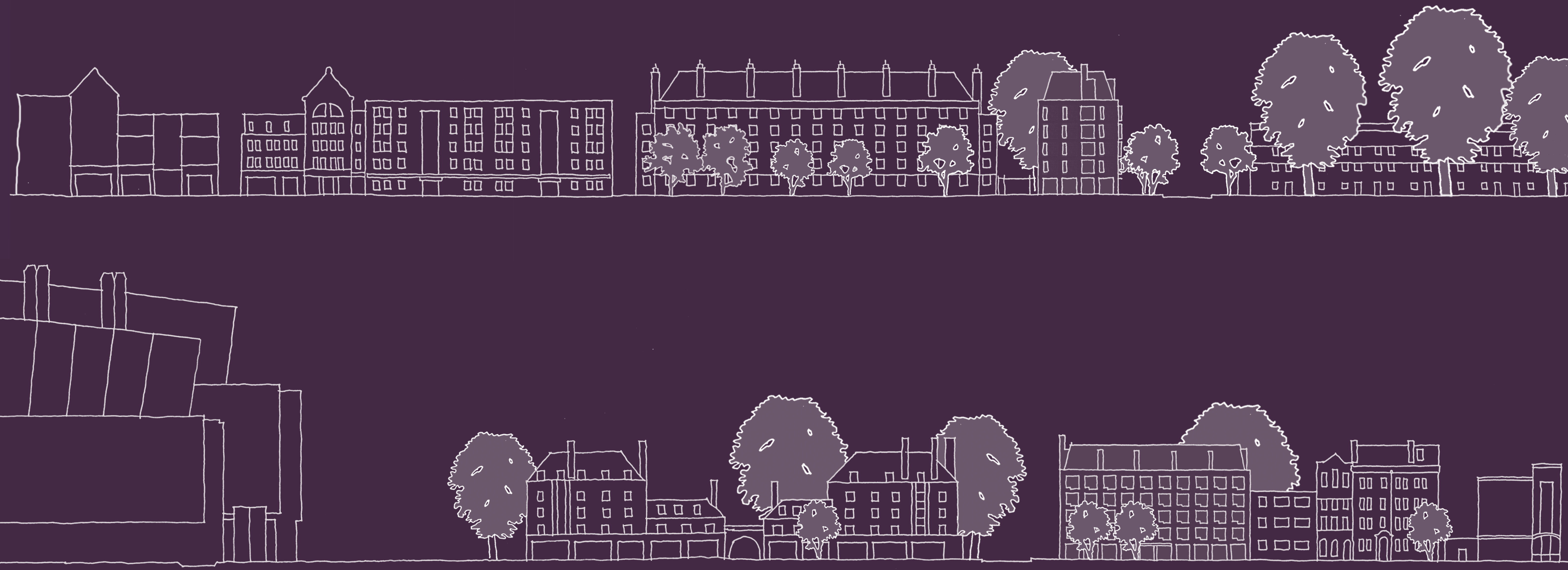
# 42 PHOENIX ROAD

## ENERGY & SUSTAINABILITY STATEMENT



**Skelly & Couch Ltd**

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## Contents



## Audit History

| Rev | Date of Issue | Status | Issued By | Checked By | Summary of Changes |
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## 1.0 Executive Summary

As per the requirements of Camden council and the London Plan, this document will detail the various design decisions and methodologies employed in order to meet the building performance and $CO_2$ reduction targets for the development of student accommodation at 42 Phoenix Road.

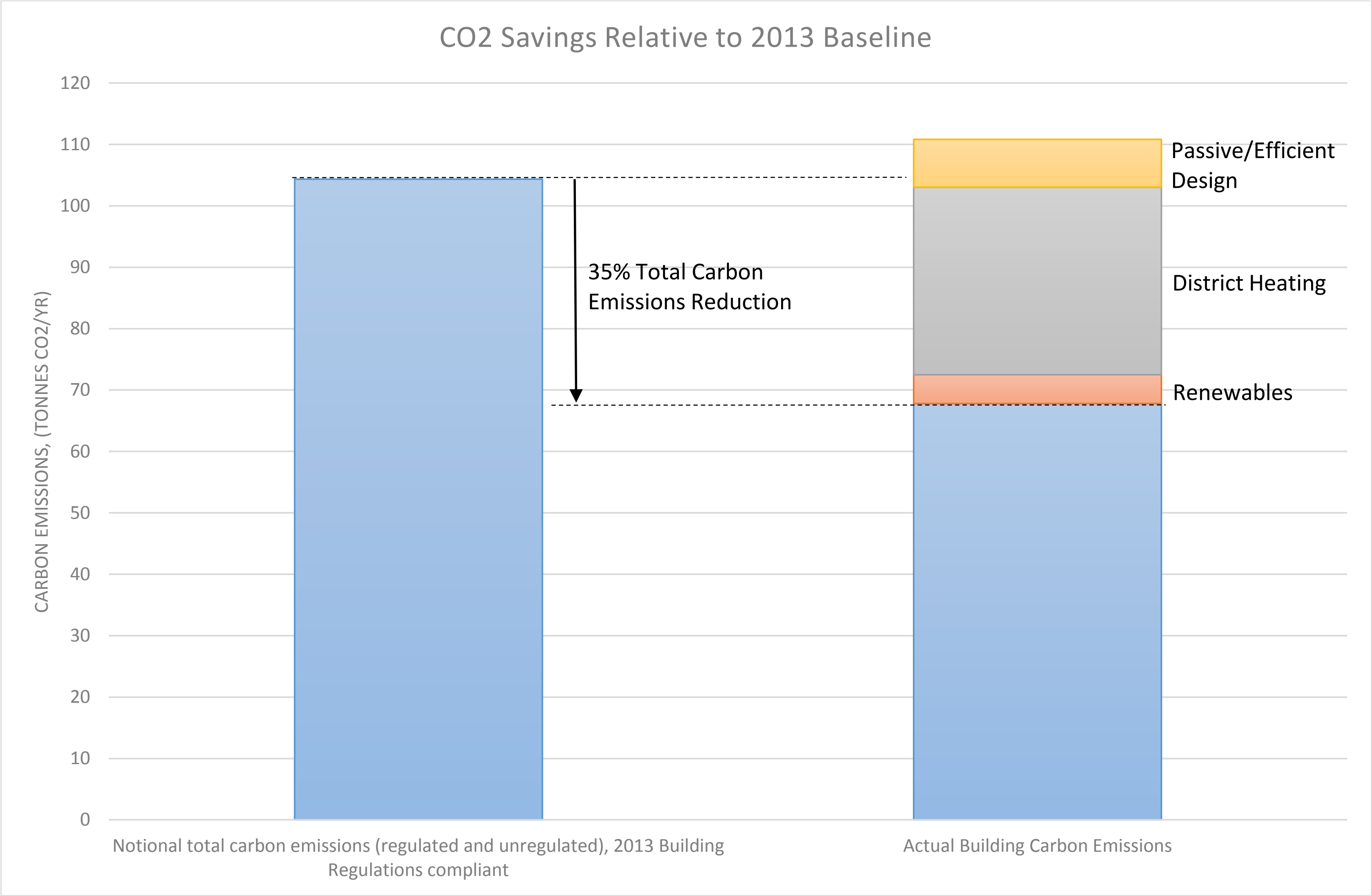
Following the energy hierarchy specified in The London Plan and Camden Councils Planning Guidance (CPG) a number of sustainable design techniques were incorporated into the design for 42 Phoenix Road to demonstrate compliance with local, regional and national dwelling performance and emission requirements:

- Passive design
- Energy efficient design of the services
- Feasibility study on joining the local district heating scheme
- Integration of an onsite Photovoltaic system

The energy assessment was carried out using approved thermal modelling analysis software TAS on the whole development and BREDEM methodology to calculate the unregulated energy.

Results, illustrated on the graph to the right, indicate that when compared to the Notional Development, the various energy efficient strategies employed collectively reduce the developments emissions enough to meet Building Regulations 2013 and the criteria set by The London Plan and Camden council. The table below provides a summative breakdown of the savings associated with each measure implemented and the cumulative effect of all of these when compared to the Baseline Actual Building Emissions.

| | Energy demand (MWh/yr) | $CO_2$ Emissions (Tonnes/yr) | Percentage Savings(%) |
|---|---|---|---|
| Notional Building | 488.8 | 104.34 | 0% |
| Energy efficient Design | 444.3 | 101.68 | 3% |
| District Heating | 350.2 | 71.15 | 29% |
| Renewables (PV) | 341.3 | 67.82 | 3% |
| Total Savings (against baseline) | 147.52 | 36.52 | 35% |



## 2.0 Introduction

42 Phoenix Road is a new build mixed use proposed development with student accommodation and communal spaces. This development will have 8 6-bed flats and 7 En-suite flats accommodating a total of 55 beds.

This development is classed under BREEAM multi-residential and is required to achieve "Excellent" status as well as satisfy other design framework specified by Camden.

The following chapter will outline the details of the most relevant regional and local policies, focusing on London and he London Borough of Camden.

A further chapter will provide an overview of the different energy efficient strategies and renewable technologies considered/employed and will set the basis upon which the results of modelling will be appraised and conclusions made.

# 3.0 Regional and Local Policies

The climate change mitigation agenda has led to policies enforcing ever more stringent standards for the sustainable design and construction of new and refurbished buildings. Building Control, The Greater London Authority (GLA) and Camden Council require that development proposals demonstrate compliance with these standards.

## 3.1 The London Plan

The London plan is the overall strategic plan for developments in London that details an integrated development framework for the capital until 2031.

The core objective of The London Plan is an overall reduction in London's $CO_2$ emissions to 60% of 1990 levels by 2025.

In order to achieve this, local policies are required to be in general conformity with the London Plan; it is in this way that The Greater London Authority is able to guide decisions on Planning Applications by councils.

There are four policies that provide relevant guidance on the design approach for 42 Phoenix road:

### 3.1.1 Policy 5.2 Minimising Carbon Dioxide Emission

In line with building regulations, it is expected that the design team demonstrate they have taken all reasonable courses of action to minimise the building estimated/predicted $CO_2$ emissions, and that it be done using the following energy hierarchy:

- Be lean: Use less energy
- Be clean: Supply energy efficiently
- Be green: Use renewable energy

All applicable developments are required to meet specific emissions targets by employing sustainable design practice. The basis upon which the targets are determined is the building regulations. These target emission rates or TER's are set to become increasingly stringent until zero carbon developments become the standard in London in 2016.

### 3.1.2 Policy 5.3 Sustainable Design and Construction

Development proposals should demonstrate that a sustainable design methodology has been employed throughout the design process and will be kept through to project completion. Below is a list of the key sustainable design principles:

- Minimising carbon dioxide emissions across the site, including the building and services (e.g. heating and cooling systems)
- Preventing overheating
- Efficient use of natural resources and the local environment
- Minimising pollution (Noise, air etc.)
- Minimising generation of waste and maximising reuse or recycling
- Mitigating impact from natural hazards (including flooding)
- Securing sustainable procurement of materials
- Ensuring developments are comfortable and secure for end users

The aforementioned principles are generally addressed by complying with the BREEAM Assessment methodology; touched upon briefly later on in the report.

### 3.1.3 Policy 5.6 Decentralised Energy Networks

With the Mayor of London pushing to have 25% adoption of decentralised energy systems by 2025, all boroughs under the London development framework have been moved to require that developers prioritise connection to an existing or planned decentralised energy network where feasible. Depending on the size of the development the options below are to be considered:

- Connection to existing heating or cooling networks
- Site-wide CHP network
- Communal Heating and Cooling

### 3.1.4 Policy 5.7 Renewable Energy

In line with the "Be green" section of the energy hierarchy put forward by the London plan, major development proposals should employ renewable energy technologies in their list of tools to reduce expected carbon dioxide emissions, where feasible. The significance of this policy is filtered through to the Planning application requirements of LDF boroughs.

All proposed renewable energy systems however are required to minimise potential adverse impacts on the various environmental factors such like biodiversity, the landscape and air quality. This in addition to the economics of available systems usually filters the list of viable options to the following technologies:

- Biomass Heating
- Photovoltaics
- Solar Thermal heating
- Wind Turbines
- Ground Source Heat Pumps
- Air Source Heat Pumps

## 3.2 Local Planning Requirements (Camden Council)

Camden council require that all applicable developments incorporate sustainable design and construction measures in their development proposal, demonstrating through an energy statement how the principles detailed in the boroughs development framework DP22 have been incorporated into the design and proposed implementation.

Through their Planning guidance, Camden promotes and measures sustainable design and construction of all the various development categories by employing Code for Sustainable Homes (CfSH), BREEAM or EcoHomes assessment methodology. Applicants are strongly encouraged to satisfy the following requirements in order to maximise the chances of a successful Planning application:

- Achieve a minimum 'Excellent' rating in BREEAM or EcoHomes
- Demonstrate through modelling that the development is designed to sufficiently mitigate against overheating.
- Implement the key policies detailed in the London plan

Applicants are given the alternative of either demonstrating the above to be technically, functionally or economically infeasible or contributing, monetarily or otherwise, to the continued expansion of the boroughs decentralised energy network.

## 3.3 Building Regulation Compliance

Building Regulations apply to most developments, and are in place to ensure all applicable buildings meet the health, safety, welfare, convenience and sustainability standards set out in the numerous government approved documents available to developers and the design team. They focus on the technical aspects of designing and constructing a building and compliance with regulations is often if not always essential in obtaining Planning permission for all kinds of developments.

The proposed development will need to be fully compliant with all of the revisions of the building regulations relevant to MEPH design that are in force at the time of Planning Application. The most relevant documents to the energy statement are the Part L Approved Documents.

All works for the proposed development will be covered by Approved Document L2A.

## 3.4 BREEAM

BREEAM is a point based methodology for assessing the performance of new and existing buildings in categories ranging from design, specification, and construction through to operation. This methodology sets benchmarks for common developments that allows clients, project teams and facilities managers to be certain that the required standard of environmental best practice is being adopted on their project, while also adding market/social value to the affected development.

Whilst BREEAM can often be unsuitable for bespoke projects and can lead to unnecessary costs in areas that are not relevant to the client's needs, it does act as a useful design checklist.

BREEAM Assessments are carried out by trained assessors and are based on a scoring architecture with nine criteria:

- **Management***: overall management policy, commissioning, site management and procedural issue resolution*
- **Health and well-being**: *indoor and external issues affecting health and well being*
- **Energy use***: pertains to operational energy use and $CO_2$ issues*
- ***Transport:*** *transport related $CO_2$ and location related factors*
- **Water:** *consumption and water efficiency*
- **Materials:** *environmental implication of building materials, including life cycle impacts*
- **Land use:** *greenfield and brownfield sites*
- **Ecology:** *ecological value conservation and enhancement of the site*
- **Pollution:** *air and water pollutions issues*

Each of the criteria is scored and then multiplied by a weighting. There are minimum thresholds that must be evidenced, however additional points are available for exemplary innovations. The final score is then classified under a standardised rating such as "Excellent".

The development proposed in this report falls under the BREEAM multi-residential category and will be required to achieve at a minimum an "Excellent" rating in order to satisfy local Planning conditions set by Camden council.

A consolidated assessment for 42 Phoenix road can be found in the Preliminary Assessment carried out by Eight Associates.

SKELLY&COUCH
Building Environment & Services Engineering Consultants

# 4.0 Environmental and Energy Strategy

This section forms the core element of the energy statement and will detail how 42 Phoenix Road has been designed in line with the Regional and Local Policies and requirements mentioned in the previous chapter. A brief description of the existing building will prelude the “Be lean, Be clean, Be green” design framework that will demonstrate how this development aims to meet the emissions and performance demands set.

## 4.1 Existing Building:

The existing facades is made up of uninsulated poorly sealed brickwork and single glazed painted steel frames windows, with top/side hung opening outwards; they are over 60 years old and have significant shortcomings with respect to their performance and do not meet current standards with regards to safety and thermal performance.

Limitations of the existing façade/window:

- Poor thermal performance
- High air leakage resulting in wasted heat energy
- Poor detailing at junctions which provide cold bridges
- Overheating due to large areas of glazing with no solar control/shading
- Poor acoustic insulation/separation resulting in noise break-in/out
- No thermal breaks
- High maintenance required including regular overhaul
- Water penetration resulting in damp

## 4.2 The Proposed Building: Baseline

As per the Building Regulations the proposed development if erected is not allowed to exceed the Target $CO_2$ Emissions Rate (TER) associated with the building. The TER is a tool that sets a minimum allowable standard for the buildings energy performance, it is determined by modelling the annual $CO_2$ emissions of a building of the same type, size and shape as the building in question under standardised conditions; this is known as the Notional Building.

In order to clearly evaluate the effectiveness of the solutions proposed a similar figure needs to be determined for the proposed building based on its actual specification, this is called the Building Emissions Rate (BER) for buildings other than dwellings. It is these two factors that will be used to quantitatively assess the improvements achieved following the energy hierarchy.

## 4.3 Be Lean: Demand Reduction

In order to maximise the energy efficiency of the proposed building a number of design measures were put forward. The proposed building will be aiming to meet or exceed the stated notional U-values shown in the table below.

| Building Element | Notional U-Values ($W/m^2K$) | Proposed U-values ($W/m^2K$) |
|---|---|---|
| Roof | 0.18 | 0.18 |
| Walls | 0.26 | 0.26 |
| Floors | 0.22 | 0.22 |
| Windows & Doors | 1.6 (@ 10% FF) | 1.6 (@10% FF) |
| Roof lights | 1.8 | 1.8 |

### 4.3.1 High thermal mass roofing:

A roof build up with dense elements is desired to significantly increase the thermal mass. The reason for this is to buffer against extreme weather in both the summer and the winter; this will naturally have positive implications on user comfort and energy use inside the proposed building.

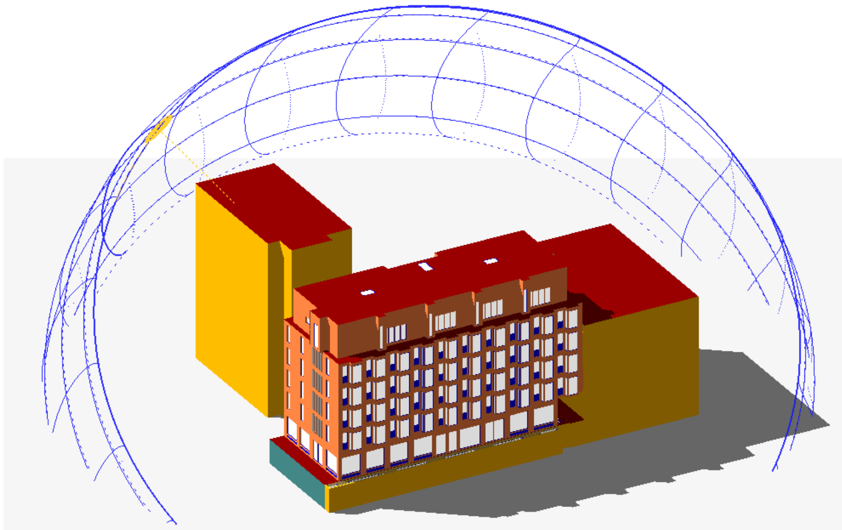
### 4.3.2 Natural Ventilation

A natural ventilation strategy has been employed in the design of the ventilation system, which minimises fan power. The design intent is to provide the minimum fresh air requirements specified in part F and have enough additional capacity to mitigate against overheating in order to avoid the need for installing an active cooling plant. In colder weather the extract unit will serve the basement level while extract systems with automatic air dampers providing make up air will serve the ground floor. Apartments will have extracts in the toilets and kitchen spaces, with background ventilation provisions for the living room and bedroom.

In order to insure that indoor air pollution levels are minimal an Indoor Air Quality plan will need to be completed, so that future design decisions are more informed of the implications on air quality.

### 4.3.3 Overheating

Thermal modelling software EDSL TAS was used to simulate the level of thermal comfort in the whole building throughout the year in a CIBSE TM52 compliant overheating analysis. Through the use of solar control glazing and appropriate purge ventilation provisions it was determined that all of the residential spaces in the building comply with TM52, with the commercial and D1 spaces achieving compliance subject to minor modifications.



### 4.3.4 Hot & Cold water demand

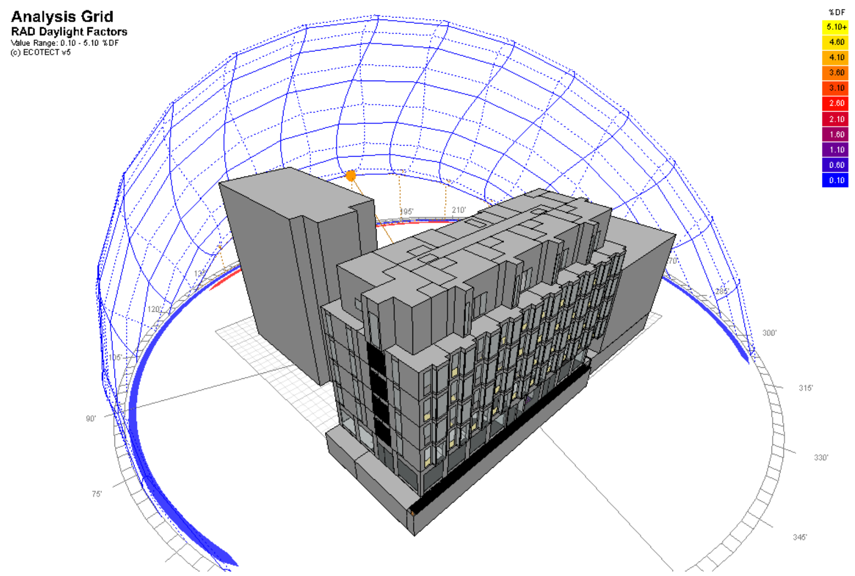
In accordance with recommendations in BREEAM Multi-residential the general water demand in the proposed dwelling will be reduced to 25% below national standards through the careful specification of flow control devices for water consuming appliances; example appliance specs are detailed in the table below.

| Appliance | Flow Rate (litres/min) |
|---|---|
| WC | 4.5 |
| Tap | 7.5 |
| Kitchen Tap (Café) | 8.3 |
| Shower | 8 |
| Bath | 160 (litres/session) |
| Washing Machine (domestic) | 50(litres/use) |
| Dishwasher | 13(litres/cycle) |

Water consumption will be monitored via through installing metering at the main and sub main levels along with leak detection systems.

### 4.3.5 Daylighting & Lighting Controls

In the interest of good design practice daylighting plays a significant role in the design of the proposed building. Although not mandatory for BREEAM Multi-residential, sufficient daylighting provision in occupied areas reduces the need for artificial lighting during the day, and this coupled with appropriate lighting controls equipped with presence detection and daylighting level sensors allows for notable reductions to be made on lighting energy demand.




A daylighting model of the proposed development was created to maximise the use of daylight, the design intent is to compliment the current daylighting provision with lighting controls that provide artificial lighting only when needed. Similar lighting control strategies are employed on the ground floor spaces and in the living room of each apartment.

All internal lighting will be designed in accordance with the SLL Code for Lighting 2012, and areas in which computer screens are regularly used the design will comply with CIBSE Lighting Guide 7 etc. All external lighting installed will be designed to comply with BS 5489-1: 2013 and BSEN 12464-2:2014 and will also be in compliance with ILP Guidance notes for to ensure minimal environmental impact from obtrusive light.

### 4.3.6 Efficient Energy Use

The building services distribution system also contributes to the buildings energy demand, and reducing this contribution would be in line with the principles of the energy hierarchy. One way in which this could be done is through the specification of energy efficient services equipment:

- Energy efficient lighting with integrated daylight/ presence detection controls
- Variable Speed Drive (VSD) fans and Pumps for plant room equipment
- Insulation on heating and hot water pipe services to reduce heat losses through distribution.
- Smart meter monitoring and controls to optimise electrical and thermal energy demand profiles
- Heat recovery technology to reduce the heating demand during winter conditions
- Free Cooling will be provided by night time ventilation and a high thermal mass exposed concrete soffit
- Battery Storage to maximise the amount of carbon offset through electricity generation

## 4.4 Be Clean: Efficient Energy Supply

To further reduce the carbon footprint of the proposed development the next phase of the energy hierarchy is the consideration of efficient sources of energy. For a given energy demand there are various levels of carbon emissions that can be assigned to a building.

Two buildings with the same energy demand, one with a traditional boiler room and electric grid connection and another with a decentralised network connection, could have completely different associated carbon emissions. This concept is defined by tools called carbon factors. This however isn't the only factor the design team must take into consideration and so a feasibility study for the various available options needs to be carried out.

### 4.4.1 CHP/Boilers

Combined Heat and Power (CHP) systems, also known as cogeneration systems make use of a process in which waste heat from the generation of electricity is captured and used rather than being thrown away. This is different from typical gas and coal fired power plants where almost two thirds of the overall energy input goes unused; for this reason CHP where applicable is preferred from an energy efficiency standpoint.

The operational efficiency of CHP systems depend on the heating and electric demand profile of the building the system is serving. CHP is best suited to a building with a well matched continuous base heat and electrical demand such as hotels and leisure centres. Whereas excess electricity can be exported back to the national grid, excess heat would need to be disposed of and this would naturally reduce the inherent efficiency.

Given the intended use of student accommodation with communal and café provisions, the proposed building is likely to have a fairly predictable heating demand. An initial energy assessment (detailed later), detailed later, was carried out to project the proposed developments energy load profile and determine feasibility.

The electrical energy produced from cogeneration would be utilised for the landlord areas while the heating system would be set up with automatic controls suited to both thermal comfort and maximising the use of CHP. Hot water demand on the other hand cannot be as easily regulated and since this forms the most significant portion of the base load, a hypothetical system would need all the associated equipment for the CHP, back up boilers in the instance that the CHP system can't meet demand or is down for maintenance; and buffer vessels to mitigate against the fluctuations in demand. This will consume a significant amount of space and the capital and maintenance costs will be relatively high.

It is primarily for reasons of space and cost that micro CHP applications are generally considered infeasible from a cost benefit standpoint; the situation changes however when CHP is applied at larger scales such as is done with District Heating Schemes.

### 4.4.2 District heating

In a District Heating (DH) scheme, heat energy is generated in a central plant and distributed to a number of buildings via a network of distribution pipes. Given the potential benefits of connecting to a district heating scheme a number of boroughs including Camden require developers to join any locally available heat network unless proven economically or practically infeasible. District Heating Schemes:

- Generate relatively larger amounts of energy efficiently and therefore have the potential to displace more $CO_2$ emissions; this would equate to a lower carbon factor but only if the produced energy is put to use by matching network demand.
- Overcome the capital cost / space availability barriers to adoption for most developments
- Pollute to a lesser degree than stand-alone Boiler/CHP systems

Camden council have a CHP district heating network expansion project based near the proposed buildings location and a study is underway to determine the carbon factor and economic feasibility. As a part of this study the initial energy assessment for the proposed building as well as an energy assessment for an adjacent school development was submitted to the team responsible for the council's project.

Connecting to this network would minimise the required amount of plant equipment for heating and hot water and maximise the available communal space in the proposed building. This in turn not only reduces capital and maintenance costs but also means the proposed development would be contributing to making the network more economically viable and also giving the local community added value.

Below is a table that summarises all of the key comparisons between an on-site CHP/Boiler energy centre and connecting to Camden's DH network.

| | CHP/Boilers | District Heating |
|---|---|---|
| Capital cost | High as this would include a gas connection, plant and associated flues etc. | Potentially Lower cost as this would include valves and a plate heat exchanger. However, the cost of getting the pipework to the building is to be determined. |
| Space | More space required for plant and flues which will rise through the building | Limited space required for plate heat exchanger and control valves |
| Carbon/ Energy | Similar but potentially a bit better than DH | Reliant on carbon factor offered by DH provider |
| Planning | 2nd tier of London Plan hierarchy | 1st tier of London Plan hierarchy |
| Running Cost | Dependant on utility gas costs, but will be higher than DH with standing charges included | Depends on agreed tariffs as part of the supply agreement |
| Maintenance | High cost which would include CHP specialist | Low tech installation and simple to maintain |

Provided the results of Camden's feasibility study maintain an economically and technically viable District Heating solution with a relatively low carbon factor, it is for the aforementioned reasons that a District Heating design scenario is proposed for this development, following guidance from Camden council.

## 4.5 Be Green: Renewable energy systems

The final step in the energy hierarchy is for the further reduction of a developments carbon footprint through the consideration of renewable energy technologies. Renewable systems have the distinct advantage of offsetting carbon emissions as they can produce energy without using any fossil based fuels; energy that would otherwise have been sourced from traditional fuel based power plants. It is for this reason that renewable technology is seen as the most sustainable energy source of the future. There are various options when it comes to renewable technology but due to a combination of project constraints the majority of these are ruled out. The constraints are:

- Capital cost
- Return on Investment
- $CO_2$ displacement potential
- Clean Energy output potential
- Space requirements
- Operation and Maintenance
- Planning permission

### 4.5.1 Photovoltaics

Photovoltaic (PV) technologies generate electrical energy from sunlight that can be used to not only reduce user reliance on the national grid, but in some instances can provide enough energy to allow electrical grid independent developments. Looking back at the factors highlighted earlier we see that with a PV solution there is scope for satisfying the implied requirements:

- Per kW peak capacity (kWp) PV systems are one of the more competitive options on the market with an installed cost range of £2100 - £3150.
- PV systems are known to have acceptable return on investment
- Displacing electricity has a higher $CO_2$ displacing potential per kWh than natural gas.
- High performance panels are known to provide a high clean energy production potential per unit area.
- An installed PV system would be on the roof and would only require cabling and minimal plant room space
- PV systems are known for having comparatively low maintenance requirements and operational costs.
- The design flexibility of such systems means there are various options to minimise the aesthetic impact of a proposed installation

PV technology has seen a dramatic change over the last decade, improvements in manufacturing and price competitiveness from eastern markets have driven costs down and provided better products. This coupled with government policies favouring PV adoption like the feed in tariff's (FIT) have made PV solutions one of the more reliable and economically flexible renewable energy solution available on the market. The success and rate of adoption of Photovoltaic or PV systems lends weight to the notion that public acceptance of PV systems is high. Given the perceived benefits, a proposal involving the integration of a PV system will be put forward as part of the design team's commitment to following the energy hierarchy.

### 4.5.2 Wind Power

A wind turbine harnesses the power of the wind to produce electricity. The amount of power that can be drawn from the wind is exponentially related to the wind speed; thus higher wind speeds significantly increase the power output. In relation to the factors affecting the viability of a renewable energy solution:

- Installed costs for Micro wind turbines range from £2500-£5000 per kWp
- The return on investment is dependent upon local wind conditions but can be satisfactory
- In a suitable location wind energy can have a relatively high clean energy production potential per unit area.
- Displacing electricity has a higher $CO_2$ displacing potential per kWh than natural gas.
- An installed wind turbine system would be mounted on the roof and would only require cabling and minimal plant room space
- There would be an additional associated maintenance costs for a proposed installation. Typically this is relatively high in comparison to alternatives.
- There is limited design flexibility for wind turbine solutions and given the associated noise and significant aesthetic impact there is a relatively increased exposure to opposition in regards to planning permission.

The impact such an installation would have on the local aesthetics and sound levels would be detrimental to the council's aims of preserving the identity of the existing building site, reducing the likelihood of gaining Planning permission. Beyond this, the unpredictability of wind speed in a densely populated urban environment is unfavourable. It is for the above reasons that the decision to not pursue wind power as a renewable energy solution was made.

### 4.5.3 Ground Source Heat Pump (GSHP)

This technology takes advantage of the relatively constant ground temperature by using the ground as a heat source for heating or heat sink for cooling. An electrically driven heat pump circulates water through buried pipes that can either dump or extract heat to or from the ground; typically the pipes are vertical and are 50 to 100 meters long. This process can be very efficient in its ability to transfer heat, with a 1kW of input yielding 3-4kW of heat transfer, this relationship is known as the coefficient of performance or CoP. Looking at the technology in relation to the factors:

- Installed costs for GSHP can be between £800-£1200 per kWp
- The return on investment can be satisfactory
- Despite using electricity (which has a higher associated carbon factor than gas) their efficiency means that they are lower carbon emitters than gas boilers
- Displacing associated emissions from mains gas is not as effective as displacing electricity
- The associated machinery required for an installed system would have negative implications on available plant space
- There would be significant associated maintenance costs
- Hazardous substances inside the pipe fluid and noise concerns would expose the project to opposition during planning application.

For ground source heat pump systems factors like capital cost, Return on investment and energy output potential are the most significant for the proposed development. The system has the potential to efficiently provide low grade heat suited for the proposed buildings underfloor heating system but the space required for a sufficiently sized system is simply too large to fit on site in a horizontal configuration; with the alternative vertical configuration requiring there be a geological investigation that would entail more costs and increased project complexity.

Investing in a GSHP system would result in an economically unfavourable investment for both the client and DH network stakeholders, as it would add unnecessary complication to the construction process and not provide the optimal $CO_2$ reduction scenario. The conclusion from this assessment is that there are cheaper more effective renewable energy solutions available

### 4.5.4 Air Source Heat Pumps (ASHP)

Air-source heat pumps are similar in operation to ground-source heat pumps, except that heat is extracted from the external air rather than the ground. Air-source heat pumps are classified as either air-to-air or air-to-water depending on whether the heat distribution system in the building uses air or water. Looking at the technology in relation to the factors:

- Installed costs for ASHP is lower than GSHP per kWp
- The return on investment tends to be satisfactory
- Uses electricity (which has a higher associated carbon factor than gas) and is only marginally more efficient than a gas boiler
- Displacing associated emissions from mains gas is not as effective as displacing electricity
- ASHP has less associated equipment than with GSHP but still requires a significant amount of plant space for storage vessels.

- Associated maintenance is relatively infrequent but still requires specialist engineers
- There are no associated emissions or known hazardous substances, and the lack of a need for ground works or gas supply in addition to a long service life is a positive argument for planning

Despite the relative technical convenience of the system, proposals using ASHP systems often fail to meet planning requirements because the associated carbon savings are insufficient; thus it was decided that an ASHP solution would not be pursued.

### 4.5.5 Earth Tubes

Ground-Coupled Heat Exchanger, also known as Earth Tubes, allow for the capture or dissipation of heat from the ground which maintains a near constant temperature. Incoming ducts or pipework can then be pre-cooled or pre-heated before reaching the internal space of a building and offset the cooling or heating requirement.

- Installed costs vary but are within the vicinity of ASHP and GSHP costs
- The return on investment is unlikely to be satisfactory
- It is difficult to accurately estimate the cooling/heating performance for Earth Tube systems, but the system does rely on electrical energy which has a high associated carbon factor.
- Displacing associated emissions from mains gas is not as effective as displacing electricity
- Minimal impact on allocated plant room space however the associated groundworks will need to be considered
- Relatively infrequent technical maintenance is required, with operational maintenance being minor.
- The flexibility of this solution lends well to obtaining planning permission

Despite the unpredictability of the operational output for an Earth Tube solution, the heat transfer and thus energy potential achieved depends proportionally on the available surface area, assuming a reasonable velocity, ground temperature and external temperature. There will likely be limited scope for allowing for sufficient surface area to achieve a feasible energy performance.

Thus the cost/benefit implications of installing and maintaining Earth Tubes in conjunction with the space constraints rule out the solution when compared to other renewable alternatives.

### 4.5.6 Biomass Boiler

Biomass refers to living or recently living biological material which are considered to be carbon neutral, having absorbed $CO_2$ during their growth, can be used to fuel energy production. It is possible to convert biomass into useful electrical or thermal energy using generator and boiler technologies; but the more commonly employed of the two is the boiler option which generates usable heat energy. Looking at this solution in relation to the factors:

- Installed costs typically range from £200-£250 per kWp
- The return on investment can be satisfactory
- Lower associated carbon emissions than fossil fuels
- Displacing associated emissions from mains gas is not as effective as displacing electricity
- The associated machinery and storage required for an installed system would negatively impact on the available plant space
- Biomass boilers require regular maintenance and deliveries of biomass fuel to the building; this will have significant implications on the operational costs and future emissions
- The NOx emissions of Biomass boilers are higher than gas boilers, making it difficult to propose Biomass in a location where pollution is heavily regulated.

Biomass powered boiler plant rooms require a relatively larger plant room to accommodate the storage of biomass and also thermal stores. To add to this the operational maintenance costs are commonly regarded to be significant due to the regularity of maintenance runs. The primary reasons for dismissing a biomass fired boiler solution are the space constraints on the current plant room, but the logistics of maintenance and securing a reliable fuel supply is also key in making this option infeasible.

### 4.5.7 Solar Collector

A Solar Thermal Collector is a renewable technology that harvest energy from sunlight that is then commonly used to heat a fluid. A conventional system uses a mains powered circulation pump to couple a hot water storage tank with the solar panels. The storage tank is placed inside the building, and thus requires a controller that measures when the water is hotter in the panels than in the tank. Looking at this solution in relation to the factors:

- Installed costs range from £625-£1000m$^2$, with 1m$^2$ generating on average 500kWh a year
- Uses electricity (which has a higher associated carbon factor than gas) but offsets far more than it uses through the production of thermal energy using sunlight
- Displacing associated emissions from mains gas is not as effective as displacing electricity
- The associated machinery and storage required for an installed system would negatively impact on the available plant space
- Infrequent maintenance and low operational costs
- The design flexibility of such systems means there are various options to minimise the aesthetic impact of a proposed installation and solar thermal technology has a track record of good public acceptance.

Given the current design intention of connecting to the district heating scheme, installing solar collectors becomes undesirable as the two systems aren't complimentary and district heating offers significantly more carbon reduction potential in this particular case. Beyond this the associated pipework and equipment again place more undesired pressure on the already stringent plant room space provisions. It is also believed that more useful energy output, and thus a better Return on investment can be achieved from other renewable technologies like Photovoltaics.

### 4.5.8 Rainwater Harvesting (RWH)

Rainwater harvesting is a process of collecting and storing rainwater for use in a limited number of applications ranging from irrigation to toilet water and washing machines or even sprinkler systems. Whilst not strictly a renewable technology, RWH does reduce demand on the mains supply and offers some resilience from local supply issues. Considering this with the aforementioned factors in mind:

- Installed costs depends on the nature and location of installation and can vary greatly;
- Installed systems tend to have unsatisfactory return on investments
- Given the reliance on electrical grid powered pumps, the emissions displacement potential is low if not zero.
- RWH systems can offset the use of mains water which has a marginally higher associated energy use.
- The associated equipment such as storage tanks will have plant room space implications
- The design flexibility of such systems means there are various options to minimise the aesthetic impact of a proposed installation

Given the generally unsatisfactory return on investment and the negative implications on the limited plant room space allocation it was determined that a rainwater harvesting solution was not applicable to the proposed development.

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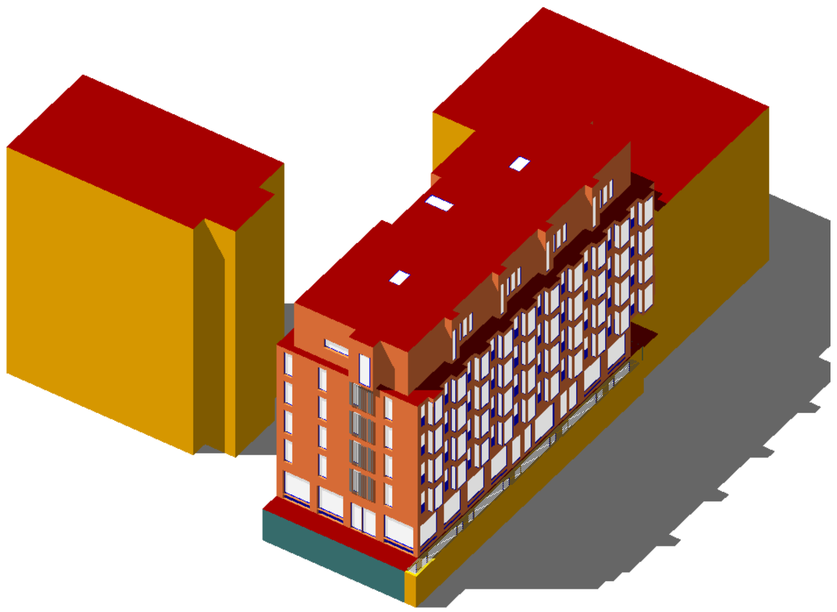
## 4.6 Energy Modelling

To demonstrate compliance with Building Regulations, a full 3D dynamic thermal and energy modelling exercise was carried out for the proposed building using Part L compliant software EDSL TAS. The nature of the modelling process is to simulate the building over a year at an hourly resolution and compare the resulting performance characteristics to a benchmark based on a counterpart notional building.

The results will be presented in a number of different documents and formats, with the key conclusions and implications being briefly discussed in the conclusions chapter.

### 4.6.1 The Model

In order to carry out the modelling exercise a predefined geometrically simplified model of the proposed building is required, detailing the correct wall and glazing arrangements; the figure below illustrates the geometrical model used for the proposed building and includes approximations of surrounding buildings.



Using this model, TAS will generate a Notional Building with standardised building performance characteristics from the national calculation methodology (NCM) that will then be used as a base case upon which the proposed building will be compared. The basis of comparison will be the resulting annual emissions rate used in the energy hierarchy discussed earlier in earlier sections of this report.

### 4.6.2 Model Parameters

As with any engineering model the modelling exercise requires assumptions be made about the internal environment of the building spaces and the interface between this environment and the external environment; as well as energy supply to the building:

**The Internal Gains**

Internal gains are typically estimated from floor area. The assumptions that fall into this category quantify how much heat energy is added to a given room from internal sources. These sources include various types of equipment and occupants and can vary greatly depending on the intended use of the room. In the case of the proposed building the internal gains assumptions were based upon NCM typical room types such as bedrooms, Domestic and Commercial Kitchens, Offices and unoccupied spaces.

**Building Usage Pattern**

How often and how long a building is occupied for has a significant influence on the building energy demand and the size of building services equipment. Using information about the type of occupants and their probable weekly schedules it is possible to formulate a more representative prediction of annual and daily energy use.

**Occupancy Density**

Traditionally some of the internal conditions of a given space are defined on the basis of the number of people in that space; one example being fresh air rates. In order to convert this in an area based internal condition it is necessary to have an idea of how many people per square meter will be occupying said room. Guidance of occupant densities is provided in a number of documents including BSRIA Rule of Thumb and CIBSE Guides.

**Façade Arrangement**

The façade arrangement ties in with the geometrical accuracy of the model, but with an emphasis on the surface areas and locations of façade elements such as windows, panels or louvres.

**Building Fabric.**

The building fabric covers the building material for all walls, ceilings, floors, windows and structure in a building. It is these elements that account for a significant proportion of the thermal performance of a building. Each element will have an associated thermal mass and U-value, among a number of other characteristics dependent on the specified material.

**Building Services Strategy**

The overall strategy for the building determines what equipment is used and where the energy to provide these services comes from. This is briefly discussed in earlier sections of the report.

**Weather Data**

Weather data is used to set the external conditions on an hourly basis and is essential if one wishes to predict how a building will perform when constructed. CIBSE's weather database was used for modelling the proposed building.

**Energy Supply Carbon Factors**

As explained earlier on in the report the Carbon Factor for a given energy supply plays an important role in determining how much $CO_2$ a development emits. For this project typical carbon factors were used, based on general guidance and experience:

- Electricity (0.519 $kgCO_2/kWh$)
- Gas (0.216 $kgCO_2/kWh$)
- DH (0.095 $kgCO_2/kWh$)

The carbon factor for District Heating is assumed based on experience from similar schemes and is subject to confirmation or modification once finalised feedback from Camden council's DH Scheme study is received. All of the above parameters were incorporated into the model to yield the outputs detailed in the following section.

### 4.6.3 Model Outputs

Simulation of the proposed building was done in a progressive manner in order to demonstrate the impact each of the energy hierarchy principles had on the BER:

- First a building with all of the design measures implemented for the Be Lean segment of the energy hierarchy was modelled and compared to the Notional Building

- Then the efficient energy supply commitments for the Be Clean design principles were added to the model. In the case of the proposed building that is the local District Heating Scheme.

- Finally a Photovoltaic system was specified to account for the remaining emissions reduction deficit when compared to the modified Target Emissions Rate (see following table).

The results of the above assessment were derived from one of a number of document outputs of the modelling software; the BRUKL Report. Upon completing a simulation the following documents are produced:

**BRUKL Report**

A BRUKL report is an energy report issued to demonstrate that an adequate reduction in energy consumption and emissions has been achieved by a proposed development using an approved calculation methodology; BRUKL reports are typically for mixed use or commercial schemes.

**Energy Performance Certificate (EPC)**

An EPC is essentially a formal document that provides an energy efficiency rating for the proposed building. In line with the EU Directive on Energy Performance of Buildings, all new developments must have an EPC displayed somewhere visible within the building.

**Raw Data**

TAS EDSL outputs a number of spreadsheets with a large quantity of unprocessed calculation results at an hourly resolution. This can in turn be formatted in any way the user sees fit to present. Example uses of this data would be to represent the annual, monthly or daily energy profile of a modelled building.

**Energy Performance Ratio**

In line with BREEAM requirements, the proposed building is required to achieve a certain level of predicted operational energy demand based on BREEAM's approved calculation methodology; this is called the Energy Performance ratio. In order to achieve the desired overall "Excellent" rating the proposed development is required to achieve at least an energy performance ratio of 0.375, which will equate to 5 BREEAM credits.

| Photovoltaic System | |
|---|---|
| Emissions Deficit | 4691.74 kgCO2/yr |
| Required annual energy production | 8869.08 kWh/yr |
| Required PV System size | 11.09 kWp |
| Required Module space | 56.26 m^2 |
| Cost per installed kWp | 2000.00 £/kWp |
| FIT Rate | 11.71 p/kWh |
| **System Spec** | |
| Sample PV | SANYO - HIT N240SE10 |
| Pmax | 240 |
| Module Efficiency | 20% |
| Output | 200 W/m^2 |
| Number of module req. | 47 Modules |
| Length | 0.8 m |
| Width | 1.6 m |
| Module Area | 1.20 m^2 |
| **Financial Analysis** | |
| Capital Cost | £22,172.69 |
| Annual Savings | £1,419.05 |
| Feed-in-Tariff | £1,038.57 |
| Payback Period | 9 yrs. |

## Energy Performance Certificate
Non-Domestic Building

HM Government

**42 Phoenix Road**
**Euston**
**London**
**NW1 1TA**

**Certificate Reference Number:**
5117-0035-5399-2125-2206



This certificate shows the energy rating of this building. It indicates the energy efficiency of the building fabric and the heating, ventilation, cooling and lighting systems. The rating is compared to two benchmarks for this type of building: one appropriate for new buildings and one appropriate for existing buildings. There is more advice on how to interpret this information on the Government's website www.communities.gov.uk/epbd.

### Energy Performance Asset Rating

More energy efficient

A+

Net zero $CO_2$ emissions

A 0-25

B 26-50

C 51-75

D 76-100

E 101-125

F 126-150

G Over 150

Less energy efficient

16 This is how energy efficient the building is.

### Technical information

**Main heating fuel:** District Heating
**Building environment:** Heating and Natural Ventilation
**Total useful floor area ($m^2$):** 2049
**Building complexity (NOS level):** 5
**Building emission rate ($kgCO_2/m^2$):** 17.29

### Benchmarks

**Buildings similar to this one could have ratings as follows:**

23 If newly built

67 If typical of the existing stock

## BRUKL Output Document
Compliance with England Building Regulations Part L 2013

HM Government

**Project name**

**42 Phoenix Road** As designed

**Date:** Fri May 29 16:53:31 2015

### Administrative information

**Building Details**
**Address:** 42 Phoenix Road, Euston, London, NW1 1TA

**Certification tool**
**Calculation engine:** TAS
**Calculation engine version:** "v9.3"
**Interface to calculation engine:** TAS
**Interface to calculation engine version:** v9.3
**BRUKL compliance check version:** v5.2.b.1

**Owner Details**
**Name:**
**Telephone number:**
**Address:** , ,

**Certifier details**
**Name:**
**Telephone number:**
**Address:** , ,

### Criterion 1: The calculated $CO_2$ emission rate for the building should not exceed the target

| | | |
|---|---|---|
| 1.1 | $CO_2$ emission rate from the notional building, $kgCO_2/m^2$.annum | 25.4 |
| 1.2 | Target $CO_2$ emission rate (TER), $kgCO_2/m^2$.annum | 25.4 |
| 1.3 | Building $CO_2$ emission rate (BER), $kgCO_2/m^2$.annum | 17.3 |
| 1.4 | Are emissions from the building less than or equal to the target? | BER =< TER |
| 1.5 | Are as built details the same as used in the BER calculations? | Separate submission |

### Criterion 2: The performance of the building fabric and the building services should achieve reasonable overall standards of energy efficiency

Values which do not meet standards in the 2013 Non-Domestic Building Services Compliance Guide are displayed in red.

**2.a Building fabric**

| Element | $U_{a-Limit}$ | $U_{a-Calc}$ | $U_{i-Calc}$ | Surface where the maximum value occurs* |
|---|---|---|---|---|
| Wall** | 0.35 | 0.26 | 0.26 | 1293 - Basement Retaining wall |
| Floor | 0.25 | 0.21 | 0.22 | Exposed Floor |
| Roof | 0.25 | 0.18 | 0.18 | Roof |
| Windows***, roof windows, and rooflights | 2.2 | 1.45 | 1.48 | 1293 - Glazing (1F-4F) |
| Personnel doors | 2.2 | - | - | No personal doors in project |
| Vehicle access & similar large doors | 1.5 | - | - | No vehicle doors in project |
| High usage entrance doors | 3.5 | - | - | No high usage entrance doors in project |

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a-Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i-Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

| Air Permeability | Worst acceptable standard | This building |
|---|---|---|
| $m^3/(h.m^2)$ at 50 Pa | 10 | 3 |

## 5.0 Conclusion

In this report an energy strategy for the proposed building was set out in line with the recommendations from and guidance of the London plan, Camden Council's SPG and building regulations. Throughout the report there was evidence of how the commitment to sustainable and environmentally conscious design will guide the design and development of the proposed building.

This was then supplemented with a dynamic thermal and energy modelling exercise that was carried out to determine whether or not the design measures and strategies employed have followed the principles of the "be lean, be clean, be green" energy hierarchy. The results of this assessment are summarised in the table below:

**Energy Efficient Design**: through energy employment of energy conscious design, an increased level of control over the buildings energy demand with tools such as natural ventilation, lighting controls, energy efficient equipment and flow control devices enabled this; and in conjunction with Part L. recommended U-values the annual energy demand was brought down by 11% when compared to a building without these systems in place.

**District Heating**: The benefit of district heating was appealing as it meant less emissions per unit of energy consumed were associated with the proposed development, but also the reduced requirement for plant equipment and increased effective distribution efficiency meant less associated energy was assigned to the development from a primary energy standpoint. Connecting to the District Heating Network is predicted to reduce emissions an additional 41% when compared to the same building without the aforementioned systems and District Heating in place.

Despite this there was still a deficit in annual emissions when compared to the Notional Building, and this had to be accounted for either financially or by investing in renewable technology.

**Photovoltaic System**: Finally a Photovoltaic system was specified to account for the remaining emissions reduction deficit. The proposed system was able to reduce the annual emissions by a further 5%, resulting in a proposed development that meets all of the imposed criteria set by Local and Regional Authorities.

| | Energy demand (MWh/yr) | $CO_2$ Emissions (kg/yr) | Percentage Savings(%) |
|---|---|---|---|
| Baseline Scheme | 488.8 | 104.34 | 0% |
| Energy efficient Design | 444.3 | 101.68 | 3% |
| District Heating | 350.2 | 71.15 | 29% |
| Renewables (PV) | 341.3 | 67.82 | 3% |
| Total (against baseline) | 147.52 | 36.52 | 35% |

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