Sustainability and Energy Statement

20 Red Lion Street

Client: BNP Paribas as Trustees of Mayfair Capital Commercial Property Trust
Project: 20 Red Lion Street, London, WC1R 4PQ

GDM PARTNERSHIP
Sustainable Engineering

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1 INTRODUCTION

GDM Partnership Building Services Consultants Limited have been appointed by BNP Paribas as Trustees of Mayfair Capital Commercial Property Trust to undertake the Sustainability and Energy Statement for proposed works associated with the refurbishment of existing building and rear new extensions from ground floor to fifth floor level and new 6th floor level at 20, Red Lion Street, London

As part of this remit a detailed, design stage energy assessment has been undertaken for submission for planning approval from Camden Council.

The purpose of the report is to detail the investigations and options considered and to provide a conclusion via the use of TAS thermal modelling as to the predicted energy demand for the development. The proposed refurbishment works within the existing part of the development is compared against the 'as existing' case building and the new extension is compared against a 2013 Part L2A compliant extension.

2 EXECUTIVE SUMMARY

This energy statement has been prepared by GDM Partnership on behalf of BNP Paribas as Trustees of Mayfair Capital Commercial Property Trust to provide a commentary on the sustainability energy issues for the proposed refurbishment of existing building, new rear extensions from ground floor to fifth floor level and new 6th floor level at 20, Red Lion Street. It sets out the energy efficiency and carbon reduction measures that will be incorporated into the development. The assessment includes an analysis of the baseline carbon emissions of the development and the measures proposed to reduce the carbon emissions, using a lean, clean and green approach.

Building	Estimated carbon savings via proposed scheme, %	Baseline case
20, Red Lion Street existing building refurbishment	69.4%	This carbon reduction is against 'as existing' case baseline building
20, Red Lion Street new extension building	34.3%	The baseline case is a Building Regulations 2013 Part L2A notional building
Total for the entire development	66.2%	This is against the total existing emissions and notional new extension emissions

The GLA energy hierarchy is been used to analyse carbon savings separately for both refurbishment and new extension cases.

The energy efficiency measures contained within this proposal include: improved fabric insulation; improved air tightness; high efficiency fans; high efficiency heating and cooling plant, heat recovery on ventilation systems and high efficiency lighting with daylight control/occupancy control of the lighting.

The London Heat Map has been utilised to check if the development can connect into an existing distribution network. However, currently there are no existing or proposed heat distribution networks in the vicinity and as such this option has been disregarded. However, it is proposed that space is allocated within the basement area for future connections to be made, should a district energy network become viable for this development.

Combined heat and power engines are not viable for developments of this nature due to the low annual heating demand and there being no significant background heat demand during the summer. As such we do not propose to utilise CHP. This combined with the lack of a district heating scheme means that the clean measures for this development are not viable. It should therefore be noted that the carbon emissions at the end of the 'be clean' stage are identical to those being at the end of the 'be lean' with no further improvements achieved.

Photovoltaic collectors are compatible with the proposed building services solution. However, the roof of this building is being used for ancillary services, therefore, this technology has been excluded from proposals. Reference should be made to section 8.9 for the roof layout.

A VRF system combined with Air Source Heat Pump is proposed for heating and cooling services to the development. The heating energy provided by this ASHP is considered as a renewable and the carbon reduction has been calculated under 'Be Green' measures.

The following GLA format tables show the savings in carbon dioxide achieved by each steps of the energy hierarchy for both refurbishment and new extension categories separately.

Existing Building refurbishment carbon savings achieved against 'as existing' baseline.

GLA Table 4: Regulated non-domestic carbon dioxide savings		
20, Red Lion Street Existing building -Refurbishment	(Tonnes CO_2 per annum)	(%)
Savings from Energy demand reduction	128.74	67.8%
Savings from heat network/CHP	0.00	0.0%
Savings from renewable energy(ASHP)	3.14	1.7%
Total cumulative savings	131.89	**69.4%**

This carbon saving is achieved within the existing part of development is mainly due to the following proposed works.

- The existing building space is open plan with a proposed new extension where it is enclosed through new thermal elements on the rear façades. Almost all the rest of the fabric standards will be improved to Building Regulation 2013 Part L2B standards.
- High efficiency LED lighting systems with occupancy and daylighting controls.
- High efficiency heating and hot water services with ventilation heat recovery.
- High efficiency VRF cooling compared to the existing traditional four pipe waterside control fancoil units.
- High efficiency Air Source Heat Pumps

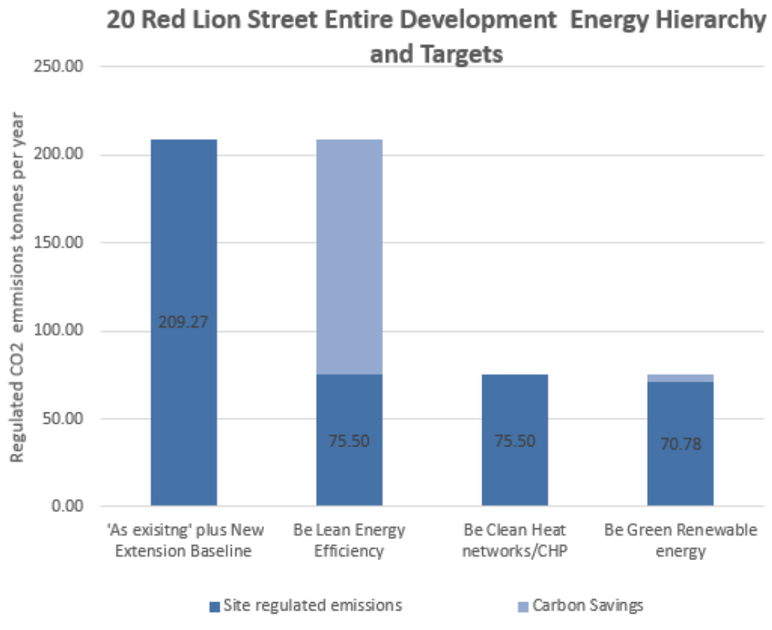
Carbon Savings achieved within New Extension against Building Regulations 2013 Notional building.

GLA Table 4: Regulated non-domestic carbon dioxide savings		
20, Red Lion Street New Extension	(Tonnes CO2 per annum)	(%)
Savings from Energy demand reduction	5.03	26.1%
Savings from heat network/CHP	0.00	0.0%
Savings from renewable energy(ASHP)	1.57	8.2%
Total cumulative savings	6.61	**34.3%**

This carbon saving is achieved mainly due to the following proposed works.

- High thermal performance of proposed fabric characteristics.
- High efficiency LED lighting systems with occupancy and daylighting controls.
- High efficiency heating, cooling, ventilation and hot water services with ventilation heat recovery.
- High efficiency Air Source Heat Pumps

The following chart detailes the total Regulated Carbon Savings achivied for the entire development.



3 BACKGROUND

This Energy Statement has been prepared by GDM Partnership on behalf of Mayfair Capital Investment Management Ltd to provide a commentary on the sustainability energy issues for the proposed refurbishment works at the existing building and new extension at 20 Red Lion Street, London. It sets out the energy efficiency and carbon reduction measures that will be incorporated into the development.

3.1 The Building

For a detailed building description, please refer to information issued by Orms architects.

3.1.1 General Arrangement Drawings

Refer to section 8 of this report for the internal layouts of the proposed development used to analyse predicted energy consumption and carbon savings.

3.2 Planning Policy and Building Regulations

3.2.1 London Plan

London Plan Policy 5.2 sets a target for all major developments to achieve 40% regulated carbon savings against a 2010 Building Regulations compliant development.

The Glossary of the London Plan clarifies that major development comprises:

- For all non-domestic uses: where the floor space will be 1000 sq. metres or more (or the site area is 1 hectare or more)

The Energy Planning GLA guidance on preparing energy assessments (March 2016) requires zero carbon to be achieved for residential developments and 35% carbon reduction against 2013 Building regulations for non-residential developments from October, 2016.

The proposed development does not create a net uplift in floor space of over 1,000 sq. m. Therefore, it is considered that the London Plan 35% target is not relevant in this instance.

3.2.2 Local Planning Policy

The Camden council's climate change policies are aligned with those set out in the London Plan. The London Plan states that developments should demonstrate that they have minimised on-site CO_2 emissions by using less energy through maximising, supplying energy efficiently and using onsite renewable energy generation.

This has been incorporated in to Camden Core Strategy Policy CS13 which expects developments or alterations to existing buildings to include proportionate measures to be taken to improve their environmental sustainability, where possible.

Further it requires non-domestic developments of 500sqm of floor space or more are required to submit an energy statement which demonstrates how carbon dioxide emissions will be reduced in line with the energy hierarchy.

London Borough of Camden Planning Guidance Sustainability CPG 3 Chapter 6 states that all developments are to target at least a 20% reduction in carbon dioxide emissions through the installation of on-site renewable energy technologies; unless it can be demonstrated that such provision is not feasible.

3.2.3 Building Regulations

The new extension is considered under Building Regulations 2013 Part L2A for calculations and existing building refurbishment considered under Part L2B.

The existing building is currently at an EPC rating of 'D'; desire for this project would be to improve this rating to an "A" rating.

3.2.4 Planning Objectives

All the above planning policies and documents together have defined the following energy related objectives for the 20 Red Lion Street development:

- The development should maximise energy demand reduction and include passive design measures wherever practical and feasible to control heat gains.
- The development should be designed to be able to easily connect to a District Energy Network (DEN) and consider CHP.
- After minimising CO_2 emissions on site, the development should assess the feasibility of renewable energy generation

This energy statement is prepared in line with the above policies and analyses how this proposed scheme meets the requirements.

The new extension and existing building are modelled separately to analyse the predicted energy demand and carbon emissions. The strategy for the assessment will follow Energy Planning, Greater London Authority guidance on preparing energy assessments (March 2016) in appraising appropriate measures to reduce carbon emissions and other climate impacts from the development:

The Energy Assessment is based on dynamic simulation modelling using software approved for the use in Building Regulations Energy Performance Calculations.

3.2.5 The Energy Hierarchy

Maximise Energy Efficiency

- Reduce use through behavior change
- Highest possible standards of thermal insulation and air tightness
- Incorporate passive heating and cooling
- Install energy efficient lighting and appliances

Supply Energy Efficiently

- Use CHP and community heating and/or cooling
- Cut transmission losses though local generation

Use Renewable Energy

- Install renewables on site

3.2.6 Structure of the Energy Assessment

This statement is structured to respond to this Energy Hierarchy. The statement includes separately;

- An assessment of the baseline carbon emissions based on the target emission rate.
- A review of the energy efficient features incorporated into the design.
- An assessment of the feasibility of connecting to a district heating network or incorporating a combined heat and power system.
- A review of renewable energy technologies and their application for this development.
- Conclusion of predicted carbon emissions and savings for the entire development.

4 ENERGY CONSUMPTION AND CARBON EMISSIONS AT 20 RED LION STREET EXISITNG BUILDING REFURBISHMENT

4.1 Baseline 'as existing' Energy Consumption

Before energy efficiency measures are investigated, it is necessary to establish the baseline energy consumption of the scheme, for comparison and evaluation of the proposed carbon reduction measures.

As stated at GLA guidance, the regulated CO_2 emissions of the existing building has been modelled to determine a BER, which is used to determine an 'as existing' case.

4.1.1 Baseline 'as existing' Building Fabric Properties

The building is a mid-20th century building, detailed construction survey not been carried out and the following Fabric characteristics has been assumed using typical values considering the UK construction for that period building.

Some thermal elements within the building were undergone replacement in 1997 and are assumed with refurbished fabric characteristics.

Element/ Characteristics	20 Red Lion Street (W/m²K)
External Wall - U value (W/m²K) (Facing Red lion and Sand land streets)	1.2
External Wall Rear- U value (W/m²K)	1.8
Ground Floor slab- U value (W/m²K)	1.1
Roof - U value (W/m²K)	2.4
Windows - U value (W/m²K) (Facing Red lion and Sand land streets- Refurbished in 1997)	3.2
Windows -rear walls - U value (W/m²K)	5.1
Doors - U value (W/m²K)	5.0
Air Permeability (m³/hr/m² @50Pa)	25

4.1.2 Baseline 'as existing' Regulated Energy Uses

A survey at the existing building energy services has been carried out to model the energy consumption of the following 'regulated' energy uses.

Heating, Cooling and Ventilation	The existing office floors are heated using LTHW Gas boilers which are around 20 years old and 75% efficiency is assumed. The cooling is supplied via traditional four pipe waterside control Fancoil unit system and cooling COP of 4.0 is estimated and used for calculations. Centralised supply and extract air handling unit (AHU) is nearing the end of its serviceable life. WCs: Mechanical extract from an existing twin extract fan appears to be from the original installation and are nearing the end of their serviceable life.
DHW	Hot water is generated by gas boilers located within the basement and are nearing the end of its serviceable life and 75% efficiency is used for calculations.
Lighting	The existing lighting comprises of a mixture of recessed low voltage and compact fluorescent downlights. The lighting control is a combination of both manual & automatic controls. No daylight linked controls were visible. A value of 55 lumens/circuit watt has been estimated and used for calculations.

4.1.3 Non-Regulated Loads

Emissions associated with non-regulated energy consumption (e.g. small power use and equipment) have been calculated by the TAS thermal model and included within the summary table.

4.1.4 Baseline 'as existing' BRUKL

Reference should be made to section 7 for the baseline BRUKL / EPC outputs.

4.2 'Be Lean' Reduce Energy Demand

The next step within the Energy Hierarchy is the 'Be Lean' strategy of reducing energy consumption as possible.

4.2.1 'Be Lean' Building Fabric Properties

The first step to reduce energy consumption is via improving building thermal elements. The following table describes the fabric improvements proposed within the existing fabrics.

Element/ Characteristics	20 Red Lion Street, As Existing	20 Red Lion Street existing building, refurbishment works
External Wall - U value (Facing Red lion and Sand land streets)	1.2 W/m²K	0.3 W/m²K
Ground Floor slab- U value	1.1 W/m²K	0.22 W/m²K
Roof - U value	2.4 W/m²K	0.18 W/m²K
Windows (Facing Red lion and Sand land street)	3.2 W/m²K	3.2 W/m²K
Windows -rear walls	5.1 W/m²K	1.5 W/m²K
Doors - U value	5.0 W/m²K	1.5 W/m²K
Air Permeability	25(m³/hr/m² @50Pa)	15 (m³/hr/m² @50Pa)

- External Walls- There are no detailed surveys undertaken at the time of this calculations and type of construction is unknown. Therefore, internal insulation considered for this wall and proposed to achieve 0.3 W/m²K U value. However, if it happens to be a cavity wall, reasonable provisions will be made to achieve 0.55 W/m²K U value to meet Part L2B requirements.

- No replacement proposed for the windows facing Red Lion and Sand Land Street as they are double glazed and were replaced in 1997. However, thermal lining is proposed to reduce air infiltration. All other single glazed windows will be replaced with double glazing windows.

- The proposed works will be targeting to reduce air permeability within this building lower than 10. However, a value of 15 is assumed at this stage for calculations as the value is currently unknown.

4.2.2 Lighting

The existing building will be fitted out with high efficiency LED lighting together with occupancy controls and daylight dimming control across the floors.

The zoning arrangement of the daylight sensors will be no more than 5m from the façade to ensure that the potential for energy savings is optimised. The dimming system will work to maintain the design illuminance on the working plane, so this will also prevent over-lighting.

The following lighting efficacies have been allowed within the building models:

- Lighting energy consumption, office – 80 luminaire lumens per circuit watt.
- Lighting energy consumption, all other – 80 luminaire lumens per circuit watt

4.2.3 Ventilation

The office spaces are mechanically ventilated. Fresh air is delivered directly to the floor from an AHU and ducted ventilation system. The air handling unit is provided with a heating coil and is designed to operate with high efficiency fans and a specific fan power of less than 1.6 Watts per litre per second. The air handling unit extracts the air from the offices and incorporates a heat exchanger to recover the energy from the exhaust air, thereby reducing the space heating demand.

A separate central extract fan with 0.5 W/l/s SFP is proposed for WC and shower areas.

4.2.4 Domestic Hot Water (DHW)

Domestic hot water services are provided by new gas fired water heater located in the lower ground floor plant room.

4.2.5 Heating

Energy/carbon calculations for heating services have been assessed with a LTHW gas boiler at this stage for the existing development.

4.2.6 VRF and ASHPs

ASHP technology is found to be suitable to provide cooling for office areas.

Through a refrigeration cycle, external ambient air can be used as a heating or cooling medium. Air source heat pumps recover or reject heat from outside air and can deliver heating or cooling, or both to an occupied space.

High seasonal efficiencies allow significant energy savings when compared to heat generation from fossil fuels, for instance three kilowatt output can be generated from a single kilowatt of input electrical energy.

Heat pumps are generally located externally, but indoor heat pump units are available; however, due to the high rates of ventilation required the restrictions on placing units internally is quite onerous.

Although electrically driven, in a heating only scenario the energy savings achieved by this solution are classified as renewable once the electricity consumed by the units is considered. This has been recognised within the current London Plan. This is further analysed within section 4.4.5 of this document.

Where cooling is required, an argument can be made that heating only heat pumps would need to be supplemented by an additional external comfort cooling plant, thereby maintaining the renewable heating energy generated by "heating only" air source heat pumps. This has a detrimental impact in terms of cost, and increased noise from an external plant, when compared to the opportunity for utilising a common system.

Therefore, an ASHP providing both heating and cooling via VRF is proposed for the commercial development. In terms of energy calculations, the improvement achieved via ASHP cooling combined with VRF is calculated at this 'be lean' stage.

The proposed cooling plant's seasonal efficiency is as follows:

Cooling SEER	6.58

4.3 'Be Clean' Stage Energy Consumption

The next step in the Energy Hierarchy is the 'Be Clean' strategy of supplying the required energy as efficiently as possible.

Potential approaches include connecting the scheme to existing low carbon or CHP-led district energy networks, or if no existing schemes exist, investigating whether such networks are planned in the area and designing systems with the flexibility to connect to these in the future. With or without a district energy system, the feasibility of CHP (combined heat and power). For larger developments, the use of a site wide communal heating system should be provided if considered viable.

4.3.1 District Energy Networks

The London Heat Map has been utilised to check if the development can connect into an existing distribution network. Currently there are no existing or proposed heat distribution networks in the vicinity and as such this technology has not been incorporated into the proposed scheme.

Figure 1 above identifies the proposed site location on the Camden decentralised energy map with potential for future District heating networks. Although it situated within 1km radius of existing network, it is outside the radius of 500m of a potential network to plan a connection. With the above in mind it is proposed that space is allocated within the basement area for future connections to be made, should a district energy network become viable for this development.

4.3.2 CHP

Combined heat and power engines are not viable for developments of this nature due to the low annual heating demand and there being no significant background domestic hot water demand during the summer. As such this technology, has not been incorporated into the proposed scheme.

4.3.3 Conclusion

The development will not be connected to a district heating network or be provided with a CHP engine and as such these Clean measures have not been adopted as part of the development's proposals.

The carbon emissions at the end of the 'be clean' stage is identical to those at the end of the 'be lean'

Figure 4. Developments within 1km radius of an existing or emerging network.

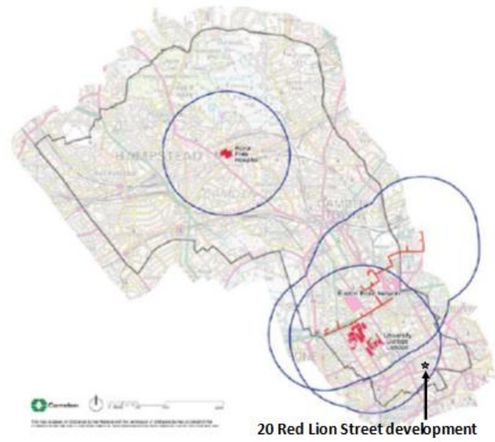


Figure 5. Developments within 500m radius of a potential network

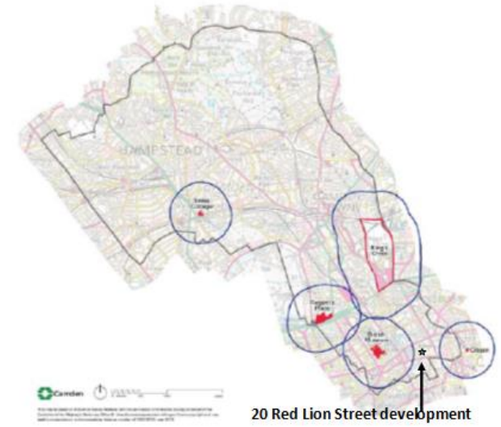


Figure 1 Proposed site location on the Camden decentralised energy map with potential for future District heating networks.

4.4 'Be Green' Renewable Energy

The third and final stage of the energy hierarchy - 'Be Green' is to review the potential of a range of renewable energy systems to serve the energy requirements of the site and thereby offset CO_2 emissions.

The following renewable energy technologies have been considered for the development:

- Solar Water Heating
- Wind Power
- Biomass Heating

- Heat Pumps
- Photovoltaics

4.4.1 Solar Water Heating

Solar thermal domestic hot water consumption is technically viable for this development. However, installing a solar thermal system to serve the toilets will not make a significant carbon saving as the domestic hot water demand is very low. Furthermore, the roof area used for external ancillary plant. This has resulted in this technology being excluded from the final design proposals.

4.4.2 Wind Power

It is recognised that wind generators are often associated with unacceptable visual and noise implications. Wind technology as a renewable energy source is not considered appropriate for this site as it is felt that the wind turbines would not be visually appropriate for this development and this technology being excluded from the final design proposals.

4.4.3 Biomass Heating

Biomass heating is not considered to be a suitable technology for urban locations. With local boilers in each unit biomass boilers are not a viable solution due fuel distribution problems on the site. In addition, the boilers are often un-used due to maintenance issues, fuel supply issues, and operating costs as such this technology being excluded from the final design proposals.

4.4.4 Photovoltaics

Photovoltaic collectors are compatible with the proposed building services solution. photovoltaic collectors are compatible with the proposed building services solution and the roof of this Building has been analysed for possible installation of solar photovoltaic collectors. As the roof area is used for ancillary plant installation, no suitable space is available for Photovoltaic collectors. Please refer the roof drawings included in section 8 of this report.

4.4.5 Air Source Heat Pump-Heating

The heating services for Office spaces are proposed to be provided by Air Source Heat Pumps (ASHP).

Although, both heating and cooling services are provided by roof mounted air source heat pump units, energy/carbon improvements associated with heating only have been considered as renewable energy and calculated at the 'be green' stage.

The Seasonal Coefficient of Performance provided by the commercial ASHPs is shown below.

Heating SCOP	5.38

4.4.6 Proposed case BRUKL outputs

Reference should be made to section 7 for the proposed case BRUKL /EPC document outputs.

4.5 Summary of Carbon Savings at 20 Red Lion Street Existing Building Refurbishment

GLA Table 3: Carbon Dioxide Emissions after each stage of the Energy Hierarchy		
20, Red Lion Street Existing building	Carbon dioxide emissions for non-domestic buildings (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations compliant development	190.00	71.09
After Energy Demand Reduction	61.26	71.09
After heat network/CHP	61.26	71.09
After Renewable energy (ASHP)	58.12	71.09

GLA Table 4: Regulated non-domestic carbon dioxide savings		
20, Red Lion Street Existing building	(Tonnes CO2 per annum)	(%)
Savings from Energy demand reduction	128.74	67.8%
Savings from heat network/CHP	0.00	0.0%
Savings from renewable energy (ASHP - heating)	3.14	1.7%
Total cumulative savings	131.89	69.4%

The carbon savings achieved at the end of 'be green' measures compared to 'as existing' case baseline building is approximately **69.4 %.**

5 ENERGY CONSUMPTION AND CARBON EMISSIONS AT 20 RED LION STREET NEW EXTENSION

5.1 Baseline energy consumption and carbon emissions

Before energy efficiency measures are investigated, it is necessary to establish the baseline energy consumption of the scheme, for comparison and evaluation of the proposed carbon reduction measures.

The baseline case against which carbon savings are assessed is a new development designed to achieve the target emission rate calculated in accordance with ADL2A (2013) of the Building Regulations. This baseline case represents a typical new build arrangement; where electricity for the development is imported from the grid and space and heating water are provided by fossil fuel sources.

The on-site energy consumption associated with non-regulated uses (e.g. lifts, small power and information technology) is included in the baseline carbon emission analysis.
The following 'regulated' energy uses are considered in the baseline energy analysis.

- Space Heating/Cooling
- Water Heating
- Ventilation
- Fans, Pumps and Controls
- Lighting (internal)

5.1.1 Baseline fabric characteristics

The table below identifies fabric characteristics for each thermal element against ADL2A.

Element/ Characteristic	20 Red Lion Street Extension - Baseline Scheme (W/m²K)	Criterion 2 - Limits on design flexibility Part L2A (Non-Domestic)
Exterior Wall - U value (W/m²K)	0.2	0.35
Exposed Floor - U value (W/m²K)	0.2	0.25
Roof - U value (W/m²K)	0.13	0.25
Windows Glazing - U value (W/m²K)	1.5	2.2
Design Air Permeability (m³/hr/m² @50Pa)	10	10

5.1.4 Regulated Loads

CO_2 Emissions related to regulated energy use in the commercial element of the scheme have been established by a dynamic thermal model using EDSL TAS.

A model of the proposed development has been constructed and the following assumptions made regarding the baseline heating and cooling system:

Heating and cooling	Fan coil units using gas fired boilers and central air cooled chillers
Ventilation	Central air handling unit providing minimum fresh air to the office areas. Central extract for WCs.
Domestic hot water	Gas fired boilers

5.1.5 Non-Regulated Loads

Emissions associated with non-regulated energy consumption (e.g. small power use and equipment) have been calculated by the TAS thermal model.

5.1.6 Baseline BRUKL

The emission rate of the baseline building is 24.5 $kgCO_2/m^2/yr$.

Reference should be made to section 7 for the baseline BRUKL /EPC document outputs.

5.2 Be Lean - Maximise Energy Efficiency

This section outlines how energy consumption will be reduced through the design of the building.

This is achieved by passive measures and the introduction of more energy efficient plant and services. Any improvement achieved at this stage will affect the extent of measures or size of the plant needed to address the subsequent 'be clean' and 'be green' stages.

The building will be constructed to exceed the limiting requirements of the Building Regulations. The offices will be fitted out to provide mechanical ventilation, heating and cooling.

5.2.7 Physical Form and Orientation of the Building

The orientation of the building is firmly fixed due to the size of the existing site and the roads closely surrounding the site.

Passive solar design involves adapting the building massing, layout and glazing to best respond to the local climate and annual sun path, with the aim of reducing energy demands and improving occupant comfort through limiting the solar gain. The orientation of the building is such that the facades with glazing face east, west and north.

In addition to the orientation solar control glass with a g-value of 0.4 will be used to limit the solar gain. The solar gain limit is not exceeded in any zones under criterion 3 of the Part L of the Building Regulations, and helps to reduce the annual energy consumption by reducing the annual cooling demand.

Good levels of natural daylight will be achieved using glazing with more than 70% light transmission factor; an average daylight factor better than 2% throughout the perimeter area. This will reduce reliance on artificial lighting with a corresponding reduction in energy consumption.

5.2.8 Building Fabric

The thermal transmittance of the building fabric will be better than the limiting requirements of Part L of the Building Regulations and in align with London Borough of Camden Planning Guidance Sustainability CPG 3 paragraph 3.22.

Details regarding the target U-values for the development are listed in the following table.

Element/ Characteristic	20 Red Lion Street Extension Proposed Scheme (W/m²K)	Criterion 2 - Limits on design flexibility Part L2A (Non-Domestic)
Exterior Wall - U value (W/m²K)	0.2	0.35
Exposed Floor - U value (W/m²K)	0.2	0.25
Roof - U value (W/m²K)	0.13	0.25
Windows average - U value (W/m²K)	1.5	2.2
Design Air Permeability (m³/hr/m² @50Pa)	8	10

The new thermal elements will provide a very air tight environment, in other words, provide very low air infiltration. However, most of the new extension space is open plan with the existing building; therefore, an air permeability of 8 m³/hr/m² @50Pa is used for calculations at this stage.

The benefit from further improvements to the U-values was investigated as part of the 'be lean' assessment and it was found that reducing the U-values of all solid elements by further 25% did not change the building emission rate.

5.2.9 Lighting

It is proposed to install new lighting and an intelligent lighting control system throughout the building. The new luminaires shall be controlled via an intelligent lighting control system consisting of lighting control modules, area control units, presence/solar detectors, scene setting switches, etc. The new luminaires shall be electrically supported from the new local tenants and landlord's distribution boards.

The zoning arrangement of the daylight sensors will be no more than 5m from the façade to ensure that the potential for energy savings is optimised. The dimming system will work to maintain the design illuminance on the working plane, so will also preventing over-lighting.

- Lighting energy consumption – 85 luminaire lumens per circuit watt.

5.2.10 Ventilation

Fresh air is delivered directly to the ground to 6th floors from a central roof mounted AHU and ducted ventilation system. The air handling unit is provided with a heating coil and is designed to operate with high efficiency fans and a specific fan power of less than 1.6 Watts per litre per second. The air handling unit extracts the air from the offices and incorporates a heat exchanger to recover the energy from the exhaust air, thereby reducing the space heating demand.

5.2.11 Domestic Hot Water

Domestic hot water services are provided by new central direct gas fired water heaters.

5.2.12 Heating

Energy/carbon calculations for heating services have been assessed as per the baseline model at this stage for the extension and further analysed within 'be green' measures.

5.2.13 VRF & ASHPs

The proposed cooling system are as per described within section 4.2.6 and plant's seasonal efficiency is as follows:

Cooling SEER	6.58

5.3 Be clean – supply energy efficiently

The next step in the Energy Hierarchy is the 'Be Clean' strategy of supplying the required energy as efficiently as possible.

Potential approaches include, connecting the scheme to existing low carbon or CHP-led district energy networks, or if no existing schemes exist, investigating whether such networks are planned in the area and designing systems with the flexibility to connect to these in the future. With or without a district energy system, the feasibility of CHP (combined heat and power). For larger developments, the use of a site wide communal heating system should be provided if considered viable.

5.3.1 District Energy Networks

The London Heat Map and Borough's Local plan map have been utilised to check if the development can connect into an existing distribution network. However, currently there are no existing or proposed heat distribution networks in the close vicinity and as such this option has been disregarded.

The location of the 20 Red Lion Street development analysed with existing network and it is proposed that space is allocated within the basement area for future connections to be made, should a district energy network become viable for this development.

5.3.2 CHP

Combined heat and power engines are not viable for developments of this nature due to the low annual heating demand and there being no significant background domestic hot water demand during the summer and as such this technology has not been incorporated into the proposed scheme.

5.3.3 Conclusion

The development will not be connected to a district heating network or be provided with a CHP engine and as such these clean measures have not been adopted as part of GDM's proposals.

The carbon emissions at the end of the 'be clean' stage are identical to those at the end of the 'be lean' as indicate within tables below.

5.4 Be Green – Renewable Energy

The third and final stage of the energy hierarchy - 'Be Green' is to review the potential of a range of renewable energy systems to serve the energy requirements of the site and thereby offset CO_2 emissions.

The following renewable energy technologies have been considered for the development:

- Solar Water Heating
- Wind Power
- Biomass Heating
- Heat Pumps
- Photovoltaics
- Air Source Heat Pump

5.4.1 Solar Water Heating

Solar thermal domestic hot water consumption is technically viable for this development. However, installing a solar thermal system to serve the toilets will not make a significant carbon saving as the domestic hot water demand is very low. This combined with the limited available space at roof level has resulted in this technology being excluded from the final design proposals.

5.4.2 Wind Power

It is recognised that wind generators are often associated with unacceptable visual and noise implications. Wind technology as a renewable energy source is not considered appropriate for this site as it is felt that the wind turbines would not be visually appropriate for this development and this technology being excluded from the final design proposals.

5.4.3 Biomass Heating

Biomass heating is not considered to be a suitable technology for urban locations. With local boilers in each unit biomass boilers are not a viable solution due to fuel distribution problems on the site. In addition, the boilers are often un-used due to maintenance issues, fuel supply issues, and operating costs as such this technology being excluded from the final design proposals.

5.4.4 Photovoltaics

Photovoltaic collectors are compatible with the proposed building services solution; However, the roof of this building is being used for ancillary services, therefore this technology has been excluded from proposals. Please refer the roof drawings included section 8 of this report.

5.4.5 Air Source Heat Pump

Air source heat pump technology is found to be suitable for this development and included within this proposal.

Although, heating and cooling is provided by roof mounted air source heat pump units, energy produced achieved via heating only mode is accounted as renewable energy and carbon savings are calculated. The proposed plant's seasonal efficiencies are as follows:

Heating SCOP	5.38

5.4.6 Proposed case BRUKL

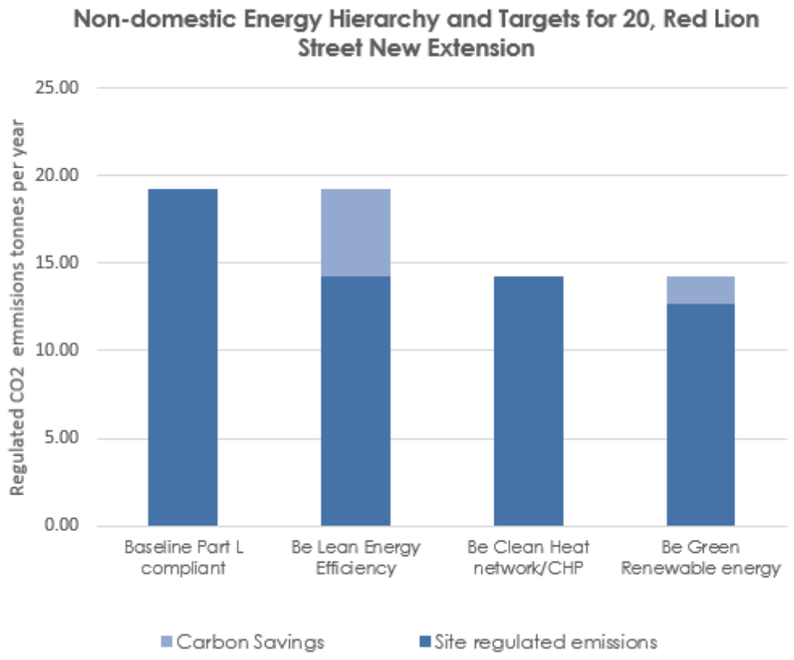
Reference should be made to section 7 for the proposed case BRUKL /EPC document outputs.

5.5 Carbon Emissions at End of 'Be Green' Stage

GLA Table 3: Carbon Dioxide Emissions after each stage of the Energy Hierarchy		
20, Red Lion Street New Extension	Carbon dioxide emissions for non-domestic buildings (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations compliant development	19.27	16.43
After Energy Demand Reduction	14.24	16.43
After heat network/CHP	14.24	16.43
After Renewable energy (ASHP)	12.66	16.43

GLA Table 4: Regulated non-domestic carbon dioxide savings		
20, Red Lion Street New Extension	(Tonnes CO2 per annum)	(%)
Savings from Energy demand reduction	5.03	26.1%
Savings from heat network/CHP	0.00	0.0%
Savings from renewable energy(ASHP)	1.57	8.2%
Total cumulative savings	6.61	34.3%

The carbon savings achieved at the end of Green measures is approximately **34.3 %.**



6 CONCLUSIONS

The following table summarises the estimated carbon emission savings for each part of the development and thereby total for the entire development.

Building	Estimated carbon savings via proposed scheme, %	Baseline case
20, Red Lion Street existing building	69.41%	This carbon reduction is against 'as existing' case building
20, Red Lion Street New Extension building	34.29%	The baseline is Building Regulations 2013 Part L2A notional building
Total for the entire development	66.18%	This is against total existing emissions and notional new extension

The 'be lean' energy efficiency measures include: improved fabric insulation; improved air tightness; high efficiency fans; high efficiency heat recovery heating, cooling and domestic hot water plant, heat recovery on ventilation systems and high efficiency lighting with right controls.

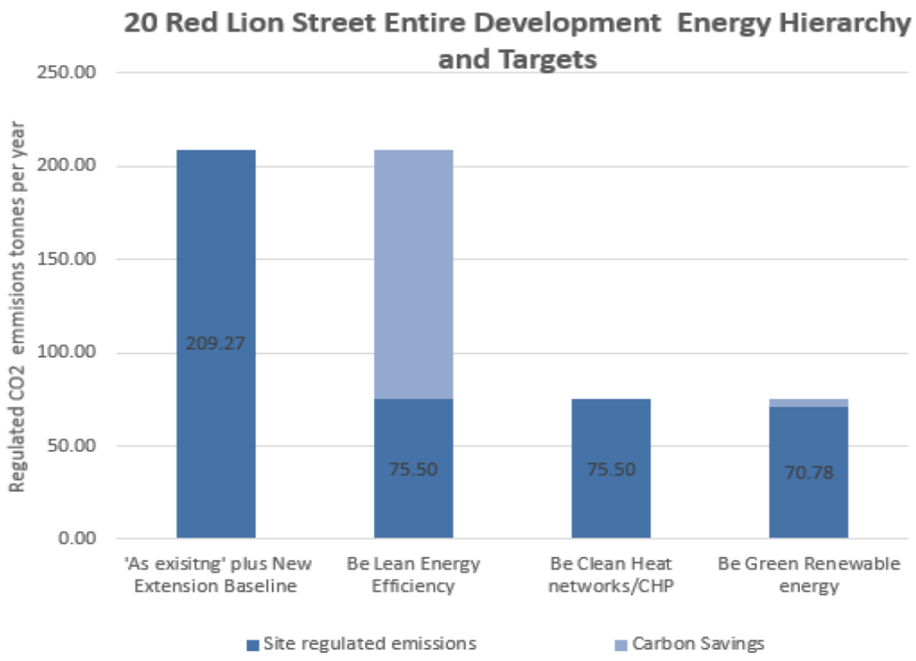
The London Heat Map has been utilised to check if the development can connect into an existing distribution network. Currently there are no existing or proposed heat distribution networks in the vicinity. Space however will be made available within the basement for future connection to a district energy scheme should this be viable in the future.

Combined heat and power engines are not viable for developments of this nature due to the low annual heating demand and there being no significant background heat demand during the summer. The carbon emissions at the end of the 'be clean' stage is identical to those at the end of the 'be lean' stage.

Renewable energy systems are evaluated to incorporate within the proposals and found technically and economically not feasible. However, Air source heat pumps are compatible with the proposed building services solution and included within the proposal. Only the heating element of the ASHP considered renewable energy generation under 'be green' measures.

The following table show the savings in carbon dioxide achieved by the three steps for the entire development.

Whole building carbon dioxide emissions and savings (Existing + new extension)			
20 Red Lion Street: Entire Development	Total Regulated emissions	CO2 Savings (Tonnes CO2 per annum)	Percentage Saving (%)
Baseline: Site Total emissions (As existing plus notional new extension)	209.27		
After Energy Demand Reduction	75.50	133.77	63.92%
After heat network/CHP	75.50	0.00	0.00%
After Renewable energy	70.78	4.72	2.26%
Total Savings	138.49	138.49	66.18%



The above chart shows clearly the proposed improvements vastly reduce the existing carbon emissions. It further demonstrates that the combined (existing plus extension) future building carbon emissions are not greater than the existing building plus a notional extension.

7 BRUKL REPORT

This chapter shows the Criterion 1 & 2 of the BRUKL outputs of energy assessments carried out and full BRUKL outputs would be available if required.

7.1 Existing Building

7.1.1 Baseline 'As Existing' BRUKL Document - existing building

BRUKL Output Document — HM Government
Compliance with England Building Regulations Part L 2013

Project name

Red Lion Street; As Exisitng — As designed

Date: Fri Nov 18 12:12:37 2016

Administrative information

Building Details
Address: 20, Red Lion Street, London, WC1R 4PQ

Certification tool
Calculation engine: TAS
Calculation engine version: "v9.4.0"
Interface to calculation engine: TAS
Interface to calculation engine version: v9.4.0
BRUKL compliance check version: v5.2.g.3

Owner Details
Name:
Telephone number:
Address: , ,

Certifier details
Name: Antonette Easwaranathan
Telephone number: +44(0)1322 299594
Address: 37-41 Spital Street, Dartford, DA1 2DR

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

The building does not comply with England Building Regulations Part L 2013

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	22.1
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	22.1
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	52.6
Are emissions from the building less than or equal to the target?	BER > TER
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 not achieving standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	1.59	2.36	Basement wall
Floor	0.25	1.11	1.51	Exposed Floor
Roof	0.25	2.42	2.42	Roof
Windows***, roof windows, and rooflights	2.2	3.93	5.39	F1 window rear
Personnel doors	2.2	3.17	3.17	Door
Vehicle access & similar large doors	1.5	-	-	No vehicle doors in project
High usage entrance doors	3.5	3.17	3.17	G0 entrance door

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = 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	25

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7.1.2 Baseline 'As Existing' EPC Document - existing building

Energy Performance Certificate — HM Government
Non-Domestic Building

20, Red Lion Street
London
WC1R 4PQ

Certificate Reference Number:
9182-3071-9463-1602-2591

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 — 78 This is how energy efficient the building is.
E 101-125
F 126-150
G Over 150
Less energy efficient

Technical information

Main heating fuel:	Other
Building environment:	Air Conditioning
Total useful floor area (m^2):	3614
Building complexity (NOS level):	5
Building emission rate ($kgCO_2/m^2$):	52.57

Benchmarks

Buildings similar to this one could have ratings as follows:
33 If newly built
97 If typical of the existing stock

7.1.3 Proposed refurbishment case BRUKL - existing building

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Red Lion Street Refurb-Be Green — As designed

Date: Tue Nov 22 14:45:16 2016

Administrative information

Building Details

Address: 20, Red Lion Street, London, WC1R 4PQ

Certification tool

Calculation engine: TAS

Calculation engine version: "v9.4.0"

Interface to calculation engine: TAS

Interface to calculation engine version: v9.4.0

BRUKL compliance check version: v5.2.g.3

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name: Antonette Easwaranathan

Telephone number: +44(0)1322 299594

Address: 37-41 Spital Street, Dartford, DA1 2DR

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

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	18.4
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	18.4
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	16
Are emissions from the building less than or equal to the target?	BER =< TER
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 not achieving standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.3	0.3	Basement wall
Floor	0.25	0.22	0.22	Ground Floor
Roof	0.25	0.18	0.18	Roof
Windows***, roof windows, and rooflights	2.2	2.88	3.17	F1 window2 dg
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	1.61	1.61	G0 HU entrance door n

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = 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	15

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7.1.4 Proposed refurbishment case EPC- existing building

Energy Performance Certificate

HM Government

Non-Domestic Building

20, Red Lion Street
London
WC1R 4PQ

Certificate Reference Number:
9182-3079-9463-1692-3595

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 — 24 This is how energy efficient the building is.

B 26-50

C 51-75

D 76-100

E 101-125

F 126-150

G Over 150

Less energy efficient

Technical information

Main heating fuel: Other
Building environment: Air Conditioning
Total useful floor area (m^2): 3613
Building complexity (NOS level): 5
Building emission rate ($kgCO_2/m^2$): 16.04

Benchmarks

Buildings similar to this one could have ratings as follows:

27 If newly built

80 If typical of the existing stock

7.2 New Extension Building

7.2.1 Baseline case BRUKL document

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

20 Red Lion Street; Baseline As designed

Date: Wed Nov 23 10:59:16 2016

Administrative information

Building Details

Address: 20 Red Lion Street, London, WC1R 4PQ

Certification tool

Calculation engine: TAS

Calculation engine version: "v9.4.0"

Interface to calculation engine: TAS

Interface to calculation engine version: v9.4.0

BRUKL compliance check version: v5.2.g.3

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name: Antonette Easwaranathan

Telephone number: +44(0)1322 299594

Address: 37-41 Spital Street, Dartford, DA1 2DR

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

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	24.5
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	24.5
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	24.4
Are emissions from the building less than or equal to the target?	BER =< TER
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 not achieving standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.2	0.2	New External wall
Floor	0.25	0.2	0.2	Exposed Floor
Roof	0.25	0.13	0.13	New Roof
Windows***, roof windows, and rooflights	2.2	1.51	1.51	G0 new window
Personnel doors	2.2	1.51	1.51	Door
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

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)] $U_{i\text{-}Calc}$ = 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	10

Page 1 of 7

7.2.2 Baseline case EPC document

Energy Performance Certificate

HM Government

Non-Domestic Building

20 Red Lion Street
London
WC1R 4PQ

Certificate Reference Number:
0592-9618-3731-4409-1623

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

34 This is how energy efficient the building is.

Less energy efficient

Technical information

Main heating fuel:	Other
Building environment:	Air Conditioning
Total useful floor area (m^2):	787
Building complexity (NOS level):	5
Building emission rate ($kgCO_2/m^2$):	24.41

Benchmarks

Buildings similar to this one could have ratings as follows:

34 If newly built

100 If typical of the existing stock

7.2.3 Proposed case BRUKL Document

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

20 Red Lion Street; Be Green — As designed

Date: Mon Nov 21 13:41:54 2016

Administrative information

Building Details
Address: 20 Red Lion Street, London, WC1R 4PQ

Certification tool
Calculation engine: TAS
Calculation engine version: "v9.4.0"
Interface to calculation engine: TAS
Interface to calculation engine version: v9.4.0
BRUKL compliance check version: v5.2.g.3

Owner Details
Name:
Telephone number:
Address: , ,

Certifier details
Name: Antonette Easwaranathan
Telephone number: +44(0)1322 299594
Address: 37-41 Spital Street, Dartford, DA1 2DR

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

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	19.2
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	19.2
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	16.1
Are emissions from the building less than or equal to the target?	BER =< TER
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 not achieving standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.2	0.2	New External wall
Floor	0.25	0.2	0.2	Exposed Floor
Roof	0.25	0.13	0.13	New Roof
Windows***, roof windows, and rooflights	2.2	1.51	1.51	G0 new window
Personnel doors	2.2	1.51	1.51	Door
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

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)] $U_{i\text{-}Calc}$ = 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	8

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7.2.4 Proposed case EPC Document

Energy Performance Certificate

HM Government

Non-Domestic Building

20 Red Lion Street
London
WC1R 4PQ

Certificate Reference Number:
0592-9618-3731-4409-1623

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

22 This is how energy efficient the building is.

Less energy efficient

Technical information

Main heating fuel:	Other
Building environment:	Air Conditioning
Total useful floor area (m^2):	787
Building complexity (NOS level):	5
Building emission rate ($kgCO_2/m^2$):	16.08

Benchmarks

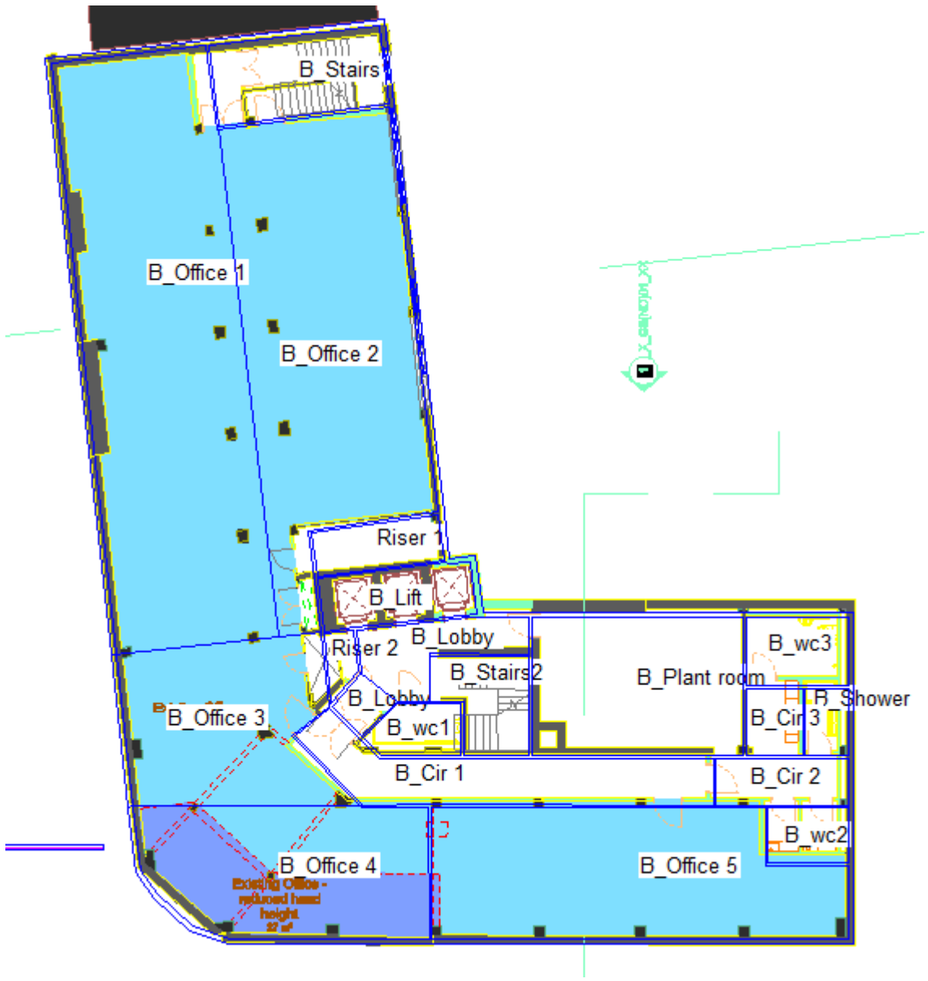
Buildings similar to this one could have ratings as follows:

27 If newly built
78 If typical of the existing stock

8 LAYOUT DRAWINGS -20 RED LION STREET DEVELOPMENT

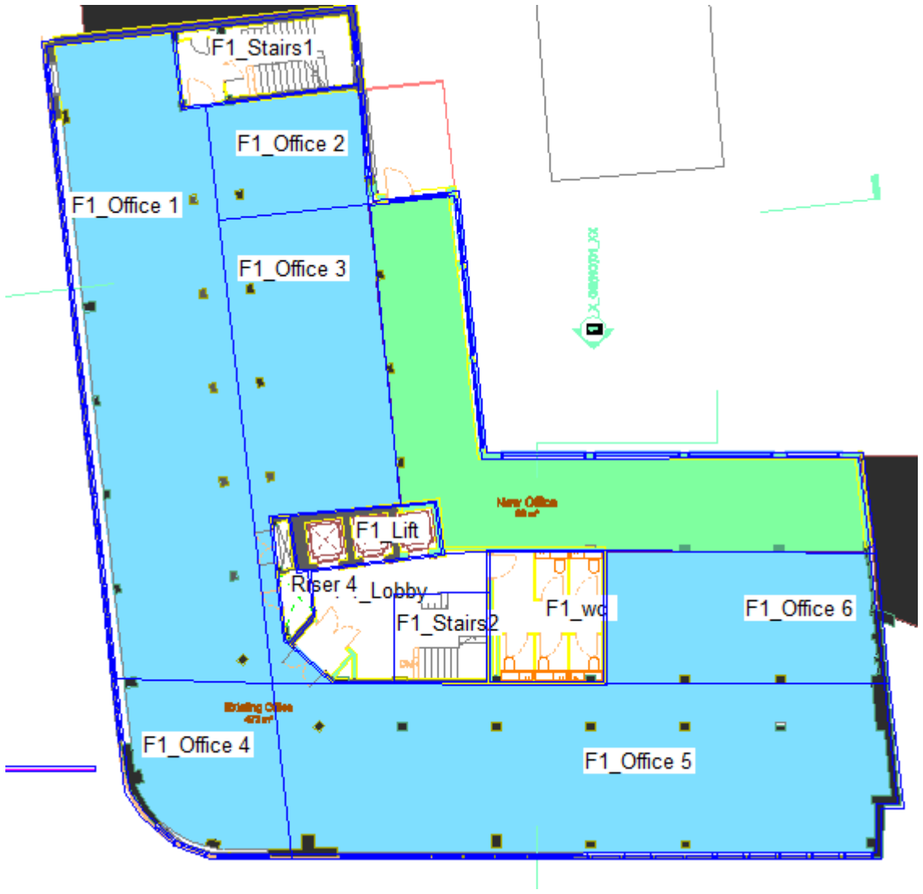
The following layouts shows the existing part of the building and proposed extension at each level.

8.1 Basement Level



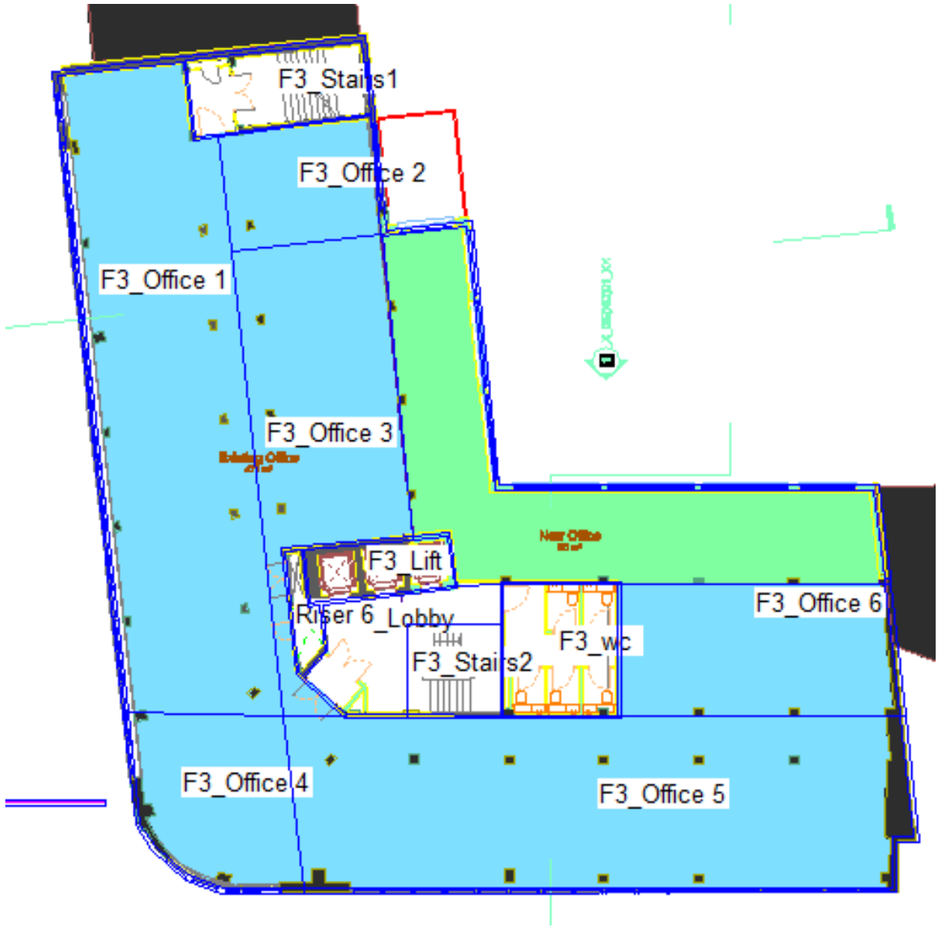
8.2 Ground Floor Level

8.3 First Floor Level



8.4 Second Floor Level

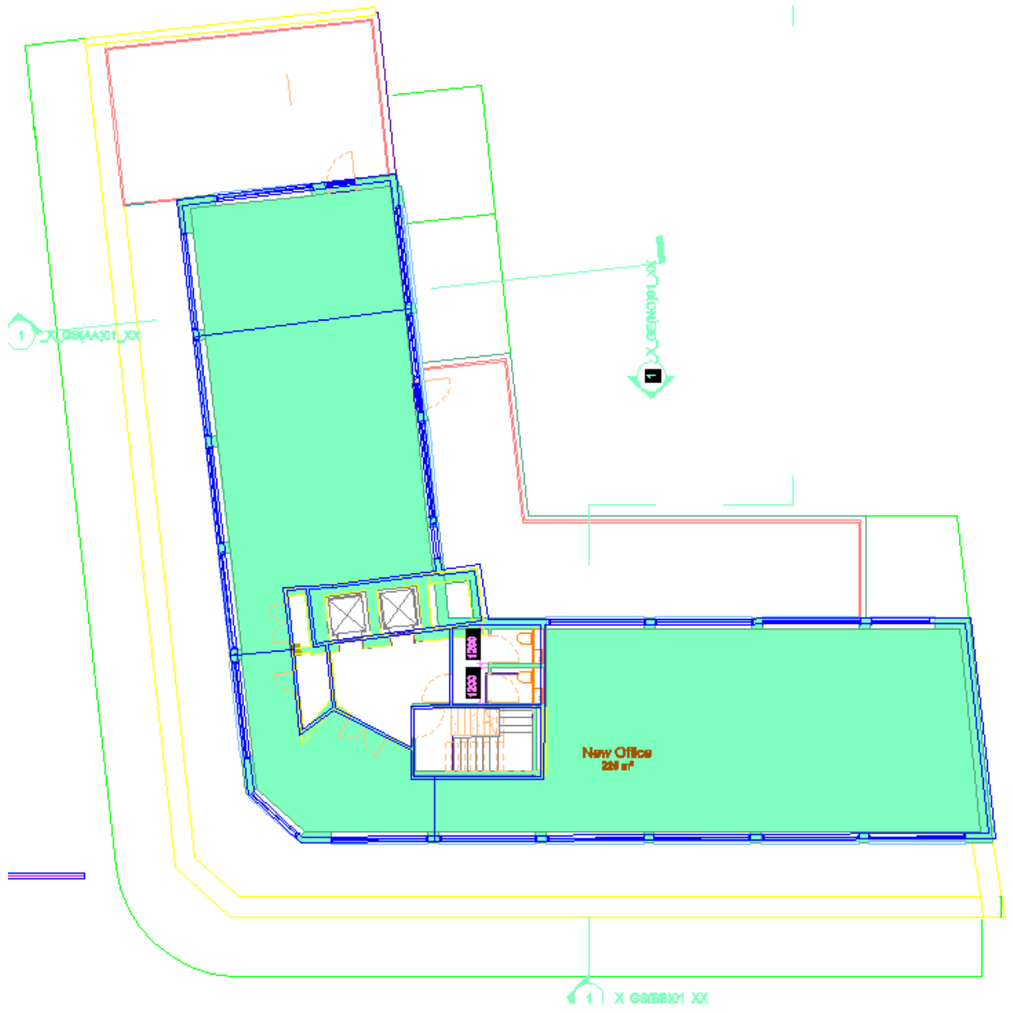
8.5 Third Floor Level



8.6 Fourth Floor Level

8.7 Fifth Floor Level

8.8 Sixth Floor Level – New Floor



8.9 Roof Level Ancillary Plant Room