ARUP

DGE Fitzroy Street Limited

13 Fitzroy Street

Energy and Sustainability Planning Context

Reference:

| 13 May 2022

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1. Introduction

This report is the updated combined Energy and Sustainability Planning Context document for the proposed development at 13 Fitzroy Street in line with the requirements of Camden Council and the Greater London Authority (GLA). This is in response to comments received on the Minor Material Amendment (MMA) documentation, tabled by the Design Team to Camden for the revised scheme in 2022. The description of MMA changes to the scheme can be found in the following page.

The report addresses the comments received from Camden on 14th March 2022, to meet local policy requirements. The comments received were as follows:

The Council requires all development to minimise the effects of climate change and encourage all developments to meet the highest feasible environmental standards that are financially viable during construction and occupation.

All developments involving five or more dwellings and/or more than 500 sqm of (gross internal) any floorspace will be required to submit an energy statement demonstrating how the energy hierarchy has been applied to make the fullest contribution to CO_2 reduction and to demonstrate how climate change adaptation measures have been incorporated in a Sustainability Statement.

The proposed development would result in an increase of 715sqm of new floor space, involving reconfiguration of the existing building rather than demolition and rebuild, as the new floor space proposed would be above the 500sqm threshold an energy statement and sustainability statement will be required and should be submitted with any future application.

Policy CC1 states that the Council will require all development to reduce carbon dioxide emissions through following the steps in the energy hierarchy; support and encourage sensitive energy efficiency improvements to existing buildings; and expect all developments to optimise resource efficiency. We will expect all developments, whether for refurbishment or redevelopment, to optimise resource efficiency by:

- *reducing waste;*
- *reducing energy and water use during construction;*
- *minimising materials required;*
- *using materials with low embodied carbon content; and*
- *enabling low energy and water demands once the building is in use.*

Policy CC3 seeks to ensure that development does not increase flood risk by requiring development to incorporate water efficiency measures and utilise Sustainable Drainage Systems (SuDS). Refurbishments and other non-domestic development will be expected to meet BREEAM water efficiency credits.

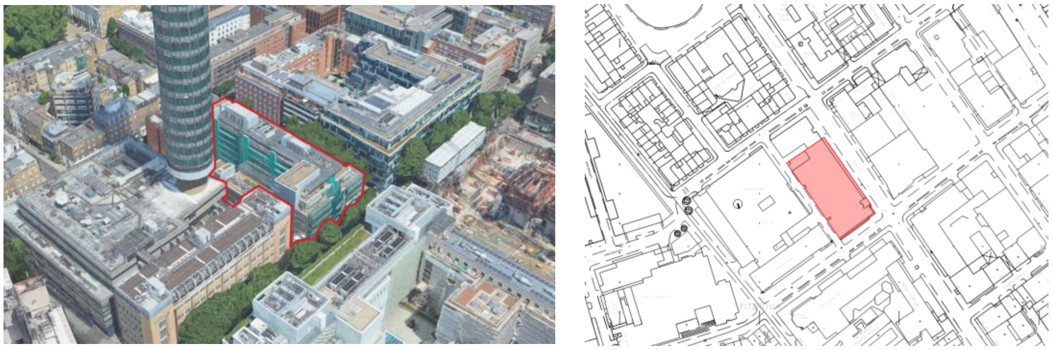


Figure 1 Site location

The site is located on 13 Fitzroy Street, London W1T 4BQ, within a mixed residential and commercial urban environment, close to existing transport infrastructure. The building scope of renovation and internal modifications was included in the original planning statement and has already been approved.

The refurbishment will be mostly internal, with no significant changes to the external façade features, which already contribute to passive design by having permanent external shading elements (brise-soleil and double skin façade on the south).

A revised planning statement seeking permission for minor material amendments (MMA) to the original planning permission has been submitted. The main amendments to the approved scheme are summarised below:

- Glazed corner entrance addition at Ground Floor on the junction of Fitzroy/Howland street, with internal slab level being lowered to facilitate this change
- Rooftop plant enclosure size amendments for Block A to align with the size of the revised plant equipment previously approved on site
- Relocation of the approved biodiverse green roof from Block B extension roof (which will host a new roof terrace) to Block C, where rooflights are being reinstated
- Black vertical cladding and glazing alterations to Block B
- Louvered door introduced at Lower Ground floor along Howland Street for below ground drainage access
- Introduction of louvres at Lower Ground floor along Fitzroy Street

Further details for the amendments can be found in the accompanying Design and Access Statement (DAS).

2. Aspirations

2.1 Energy Targets for Refurbishment

The project is seeking to significantly improve the building's operational energy performance by reducing energy demands through a selection of energy efficient systems for heating, cooling, ventilation, hot water provision, lighting and reducing the overall power demands compared to a typical modern office space. Low carbon strategies will also be followed to take advantage of the continuously reducing electricity grid carbon factors, thus reducing CO_2 emissions related to the building operation. GLA guidance for reducing energy demands and carbon reporting will be followed, as described in section 2.3.

2.2 Sustainability Targets for Refurbishment

Due to the scope of the refurbishment, the existing and new build elements of the project are being assessed together using the BREEAM UK Refurbishment and Fit-out (RFO) 2014 scheme. The assessment covers Part 2 (Core services) & Part 3 (Local services). Under this scheme, the project is currently targeting an ‘Excellent’ rating (> 70% of available credits) with aspirations to maximise the score where it is possible to meet the credit criteria. The full BREEAM Pre-Assessment is outlined in Section 6.

2.3 Approach to Modelling

2.3.1 Carbon Factors

The Greater London Authority Energy Assessment Guidance (2020) states planning applicants are encouraged to use the SAP (Standard Assessment Procedure) 10.0 emission factors for referable applications when assessing the carbon emission performance against London Plan policies. There are exceptions to use different emission factors (such as SAP 2012) for locations belonging to a Heat Network Priority area, and where there is potential to connect to an existing heat network with CHP. Currently, there are no live heat networks in the near vicinity of the site.

The proposed SAP 10.0 carbon emission factors reflect a slight reduction in the carbon emissions associated with energy from gas, and a more significant reduction in emissions associated with energy from grid electricity when compared to the older SAP 2012 values. This is due to the decarbonisation of the grid and the increase of renewable uptake in electricity generation within the UK, as can be seen in the figure below after 2012.

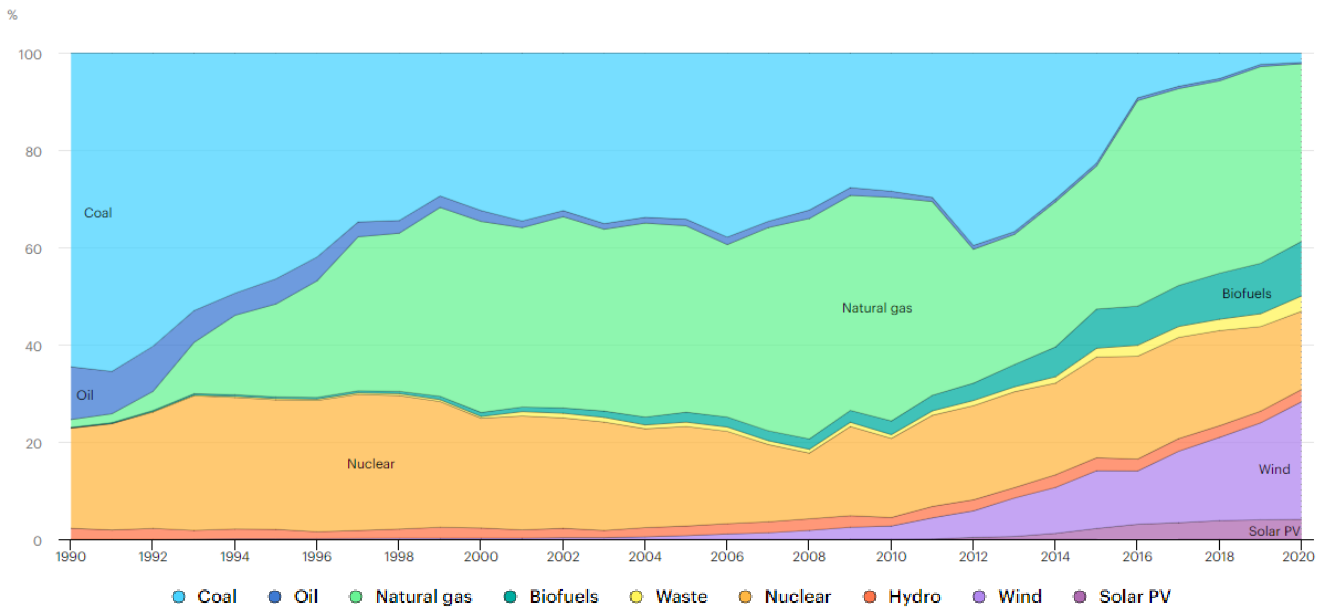


Figure 2 UK Electricity Generation Mix between 1990-2020 (International Energy Agency)

The incorporation of these figures within energy models ensures the energy assessment of new developments better reflects the actual carbon emission associated with their modelled operation. Alongside the GLA Energy Assessment Guidance, a spreadsheet (version 1.2) was used to calculate the potential savings based on SAP 10.0 carbon factors.

Table 1 Carbon Emission Factors (GLA Energy Assessment Guidance, 2020)

	Emissions kgCO$_2$e per kWh	
	SAP 2012 (not used)	SAP 10.0
Mains Gas	0.216	0.210
Electricity	0.519	0.233

As per the London Plan and updated guidance, the development will aim to achieve 35% reduction in CO_2 emissions over the whole site. Non-domestic developments should also achieve at least a 15% improvement on Building Regulations from energy efficiency.

SAP 10.0 emission factors reduce the impact made by technologies that generate onsite electricity (e.g. solar PV), therefore alternative methods will be required in order to achieve the required 35% savings for the development's carbon emissions.

The modelling strategy follows the energy hierarchy stated by the GLA in the London Plan (and the CPG documents) - Be Lean, Be Clean and Be Green. The cumulative effect of implementing these design stages allows for maximal energy reduction and carbon emission savings to be achieved.

2.3.2 Air-to-air heat pumps

Air-to-air heat pumps are integral to the proposed design and link to the final (Be Green) part of the energy hierarchy. A 3-pipe VRF system with heat recovery has been implemented in the design to maximise energy efficiency and provide flexibility in installation, modification and operation. The technology implemented aligns with section 5.16 of Camden Planning Guidance: Energy efficiency and adaptation (January 2021).

2.3.3 New build (extension) fabric properties

The new build part of the development – 2-storey extension on the west block, has already been designed with building fabric constructions that exceed the performance of the limiting fabric parameters stated within the Building Regulations Approved Document Part L2A. Refer to table 4 in section 4.6.2.

This extension was previously approved via the July 2020 planning consent. No further changes have been described as a result of the MMA.

3. Planning Context

3.1 Planning Criteria

3.1.1 National Policy

The National Planning Policy Framework sets out the overarching planning policies for England, with guidance on how these are expected to be applied. The underlying theme running throughout this policy guidance is a presumption in favour of sustainable development. At a national level, the British Government is committed to reduce greenhouse gas emissions by 78% by 2035, relative to 1990 levels, with a final commitment for net zero by 2050 (as stipulated by the Department for Business, Energy & Industrial Strategy, Press Release 20th April 2021).

3.2 General London Plan Policy

London Plan Policy SI 2 – Minimising CO_2 Emissions

Policy SI 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 and manage demand during operation.*
- *Be Clean: exploit local energy resources (such as secondary heat) and supply energy efficiently and cleanly.*
- *Be Green: maximise opportunities for renewable energy by producing, storing and using renewable energy on site.*
- *Be Seen: verify and report on energy performance.*

The GLA provides guidance for developers and their advisers for energy assessments. Recommendations include the following:

- *Estimate site-wide 'Regulated' CO_2 emissions and reductions 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.*
- *Where applicable, investigations of the feasibility of installing low-emission CHP in the proposed development (if connection can't be made to an area wide network) before considering renewables, but only in instances where it can support the delivery of an area-wide heat network at large, strategic sites.*

- *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.*

3.3 Camden Local Plan, CC1 and CC2

On the local level, the site falls under the jurisdiction of the London Borough of Camden. The Camden Local Plan sets out the Council's planning policies and replaces the Core Strategy and Development Policies planning documents (adopted in 2010). It ensures that Camden continues to have robust, effective and up-to-date planning policies that respond to changing circumstances and the Borough's unique characteristics and contribute to delivering the Camden Plan and other local priorities. The Local Plan covers the period from 2016-2031.

Camden's environmental sustainability plan (2011-2020) commits Camden to a 27% borough wide Carbon Dioxide (CO_2) reduction by 2017 and a 40% borough wide CO_2 reduction by 2020 (London carbon reduction target). Over 90% of Camden's carbon dioxide emissions are attributed to the operation of buildings.

The key policies regarding energy efficiency and renewable energy in the Camden Local Plan are summarised below.

Policy CC1 Climate change mitigation

- *Promote zero carbon development and require all development to reduce carbon dioxide emissions through following the steps in the energy hierarchy.*
- *Require all major development to demonstrate how London Plan targets for carbon dioxide emissions have been met.*
- *Working with local organisations and developers to implement decentralised energy networks in the parts of Camden most likely to support them.*
- *Protecting existing decentralised energy networks (e.g. at Gower Street, Bloomsbury, King's Cross, Gospel Oak and Somers Town) and safeguarding potential network routes.*
- *Requiring all major developments to assess the feasibility of connecting to an existing decentralised energy network, or where this is not possible establishing a new network*

Policy CC2 Adapting to climate change

- *Ensuring development schemes demonstrate how adaptation measures and sustainable development principles have been incorporated into the design and proposed implementation.*

3.3.1 CPG Policies - Energy

Camden Planning Guidance: Energy efficiency and adaptation (January 2021) replaces the previous revision issued March 2019. The Energy efficiency and adaptation document has been studied and considered in the design of both schemes (2020 and 2022) related to this development. It provides information on energy and resource issues within the Camden Borough and supports the other associated local Plans and guidance mentioned in section 3. It states that development energy strategies are to be designed in line with the energy hierarchy. Emphasis is made on the prioritisation of passive design measures over higher cost active systems.

3.3.2 BREEAM

Camden Local Plan (2017) Policy CC2 Adapting to climate change

The Council's Local Plan outlines that it will promote and measure sustainable design and construction by expecting non-domestic developments of 500m^2 of floorspace or above to achieve BREEAM Excellent. In addition, it states that refurbishments and other non-domestic development will be expected to meet BREEAM water efficiency credits.

Camden Planning Guidance: Energy Efficiency and Adaptation: Sustainable Assessment Tools

As outlined in the Local Plan, Camden's CPG states that development of 500m^2 or more of non-residential floorspace will need to be designed in line with BREEAM. The CPG also stipulates minimum standards for BREEAM categories as a % of un-weighted credits as follows:

- Energy – 60%
- Water – 60%
- Materials – 40%

The CPG stipulates that BREEAM Excellent is required for all non-residential development of 500m^2 or more floorspace. Furthermore, it outlines that refurbishments/change of use schemes can undertake a BREEAM Refurbishment and Fit Out (RFO) assessment, using a combination of the following four parts, depending upon the scope of the works:

- Part 1 – Fabric and structure: external envelope including walls, roof, windows and floor
- Part 2 – Core services: centralised mechanical and electrical plant including heating, cooling and ventilation
- Part 3 – Local services: localised services including lighting, local heating, cooling and ventilation
- Part 4 – Interior design: interior finishes, furniture, fittings and equipment

The CPG states that the BRE should be consulted on the best assessment approach to help decide which of the above parts should be included within the RFO schedule, depending on the extent of refurbishment. In addition, they can advise on whether a separate BREEAM New Construction (NC) assessment is required for new build areas; or whether they can be assessed together with the refurbishment areas.

3.4 Camden Local Plan – Policy CC3 Water and Flooding

Camden Council seeks to ensure that developments do not increase flood risk and reduce the risk of flooding, where possible. In addition, the development is required to:

a. incorporate water efficiency measures;

b. avoid harm to the water environment and improve water quality;

c. consider the impact of development in areas at risk of flooding (including drainage);

d. incorporate flood resilient measures in areas prone to flooding;

e. utilise Sustainable Drainage Systems (SuDS) in line with the drainage hierarchy to achieve a greenfield run-off rate where feasible; and

f. not locate vulnerable development in food-prone areas.

4. Assessment Methodology

4.1 Modelling

The models have been developed and simulated using dynamic thermal modelling software - Integrated Environmental Solutions (IES) Virtual Environment 2021.4.0.0, with calculation engine version 7.0.13.0 and BRUKL compliance check version v5.6.b.0.

Two separate models have been built:

- Model 1: Refurbished building (including extension)

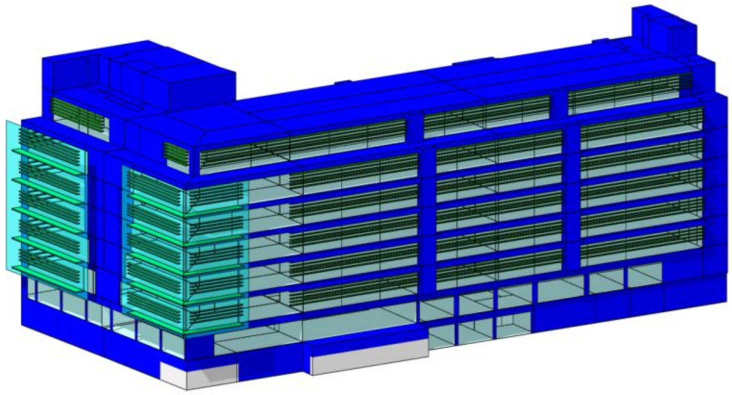


Figure 3 Model 1 - IES Model

- Model 2: Extension (New build) only

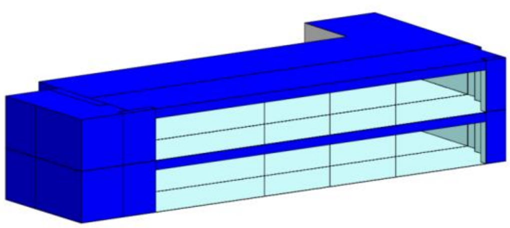


Figure 4 Model 2 - IES Model

An energy assessment has been carried out on both models to ascertain the predicted building CO_2 emissions and savings against the respective baseline values.

The following sections detail the modelling methodology and the adopted design approach that allows for the reduction of energy usage and carbon emissions.

4.2 Baseline

Due to the nature of the refurbishment, the software generated baseline building is not applicable for Model 1 (refurbished building including extension). The baseline for this has been developed using the existing building's glazing sizes and locations, fabric performance values and HVAC systems.

The new build extension baseline has been modelled using the Part L2A limiting fabric values. Model 2 has used the software generated baseline, as typically used within energy assessments, implementing the NCM (National Calculation Methodology) default values for fabric properties and HVAC systems.

4.3 Be Lean

The following sections detail both passive and active measures taken to reduce the energy demand of the development.

4.3.1 Passive Design Measures

Building Form (Model 1):

There are no significant changes in the form of the building. The majority of the existing façade will be retained. The built form has been optimised in the previous refurbishment to reduce heat losses through the building fabric during winter, to maximise the benefits of solar and internal gains and to reduce losses associated with uncontrolled air infiltration.

Extension Building Fabrics (Model 2):

Improvements to The Building Regulations Part L2A minimum fabric performance have been made in line with the design of the 2-storey extension as shown in section 4.6.2.

Thermal mass (Model 1):

13 Fitzroy Street is a 6-storey concrete and steel structure, with lateral stability provided by multiple cores. The scope of the refurbishment will be exposing the floor slabs on every level. Exposing the floor slabs provides the opportunity to utilise some of exposed thermal mass along the floor plates to even out variations in internal and external conditions, absorbing heat as temperatures rise and releasing it as they fall. This can have a positive effect in reducing the demand for the conditioning building services systems. Please refer to Section 5 for further information on how exposed Thermal mass is intended to be utilised.

Natural Ventilation (Model 1):

Existing high-level operable windows on the external façade provide the opportunity for single-sided and cross vent natural ventilation between Levels 1-6. The 6th Floor offers an even increased cross-vent natural ventilation potential. The opportunity of mixed mode operation of the mechanical ventilation system will be explored in order to reduce active ventilation energy demand when the operable windows are in use. Please refer to Section 5 for further information.

Daylighting and optimisation of glazing (Model 1):

During summer, the building has been designed to allow optimum levels of daylighting and to minimise solar heat gain and avoid overheating. For instance, the early 2000s façade replacement takes the impact of solar gain heavily into account; fixed external louvres (brise-Soleil) are installed on the critical elevations of Fitzroy and Howland street, as shown in Figure 6.

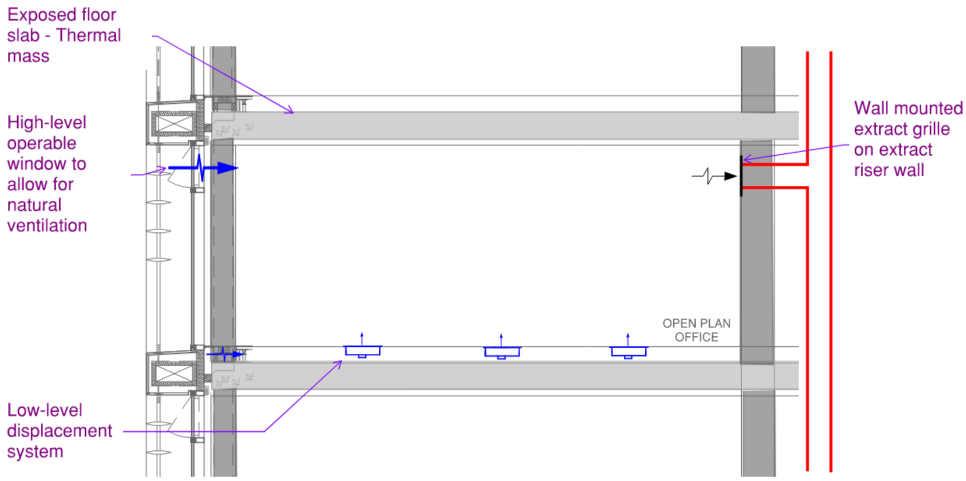


Figure 5 Office Ventilation Strategy

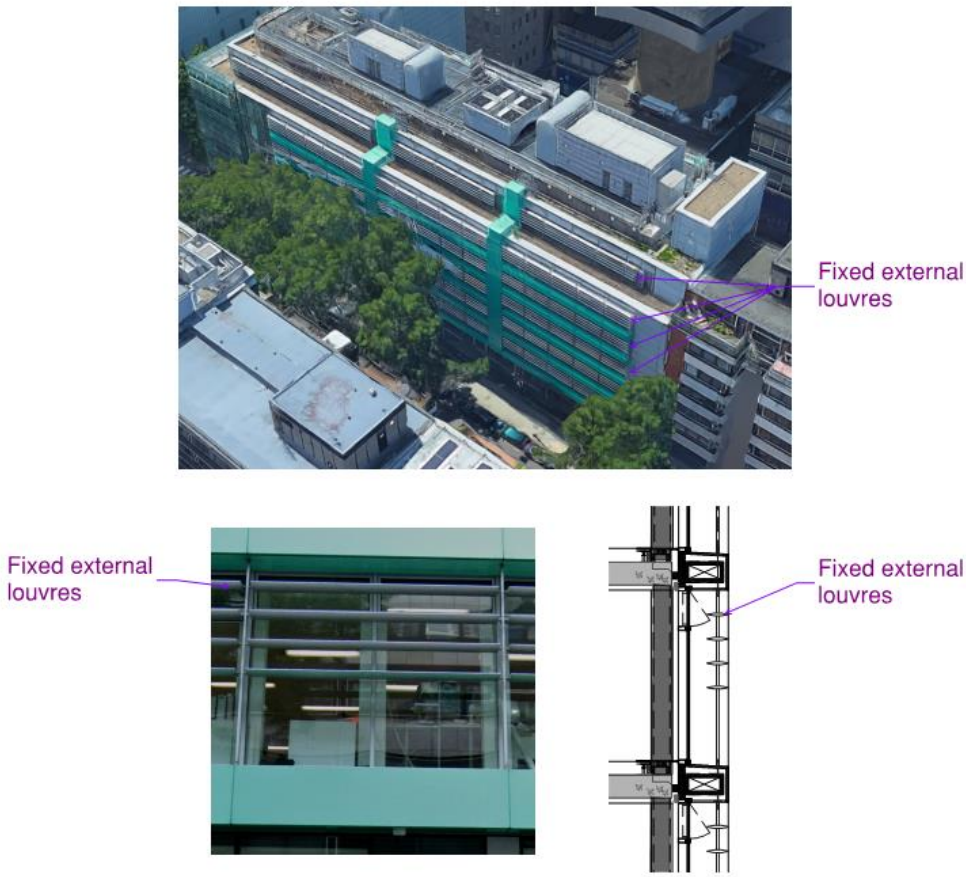


Figure 6 Fixed external louvres (brise soleil) for solar shading

Furthermore, existing internal blinds will be upgraded to reduce solar gains at the perimeter zones. The atrium enables sunlight to penetrate in the centre of the floor plans (which will have relaxed summer temperature conditions being a transient circulation space) to also maximise daylight provision potential.

4.3.2 Active Design Measures

Energy efficient systems (Model 1 & 2):

Space heating is provided by the air-to-air heat pumps, with this system having a high efficiency aligning with that quoted by the manufacturer. Air-to-air heat pumps will also be implemented to provide underfloor heating in the newly formed café area and domestic hot water pre-heat.

The ventilation strategy has changed from an all-air system, in the pre-refurbished building, to a minimum fresh air system. This has allowed the reduction in size of the air handling units (AHUs) and therefore reduced the energy consumption associated with ventilating the building. The new AHUs are to be provided with high efficiency sensible heat recovery and specified with low specific fan powers, in line with Non-Domestic Building Services Compliance Guide.

Efficient lighting and lighting control (Model 1 & 2):

Low energy LED lighting is to be used throughout the building. Daylighting sensors will be installed within the office spaces, this will allow for the reduction in lighting energy consumption and take advantage of natural light where possible. PIR detectors will also be used to further reduce energy consumption by ensuring lighting is only used within the spaces when they are occupied.

4.4 Be Clean

There are two decentralised energy networks in close proximity to the site area, namely Bloomsbury and Gower Street Heat and Power networks. An energy network expansion has been proposed to extend to the surrounding area of the site. Space provision has therefore been made for the connection to potential network, the development of this will occur in the next design stage.

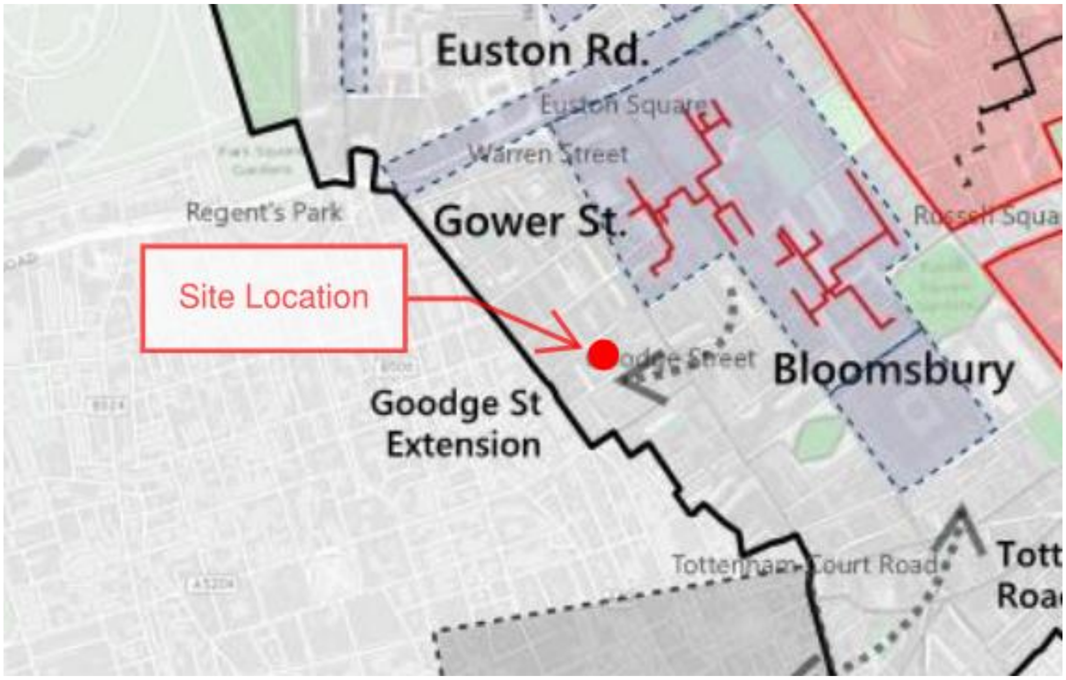


Figure 7 Location of existing heat networks

As there is no current energy network connection available – this has not been included in the calculations detailed within this document. Therefore, there are no additional savings made between the Be Lean and Be Clean stages of the energy hierarchy for either model assessed.

4.5 Be Green

Reduction of development CO_2 emissions via on site renewable energy sources has been pursued where feasible. A Low and Zero Carbon Feasibility Study has been undertaken to assess the viability of implementing any of the potential technologies within the development to help further reduce the building carbon emissions. The table below summarises the findings from the investigation – for further details please refer to Appendix contents.

Table 2 Low and Zero Carbon Technologies Summary

LZC Technology	Issues	Feasible
District CHP use	Future provision for CHP network extension	YES
Local CHP system	Low building hot water for viability	NO
Ground source heat pump	Additional land use and significant disruption	NO
Air source heat pump	No issues	YES
Wind power	LVMF Framework makes it not viable	NO
Biomass boiler	• Air quality issues (NOx emissions) • Fuel storage and security issues	NO
Solar PV	No issues but limited space on roof (above Core 1 lifts) and access required	YES
Solar Thermal	Viable but technically challenging due to network of pipework required	YES

Legend for Table 2: Green (adopted), Red (not adopted), Purple (potential but not suitable for project)

The proposed design includes a 3-pipe air-to-air heat pump VRF (variable refrigerant flow) system for the space heating and cooling. This system enables the recovery of heat when there is both a cooling and heating demand in different parts of the building, allowing for further energy reduction hence carbon savings.

4.6 Model Results

Results of the dynamic energy modelling are detailed below –SAP 10.0 carbon factors have been used.

The full BRUKL documents produced from the energy modelling process (using SAP 2012 values) can be found in the Appendices.

The values on the bar charts display the percentage saving relative to the previous energy hierarchy stage. The final total carbon emission saving, relative to the baseline, is shown in brackets on the 'Be Green' bar.

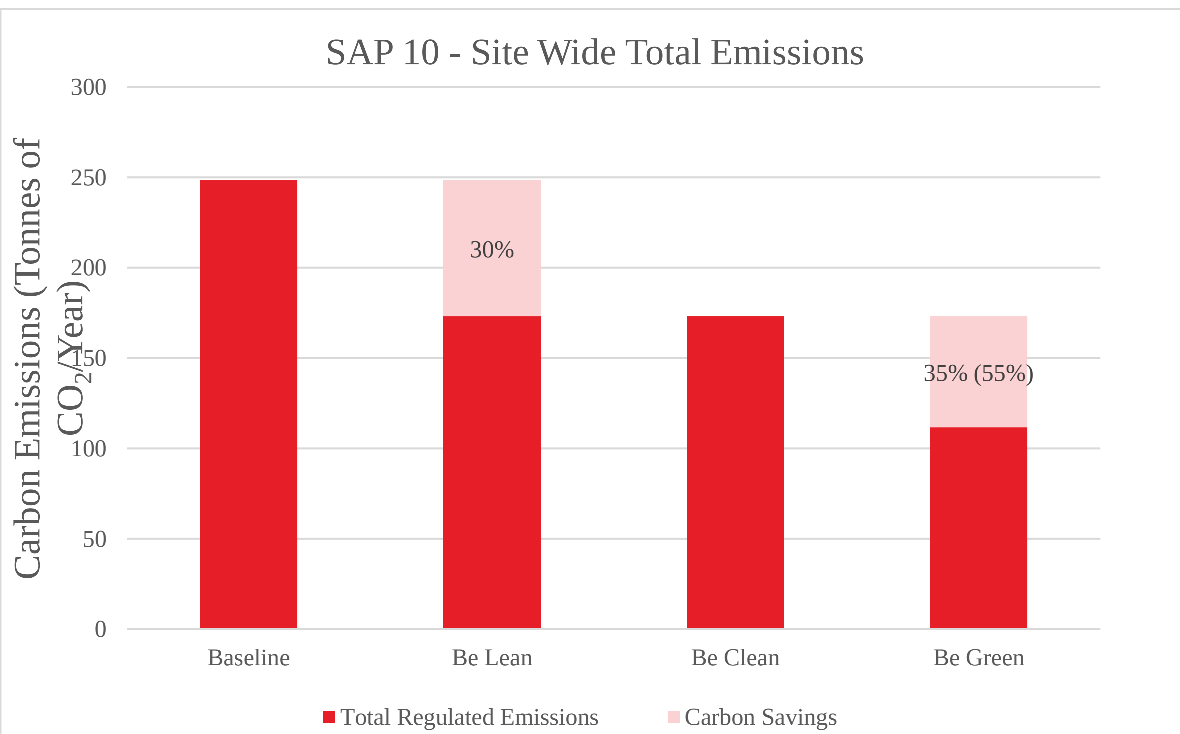
4.6.1 Refurbished Building Emissions – Model 1

Using the SAP 10.0 carbon factors the refurbished building model achieved carbon savings of 30% using energy reduction methods alone (Be Lean).

The adoption of renewable technologies – 3 pipe air-to-air heat pump (Be Green), results in carbon savings of 55%, exceeding the 35% saving required by the GLA and Camden.

Table 3 Refurbished Building - Carbon Emissions Savings Comparison

	SAP 10.0	
	Total regulated emissions (Tonnes CO_2/year)	Percentage saving against baseline (%)
Baseline	248	-
Be Lean	173	**30%**
Be Clean	173	30%
Be Green	112	**55%**



4.6.2 Extension (New Build) Emissions – Model 2

Using the SAP 10.0 carbon factors the Extension (New build) model increased in carbon emissions between the baseline and Be Lean model by 64%. The extension has been designed to take advantage of available daylighting and hence has a relatively high glazing percentage which results in higher energy usage over the year from heat losses (winter) and solar gains (summer).

As highlighted in sections 2.3.3 and 4.2, the building fabric properties of the extension are better performing than those stated in The Building Regulations Part L2A. However, it should be noted that the IES generated baseline is constructed to a concurrent notional specification (detailed in National Calculation Methodology 2013). These properties are significantly improved on the Part L2A minimum values and are slightly better performing than the proposed design external wall and glazing constructions, a summary of the values stated in Table 4.

Table 4 Extension Building Fabric Properties - U-values

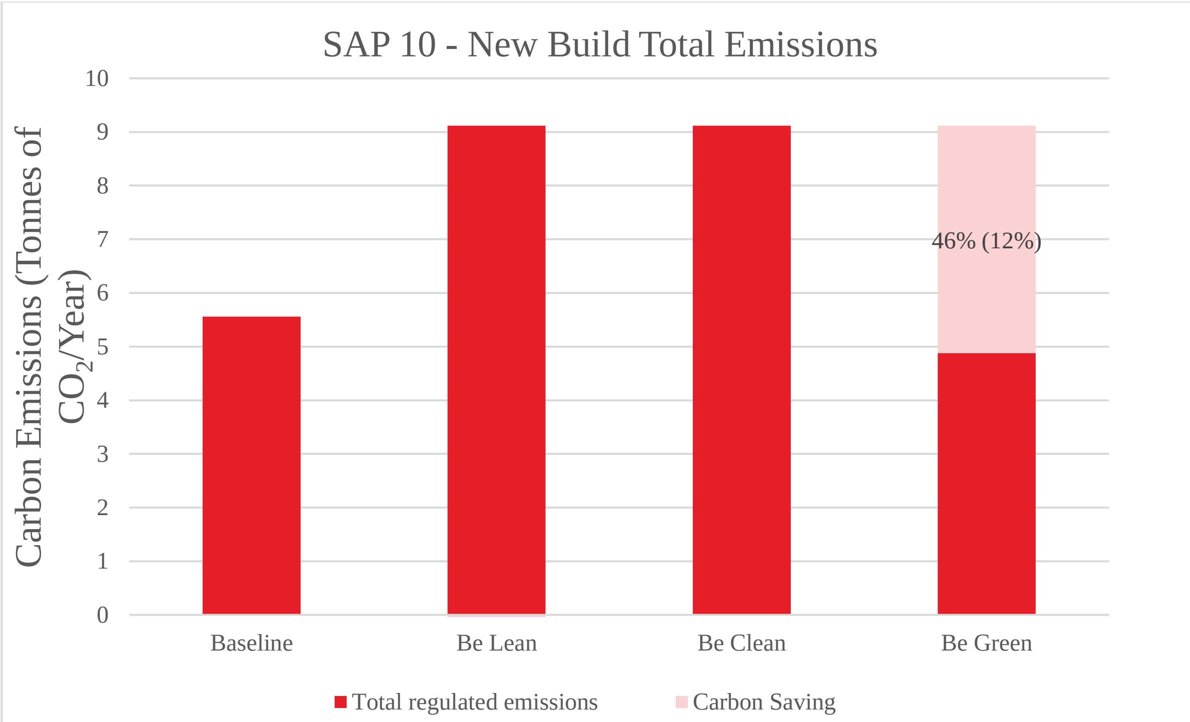
	Part L2A	**IES NCM Baseline**	**Proposed Design**
External Wall ($W/m^2.K$)	0.35	0.26	0.28
Roof ($W/m^2.K$)	0.25	0.18	0.18
External glazing ($W/m^2.K$)	2.2	1.6	1.8

The combination of the factors highlighted above result in the reduced performance of the building when comparing the baseline and Be Lean models.

The final proposed design, including renewable technologies - 3 pipe air-to-air heat pump (Be Green), results in the total carbon emission savings of 12% when compared against the baseline. This is attributed to the well performing fabric and systems of the baseline, however this is less than 5% of the overall building emissions and this is also representative of approximately 5% of the net floor area. The whole building does however achieve considerably higher energy savings (55%) than the 35% saving required by the GLA due to the “Be Lean” and “Be Green” measures implemented across the project.

Table 5 Extension (New Build) - Carbon Emissions Savings Comparison

	SAP 10	
	Total regulated emissions (Tonnes CO_2/year)	Percentage saving against baseline (%)
Baseline	6	-
Be Lean	9	**-64%**
Be Clean	9	-64%
Be Green	5	**12%**


SAP 10 - New Build Total Emissions
Carbon Emissions (Tonnes of CO2/Year)
10
9
8
7
6
5
4
3
2
1
0
46% (12%)
Baseline
Be Lean
Be Clean
Be Green
Total regulated emissions
Carbon Saving

5. Mitigating Overheating (Cooling Hierarchy)

Camden Local Plan Policy CC2 and New London Plan Policy SI 4 Managing heat risk provide specific guidelines and identify the “cooling hierarchy” to minimise overheating. Adherence to these guidelines will set the following main aims:

- *Reduces the impact of urban heat island effect within Borough of Camden and Central London in general.*
- *Reduces excessive heat generation requiring energy intensive active cooling measures used to mitigate against this effect.*
- *Futureproofs increased overheating effect due to climate change.*

The cooling hierarchy describes the following ways to reduce overheating and reliance on active air conditioning:

1. *Minimise internal heat generation through energy efficient design.*
2. *Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls.*
3. *Manage the heat within the building through exposed internal thermal mass and high ceilings.*
4. *Passive ventilation.*
5. *Mechanical ventilation.*
6. *Active cooling systems (ensuring they are the lowest carbon options).*

The cooling hierarchy has informed the building design wherever possible, to reduce effects of overheating. The building already has some inherent shading elements that from the previous refurbishment in 2003 that contribute as passive means for reducing solar heat gains (see Figure 4). These consist of several external static louvres installed on the elevations of Fitzroy and Howland Street. The overall open plan space flexibility and fit out arrangements within each floor plate have been carefully considered to also optimise the use of static louvre positions, aiming to reduce solar heat gains throughout the year. Areas with higher risk for glare affecting working conditions will also be provided with manually operated internal blinds which could be utilised for reducing solar heat gains along building perimeter zones.

There are also manually operable high level vents around the perimeter on every floor which will be retained to provide manually operated natural ventilation for the open plan. All floors L1-6 are provided with operable vents, with potential for single sided and cross vent natural ventilation (depending on location respective to the atrium), provided acoustic and air quality conditions for indoor office spaces are satisfied. The presence of a double skin façade along the southern side and corners of the building makes acoustic conditions more likely to be satisfied. Natural ventilation can be used during mild summer weather to avoid the need for using mechanical ventilation.

Furthermore, the use of thermal mass in certain parts of the building will be promoted. The typical floor slabs comprise thick hollow pot slabs, spanning onto floor beams of the same depth. There is a floor void above this zone on every floor, which is typically 160mm deep. The scope of the refurbishment will be exposing the floor slabs on every level. This creates the opportunity to utilise the underside of the exposed concrete floor slabs to provide free cooling during certain times of the year. The floor slab will absorb heat generated by gains during a warm summer day and release this load in evening/night when it is cooler. A managed process regime will be promoted to utilise the operable vents throughout warmer days to facilitate this.

By analysing solar radiation patterns, positioning of equipment and the hours of operation of building services, an optimum operational pattern can be established for reducing demand for air conditioning systems. Depending on the time of the year and prevailing weather conditions, exposed thermal mass can absorb heat from occupants, lighting and equipment as internal temperature rises and release it when it falls.

When the building will be in mechanical ventilation mode, the use of displacement ventilation and elevated supply temperature (compared to an overhead supply air mixing system), would increase the opportunity to utilise free cooling without the need to actively subcool the air during mid-season months. This can achieve the desired internal conditions utilising free cooling for intake air for larger parts of the year. A displacement system also offers the opportunity to utilise indirect evaporative cooling that provides a significant energy reduction to cool incoming fresh air in the air handling units, compared to an active chiller-based cooling system.

High efficiency LED lighting will be specified along with daylight and presence detector sensors, dimmable function and zoning controls to reduce lighting heat gains compared to the current lighting systems. It is also anticipated that current centralised server room infrastructure will be replaced by distributed cloud-based servers with more energy efficient and lower heat dissipation hardware. This will reduce unregulated power demand for day-to-day operation and cooling.

Overheating analysis will also be carried out in line with BREEAM requirements for both current and predicted future weather conditions, to further test and validate the overall design specifics in terms of limiting overheating.

Finally, as mentioned in previous sections, the main building cooling system consists of a 3-pipe air-to-air heat pump VRF (variable refrigerant flow) system. This system enables the recovery of heat when there is both a cooling and heating demand in different parts of the building, allowing for further energy reduction when in use. The choice of an air source heat pump with high efficiency to provide active cooling to the building when this is required was also affected by the reducing carbon factors of the grid, meaning that is an overall low carbon option throughout the year for building operation.

6. BREEAM RFO 2014 Assessment

6.1 Scheme Selection

Prior to undertaking a BREEAM pre-assessment, details of the project were assessed against the guidance outlined in the BREEAM RFO 2014 manual to determine the most appropriate assessment and certification option for a mixed new build and refurbishment scheme. The project will be assessed as a bespoke BREEAM RFO 2014 assessment which incorporates specific requirements for the new build extension.

Due to the scope of the refurbishment, Part 2 (Core services) and Part 3 (Local services) criteria were considered to be appropriate for the assessment. BREEAM credits related to Part 1 (Fabric and structure) and Part 4 (Interior design) only were scoped out as the extent of work proposed is not significant for BREEAM assessment purposes.

6.2 Pre-Assessment

During the early stages of the project's design process, a BREEAM pre-assessment workshop was held. The workshop involved an initial review of the design proposals against the applicable BREEAM criteria to determine an indicative 'Target' score (i.e. what should be achievable) and 'Potential' score (i.e. what might be achievable).

Following the pre-assessment exercise, a 'Excellent' (> 70%) target was established as a minimum target for the project, with an aspiration to maximise the score above this threshold to mitigate against any potential losses in credits throughout design and construction.

During the early design stages, the Target and Potential scores were regularly reviewed with the project team to assess opportunities to target Potential credits and identify potential risks to achieving the Target credits.

The current BREEAM strategy includes a Target score of 77.52%. A full credit checklist is provided in the Appendix.

The project is currently exceeding the minimum % requirements of the core credits outlined in the Local Plan for the key sustainability areas as follows:

- Energy – 79%
- Water – 100%
- Materials – 75%

It should be noted that the final bespoke credit requirements for the project are not finalised at this stage and specific credit scores and weightings of categories may change during the detailed design process.

Further details on how the project is addressing sustainability issues in these three key categories is provided in Sections 6.3 to 1.1 below. Credits denoted "e" are exemplary credits which are awarded in the innovation category.

6.3 Energy

Measures to reduce energy consumption have been outlined in Section 4 in line with GLA energy hierarchy.

Dynamic thermal simulation modelling for Part L compliance has been completed with inputs based on the current fabric performance and equipment efficiencies. This has determined that the building is currently achieving 11 out of 15 credits under BREEAM Ene 01 Reduction of energy use and carbon emissions. Part L simulations will be further developed in the following design stages to provide information on the building's regulated energy.

The project is also seeking to improve the building's operational energy performance through the installation of energy sub-metering that facilitates the monitoring of major energy consuming systems. Energy efficient light fittings and lighting control systems will also be specified for the existing and new lighting within the scope of refurbishment works to reduce energy consumption.

Table 6 Summary of current performance against the BREEAM Energy credits.

Energy			
Credit ID	**Credit description**	**Available**	**Targeted**
Ene 01	Reduction of energy use and carbon emissions	15 + 5e	11
Ene 02	Energy Monitoring	2	2
Ene 03	External Lighting	1	1
Ene 04	Low carbon design	3	2
Ene 06	Energy Efficient Transportation Systems	3	3
		24 + 5e	**19**

6.4 Water

Efficient water use will be encouraged during the construction stage of the project through the monitoring, recording and reporting of water consumption and total net water consumption (i.e. consumption minus any recycled water use from the construction process) resulting from all on-site processes.

Water demand will be reduced in operation through the specification of more efficient fittings, leading to lower flow rates and flush volumes and an improvement on the BREEAM Wat 01 baseline water consumption that is equivalent to 5 credits.

Water meters will be added to ensure water consumption can be monitored and managed. Leak detection will also be present on all main water supplies, which will be connected to the BMS system to reduce the impact of water leaks that may otherwise go undetected.

Table 7 Summary of current performance against the BREEAM Water credits.

Water			
Credit ID	**Credit description**	**Available**	**Targeted**
Wat 01	Water Consumption	5 + 1e	5
Wat 02	Water Monitoring	1	1
Wat 03	Leak Detection	2	2
Wat 04	Water Efficient Equipment	1	1
		9 + 1e	**9**

6.5 Materials

In order to encourage the specification of materials that reduce the development's environmental impact, a life cycle impact assessment will be undertaken for the materials used for the refurbishment and extension works, using the Green Guide to Specification. The guide gives materials a 'rating' which is based on its environmental impacts, such as embodied carbon (global warming potential), embodied water use, fossil fuel use and consumption of all virgin mineral materials. This assessment will also cover all new insulation specified on the project, in order to encourage the use of thermal insulation which has a low embodied environmental impact relative to its thermal properties. For this exercise, the project will achieve six BREEAM credits under Mat 01 Life Cycle Impacts.

In addition, the specification and procurement of responsibly sources materials will be promoted through compliance with the criteria under BREEAM credit Mat 03 Responsible sourcing of materials. All timber and timber-based products used on the project will comply with the UK government's definition of legally sourced timber, as outlined in the UK Government Timber Procurement Policy. Furthermore, the Principal Contactor will be required to source materials for the project in accordance with a documented sustainable procurement plan. This plan will identify risks and opportunities against a broad range of social, environmental and economic issues, set targets to guide sustainable procurement and outline procedures for monitoring and evaluation. Currently, the project is aiming to source at least three key building material types from BREEAM-recognised responsible sourcing certification schemes.

The project is committing to developing and implementing a resource management plan (RMP) covering the waste arising from the refurbishment. The RMP will aim to ensure that the non-hazardous waste relating to on-site refurbishment and dedicated off-site manufacture or fabrication processes generated by the building's design and construction does not exceed 4.5m^3 (or 1.2 tonnes) per 100m^2 gross internal floor area. The project is also aiming to divert 95% of the volume (or 97% tonnage) of non-hazardous waste from landfill.

In addition to the above measures, recycling of waste during the operation of the building has been considered and appropriate, accessible space for collection of recyclables has been included in the design. A designated refuse store has been increased in size from the previous scheme, allocating a 41m^2 area that can fit 11x1100 litre Eurobins, leaving substantial space to manoeuvre the bins. The refuse store itself will be designed to meet all criteria set out in CPG1 – Design. A 2m wide refuse corridor has been assigned within the loading bay which ensures unobstructed access between the pickup location and the refuse store. Provision of segregated recycling waste storage areas will contribute towards local targets for reductions in waste volumes sent to landfill.

Table 8 Summary of current performance against the BREEAM Materials credits.

Materials			
Credit ID	**Credit description**	**Available**	**Targeted**
Mat 01	Life Cycle Impacts	6 + 1e	6
Mat 03	Responsible Sourcing of Materials	4 + 1e	2
Mat 04	Insulation	1	1
Mat 05	Material Efficiency	1	0
		12 + 2e	**9**

7. Sustainable Design and Construction Principles

As outlined in Section 10 of the Camden Planning Guidance: Energy Efficiency and Adaptation (January 2021), projects need to demonstrate how sustainable design and construction principles and climate change adaptation measures have been incorporated into the design. The principles outlined in the CPG have informed the design process as outlined below.

Energy demand reduction: building fabric (passive measures)

Addressed in Sections 4 and 6.3.

Energy demand reduction: Energy efficient services (active measures)

Addressed in Section 4 and 6.3.

Energy generation

Addressed in Section 6.3.

Water conservation

Addressed in Section 6.4.

Adaptation to climate change

A number of measures are being taken to mitigate the impact of extreme weather conditions arising from climate change over the lifespan of the building. For instance, as part of the refurbishment works the floor slabs on each level will be exposed, providing the opportunity to utilise thermal mass along the floor plates to even out variations in internal and external conditions, absorbing heat as temperatures rise and releasing it as they fall. This can mitigate against more extreme variations that might result from future climate change. Further measures to reduce overheating in line with the cooling hierarchy are outlined in Section 5.

The microclimate of the site was considered in the passive design analysis, undertaken during Stages 1 and 2. It outlines that the site is located in central London, and therefore may benefit from a raised external temperature in Winter as a result of the heat island effect. This has the impact of reducing the heating load in winter months. With regard to environmental wind, given the building's layout and orientation will remain unchanged, and its location in a heavily built up area, it is not expected to have a material impact on the site's microclimate.

Materials and resource conservation

Addressed in Section 1.1.

Nature conservation and biodiversity

Two roof terrace spaces have been proposed on the south east corner of the building's gantry level, and on the west side. Both terraces include provisions for landscaping elements. The terraces are designed with both the pre-application advice and LBC's Amenity CPG in mind. The terraces will be surrounded by greenery to reduce any overlooking issues by those using the space and to soften the impact of the massing. Refer to the Design and Access Statement for a description of this proposal.

To support the development of a new habitat on site, a landscape and habitat management plan will be produced in accordance with BS 42020:2013 *Biodiversity. Code of practice for planning and development* covering at least the first five years after project completion. This will be handed over to the building owner for use by the grounds maintenance staff.

In addition, the habitat will be designed to support nationally, regionally or locally important biodiversity; including any UK Biodiversity Action Plan (UK BAP) priority habitats, Camden Biodiversity Action Plan (CBAP) habitats, or those within non-statutory sites identified in the Local Plan. An ecologist will be engaged to help identify species of local biodiversity importance on-site and ensure that the proposals support local priorities.

Sustainable and active travel

Due to the uplift in GIA, the scheme will provide a CPG 7 policy compliant uplift in cycle storage spaces. The scheme provides a total of 143 storage spaces; 48 of these are two-tiered Josta stands (or similar) and over 5% of the total spaces (8 in total) are achieved using Sheffield Stands. These stands can accommodate non-standard cycles. 72 spaces are achieved through single tier stands and there are 15 lockers for foldable bikes. The cycle storage is easily accessed from street level via a level threshold and is contained within a secure space. The internal cycle storage is complimented via the 12 (24 spaces) existing public Sheffield Stands near to the frontage of the site. Also, to encourage active travel the scheme seeks to entirely remove all existing site car parking bays, making it a car-free development.

Other

The Principal Contractor for the project will be required to operate an environmental management system (EMS) covering their main operations and appoint a ‘Sustainability Champion’ to monitor compliance with the relevant sustainability performance criteria, during the Construction, Handover and Close Out stages.

Post-handover aftercare will be provided to the occupants following the refurbishment works to ensure the building operates and adapts in accordance with the design intent and operational demands. Initial aftercare support will include meetings with the build occupiers and management, the provision of a Building User Guide and training delivered to facilities management regarding the building systems, their controls and how to operate them in accordance with the design intent and operational demands.

Longer term aftercare support for occupants for at least the first 12 months from occupation will also be provided. There will be operational infrastructure and resources in place to coordinate the collection and monitoring of energy and water consumption data once the building is occupied. Discrepancies between actual and predicted performance will be identified and actions to address any discrepancies will be carried out.

8. Water efficiency measures and Sustainable Drainage

The refurbishment of 13 Fitzroy Street is not a major development therefore a dedicated SuDS report is not required, although SuDS have been considered throughout the design.

The existing building (Block B) only includes a small area of green roof ($25m^2$), which was installed as a trial in 2006 (shown in Figure 8). This area of green roof is to be removed from Block B and a larger area (circa $124m^2$) of green/blue roof is to be installed on Block C (shown in Figure 9). Allowable build up depths and achievable attenuation volumes are to be detailed further in the next stage.

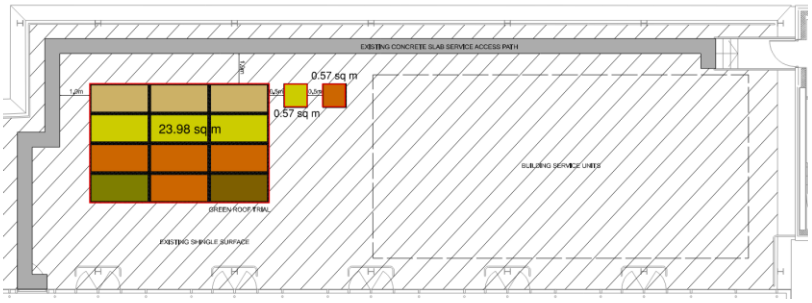


Figure 8: Extent of Existing Green Roof Trial

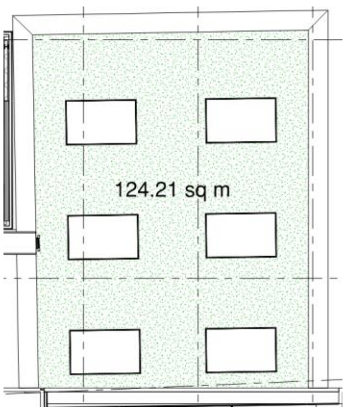


Figure 9: Extent of New Green / Blue Block C Roof

The building refurbishment incorporates an increase in the number of showers provided. As this could lead to an increase in peak foul discharge, a greywater harvesting system has been incorporated, reducing the peak foul discharge rate, whilst also reducing the potable water consumption of the building.

To further reduce the water consumption of the building low flow, water efficient fittings will be installed throughout . This would improve the water consumption of the building by 65.48% (compared to BREEAM baseline figures) and allowing 5no Wat 01 BREEAM credits to be achieved.

Appendix A - BRUKL exports for Refurbished Building

Refer to separate PDF file.

Appendix B - BRUKL exports for Extension (New Build)

Refer to separate PDF file.

Appendix C - Baseline Building – Model Inputs

Table 9 Existing Building Fabric (Model 1)

	U-Value ($W/m^2.K$)	G-Value
External Wall	0.298	-
Roof	0.25	-
Window	1.83	0.47

Table 10 Extension building fabric - Part L2A values (Model 1)

	U-Value ($W/m^2.K$)	G-Value
External Wall	0.35	-
Roof	0.25	-
Window	2.2	0.47

Table 11 Baseline Building Services Systems (Model 1)

Systems	Parameter
Heating	LTHW Boiler, Seasonal Efficiency – 87%
Cooling	Air cooled Chillers, SEER – 2.5
Ventilation	AHU fans, SFP – 2.5 W/l/s
Heat Recovery	Plate heat exchanger, Efficiency – 65%
WC Extract	Fans, SFP – 0.8W/l/s
FCU	Fans, SFP – 0.5 W/l/s
Lighting	Efficacy – 60lm/W

Appendix D – BREEAM Checklist

BREEAM Checklist

	Credit	Available	Targeted
Management			
	Man 01 Project Brief and Design		
Credit 1	Stakeholder consultation (project delivery)	1	1
Credit 2	Stakeholder consultation (third party)	1	0
Credit 3	Sustainability Champion (design)	1	1
Credit 4	Sustainability Champion (monitoring progress)	1	1
	Man 02 Life Cycle Cost and Service Life Planning	**Available**	**Targeted**
Credit 1	Elemental life cycle cost (LCC)	2	0
Credit 2	Component level LCC plan	1	1
Credit 3	Capital cost reporting	1	1
	Man 03 Responsible Construction Practices	**Available**	**Targeted**
Credit Pre-req	Pre-Requisite		✓
Credit 1	Environmental management	1	1
Credit 2	Sustainability Champion (construction)	1	1
Credit 3	Considerate construction	2	2
Credit 4	Monitoring of construction site impacts - Utility consumption	1	1
Credit 5	Monitoring of construction site impacts - Transport of construction materials & waste	1	1
Credit e1	Considerate Construction: Exemplary performance	1	0
	Man 04 Commissioning and Handover	**Available**	**Targeted**
Credit Pre-req	Pre-Requisite (Excellent & Outstanding only)		✓
Credit 1	Commissioning and testing schedule and responsibilities	1	1
Credit 2	Commissioning building services	1	1
Credit 4	Handover	1	1
Management Section Points		17	14
Exemplary Credits		1	0
Weighted Percentage Score		15.96	12.32
Health and Wellbeing			
	Hea 01 Visual Comfort	**Available**	**Targeted**
Credit 4	Internal and external lighting levels, zoning and control	1	1
	Hea 02 Indoor Air Quality	**Available**	**Targeted**
Credit 1	Indoor air quality (IAQ) plan	1	1
Credit 2	Ventilation	1	1

Credit 5	Potential for natural ventilation	1	0
	Hea 04 Thermal Comfort	**Available**	**Targeted**
Credit 1	Thermal modelling	1	1
Credit 2	Adaptability - for a projected climate change scenario	1	1
Credit 3	Thermal zoning and controls	1	1
	Hea 05 Acoustic Performance	**Available**	**Targeted**
Credit 1	Acoustic performance	2	2
Health and Wellbeing Section Points		9	8
Exemplary Credits		0	0
Weighted Percentage Score		9.45	8.40
Energy			
	Ene 01 Reduction of Energy Use and Carbon Emissions	**Available**	**Targeted**
Credit 1	Energy performance	15	11
Credit e1	Zero regulated carbon / carbon negative	5	0
	Ene 02 Energy Monitoring	**Available**	**Targeted**
Credit 1	Sub-metering of major energy consuming systems	1	1
Credit 2	Sub-metering of high energy load and tenancy areas	1	1
	Ene 03 External Lighting	**Available**	**Targeted**
Credit 1	External lighting	1	1
	Ene 04 Low Carbon Design	**Available**	**Targeted**
Credit 1	Passive design - Passive design analysis	1	1
Credit 2	Passive design - Free cooling	1	0
Credit 3	Low and zero carbon technologies - LZC feasibility study	1	1
	Ene 06 Energy Efficient Transport Systems	**Available**	**Targeted**
Credit 1	Energy consumption	1	1
Credit 2	Energy efficient features	2	2
Energy Section Points		24	19
Exemplary Credits		5	0
Weighted Percentage Score		26.36	16.91
Water			
	Wat 01 Water Consumption	**Available**	**Targeted**
Credit 1	Water consumption	5	5

Credit e1	Water consumption: Exemplary levels	1	0
	Wat 02 Water Monitoring	**Available**	**Targeted**
Credit Pre-req	Pre-requisite (Good to Outstanding ONLY)		✓
Credit 1	Water monitoring	1	1
	Wat 03 Leak Detection	**Available**	**Targeted**
Credit 1	Leak detection system	1	1
Credit 2	Flow control devices	1	1
	Wat 04 Water Efficient Equipment	**Available**	**Targeted**
Credit 1	Water efficient equipment	1	1
Water Section Points		9	9
Exemplary Credits		1	0
Weighted Percentage Score		10.27	9.27
Materials			
	Mat 01 Life Cycle Impacts	**Available**	**Targeted**
Credit 1	Life cycle impacts	6	6
Credit e1	Green Guide to Specification - Exemplary performance	1	0
	Mat 03 Responsible Sourcing of Materials	**Available**	**Targeted**
Credit Pre-req	Pre-requisite		✓
Credit 1	Sustainable Procurement Plan	1	1
Credit 2	Responsible sourcing of materials (RSM)	3	1
Credit e1	Exemplary performance: Responsible sourcing	1	0
	Mat 04 Insulation	**Available**	**Targeted**
Credit 1	Embodied impact	1	1
	Mat 06 Material Efficiency	**Available**	**Targeted**
Credit 1	Material efficiency	1	0
Materials Section Points		12	9
Exemplary Credits		2	0
Weighted Percentage Score		19.88	13.41
Waste			
	Wst 01 Construction Waste Management	**Available**	**Targeted**
Credit 1	Pre-refurbishment audit	1	0
Credit 2	Reuse and direct recycling of materials	2	0

Credit 3	Construction resource efficiency	3	2
Credit 4	Diversion of resources from landfill	1	1
Credit e1	Resource efficiency / Diversion of waste from landfill: Exemplary performance	1	0
	Wst 04 Speculative Floor and Ceiling Finishes	**Available**	**Targeted**
Credit 1	Speculative floor and ceiling finishes	1	1
	Wst 05 Functional Adaptability	**Available**	**Targeted**
Credit 1	Functional adaptability	1	1
Waste Section Points		9	5
Exemplary Credits		1	0
Weighted Percentage Score		9.64	4.80
Land Use and Ecology			
	LE05 Long Term Impact on Biodiversity	**Available**	**Targeted**
Credit 1	Long term impact on biodiversity	2	2
Ecology Section Points		2	2
Exemplary Credits		0	0
Weighted Percentage Score		6.20	6.20
Pollution			
	Pol 01 Impact of Refrigerants	**Available**	**Targeted**
Credit 1	Impact of refrigerants	3	1
	Pol 02 NOx Emissions	**Available**	**Targeted**
Credit 1	NOx emission levels for heating and hot water	3	0
	Pol 03 Surface Water Run-Off	**Available**	**Targeted**
Credit 1	Flood resilience	2	2
	Pol 04 Reduction of Night Time Light Pollution	**Available**	**Targeted**
Credit 1	Reduction of night time light pollution	1	1
	Pol 05 Noise Attenuation	**Available**	**Targeted**
Credit 1	Reduction of noise pollution	1	1
Pollution Section Points		10	5
Exemplary Credits		0	0
Weighted Percentage Score		11.90	5.95
TOTAL SCORE			**77.52%**

Appendix E – Low and Zero Carbon Feasibility Study

E1 Low & Zero Carbon Feasibility Study

E1.1 Possible LZC technologies

The successful integration of the feasible LZC technologies within buildings depends on a number of technical, economic and social factors. Possible technologies have been analysed in relation to the site and the building's features. Details on these aspects are given in the following paragraphs.

E1.1.1 Combined Heat & Power (CHP)

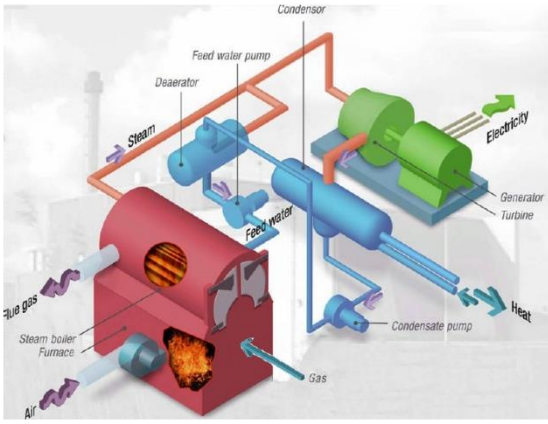


Figure 9 Typical gas-fired CHP plant providing both electricity and heating.

Combined Heat and Power (CHP) is the generation of electricity and useful heat in one process, in the respective approximate ratio of 3:5. CHP plants generate electricity from fossil fuels while using the waste heat to provide heating and hot water.

The GLA recommends that certain developments are not considered appropriate for gas-engine CHP[1]. These include "Non-domestic developments with a simultaneous demand for heat and power that do not have a year-round base load for optimum operation of CHP: Examples of such developments may include offices and schools. CHP will not be applicable in these circumstances." In addition, due to the future planned decarbonisation of the grid, there will be a shift towards electric heating and away from natural gas.

The office spaces provide a constant demand for electricity, extending past weekday office hours and into the weekend. However, the building is not expected to have a significant heating and hot water demand throughout the year. The anticipated daily and yearly hot water demand profile assumes a maximum of 2.5 hours a day, resulting to less than 1000 hours a year of high hot water demand. This is greatly below the usual requirement for 6000 hot water hours provision per year. Therefore, it is not expected that there would be sufficient simultaneous demand for heat and power for the introduction of a CHP to be a viable option.

[1]Energy Planning – Greater London Authority guidance on preparing energy assessments (October 2018)

E1.1.2 Possibility to connect to existing CHP plant and district heating network

There are two decentralised energy networks in close proximity to the site area, namely Bloomsbury and Gower Street Heat and Power networks. An energy network expansion has been proposed to extend to the surrounding area of the site. It is therefore recommended that space provision in the boiler plantroom should be made for plate heat exchanger components to connect to an expanded heat network in the future.

E1.1.3 Ground Source Heat Pump (GSHP)

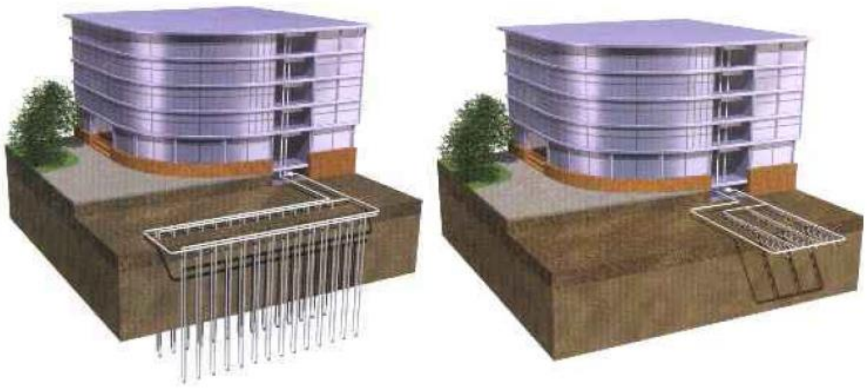


Figure 10 Typical GSHP installation types – vertical loop (left) and horizontal loop (right).

Ground Sourced Heat Pumps (GSHP) are generally used in conjunction with closed/open loop pipework systems installed either horizontally, approximately 2 metres below ground level. Closed loop systems are vertically connected in bore holes, with bore hole depths varying between 15 and 100 metres depending upon particular site ground conditions. Open loop systems are vertically connected with groundwater reserves, extracting and returning water off the reserves.

Fitzroy Street is in a very dense urban area, where no free land space is available next to the buildings, thus a horizontal loop GSHP is not viable. The introduction of a vertical loop GSHP will require considerable road disruption to adjacent buildings and will have considerable costs associated with the installation. In addition, there are significant space constraints for a vertical loop installation. These factors render the implementation of GSHP impractical from both economic and technical feasibility perspectives.

E1.1.4 Air Source Heat Pump (ASHP)

ASHPs system use electrical power to extract heat from the ambient air and transfer it to air (air-to-air heat pumps) or to water (air-to-water heat pumps). The heat is absorbed by a fluid at a low temperature and pressure which causes the fluid to evaporate. The vapour is compressed electrically causing an increase in temperature which can then be used for heating purposes. A reverse process is also possible that enables cooling applications.

As the UK electricity grid decarbonises, it is increasingly clear that heat pumps are becoming part of the solution to deliver low carbon heat in the future with electricity driven solutions improving when compared to gas-fired systems. ASHPs are considered a renewable technology if they have CoP > 2.9 and SPF > 2.5; this shall be considered when selecting the specific product.

The technology is similar to conventional rooftop air cooled chillers. These heat pumps can typically deliver up to 45˚C low temperature hot water (LTHW) that can serve trench heaters/ underfloor heating requirements directly. This low grade LTHW from ASHPs can also be used to pre-heat the hot water for domestic use (DHW) which can be then re-heat up to 65˚C through the gas-fired boilers. There can be some noise issues related to the heat pumps' fans, which can be mitigated by specifying equipment within existing acoustic levels.

Air Source Heat Pumps (ASHPs) are a viable technology for 13 Fitzroy Street. 3 pipe air-to-air heat pumps have been included in the proposed design, these enable the recovery of heat when there is a simultaneous space heating and cooling load within the building.

E1.1.5 Wind turbines

Figure 11 Typical wind turbine.

A wind turbine is a machine that converts kinetic energy (wind) into mechanical energy. via a rotor coupled to a generator. WTs are available in horizontal axis or vertical axis configurations.

The issues for wind turbines are mainly related 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. Bearing in mind the location of the development, additional height would be required to achieve reasonable WT performance.

The London View Management Framework (LVMF) makes both horizontal and vertical turbines unfeasible at this site. In addition, issues with generation intermittency can only be countered by a convenient means of energy storage. This would come at significant additional cost, and space allowance for batteries, making this option less attractive.

E1.1.6 Biomass heating

Figure 12 Typical Biomass Boiler and Auger © BSRIA.

Biomass is the use of fuels that have been 'grown', collected, processed and used as a fuel. Various systems are available with the most commonly known being a pellet -based system burnt in furnaces. The pellets can be made from anything combustible including processed animal droppings and wood pellets from forest management (pruning) or managed woodlands (trees grown for the purpose). Biofuel is most often used to produce heating services.

A number of reasons deem this technology to be unsuitable for the development location, these include:

- Large pellet storage areas and the requirement for fire resistant storage, risk of spontaneous combustion.
- Regular delivery of fuel (approx. every two weeks) – noise and vehicle emissions, dust generation from pellets
- All biofuels combust with a high NOx content in the flue gasses.

E1.1.7 Solar Photovoltaic (PV)

Figure 13 Example of solar photovoltaic panels.

Photovoltaic (PV) systems work by converting solar energy directly into electricity. PV panels can generate electricity by either direct or diffuse sunlight (i.e. sunlight that has been scattered/reflected by the atmosphere or surrounding objects). Individual PV cells generate DC (Direct Current) electricity and are arranged in modules that include inverters to convert electricity into AC (Alternating Current) which can be used by the building systems. They can either be installed on the roof or integrated onto the building facade. 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;
- Grid connection avoids the cost of storage and ensures security of supply.

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

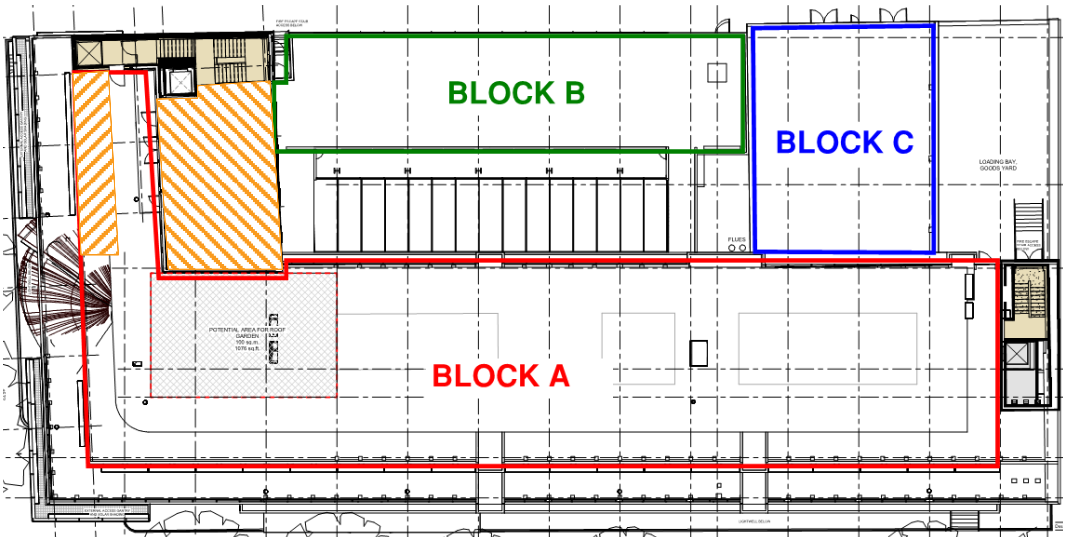


Figure 14 Roof Plan

In the case of 13 Fitzroy Street, locating façade mounted solar panels is discounted, due to the scope of not having any external façade modifications for the refurbishment. Two roof areas will be considered for locating solar panels: Block A (circa 820m^2) and Block B (circa 225 m^2) roof area. Block C roof has been excluded, as it is located 4-5 floors below the other roofs, thus having extensive shading and reduced direct sunlight exposure. Blocks A and B have a large part of area reserved for mechanical plant, existing ductwork, roof landscape features (green or brown roof) and roof terrace space. The space at the south west of Block A and above Core 1 (between Blocks A and B), shown in orange hatching on Figure 12, has space that could be used for solar panels. Significant coordination will be required to locate solar panels in practical south-facing locations for the installation to be technically and practically feasible.

Although this option is technically viable, the limited roof space and need for adequate access to be provided to the orange areas in Figure 12 significantly negatively impacts the benefits that could be sought from installing this type of system.

E1.1.8 Solar Thermal (ST)

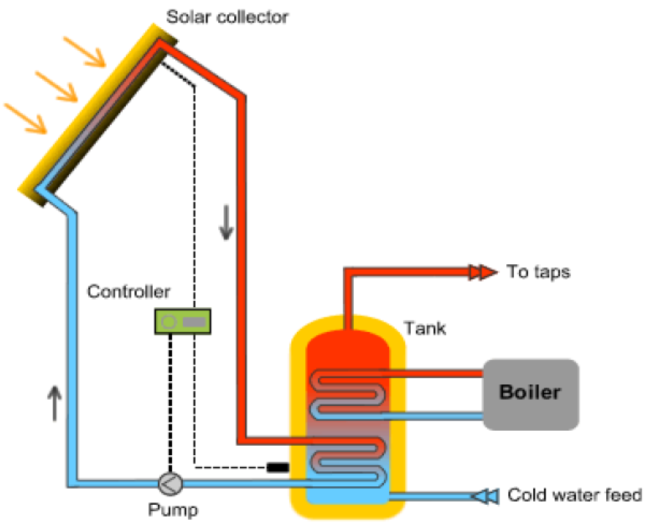


Figure 15 Example of a typical solar hot water system © Payless Solar System.

Solar water systems harness solar energy to heat water, typically domestic hot water. This is achieved using solar panels through which a fluid flows. As with PV systems, panels can be mounted on the roof or on the building façade, with the same orientation and mounting requirements.

Solar thermal arrays are typically either flat panels or evacuated tubes. Evacuated tubes provide a higher level of output. Arrays are generally installed with buffer vessels to act as reservoir for the hot water generated to ensure availability when in demand. A back-up method of water heating is provided for days when solar energy is sufficient.

Solar thermal technology is a proven technology, 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. As with PV panels, locating façade mounted panels is again discounted and consideration will be made for locating roof mounted panels.

Due to the limited roof space available, the system would only provide part of the domestic hot water load only and will not export heat. The integration of new pipework for the distribution of the heat to the centralised heating plant would increase both the cost and complexity of the design.