Milieu Consult
Engineer| Energy| Environment

Energy Statement

For

Kingsway House, Kingsway, London

DOCUMENT INFORMATION

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TABLE OF CONTENTS

1 Executive Summary

This report has been produced by Milieu Consult to provide an Energy Statement to support the planning application for the remodelling and extension of Kingsway House, Kingsway. The site is located in the London Borough of Camden

The building's use is commercial development with retail outlets at ground floor and basement, and seven floors of office space above. The retail units are planning classification A3, Food and Drink, and total 502m² net internal are. The office floors are planning class B1, Offices, and total 2250m² net internal area.

Energy efficiency measures will be implemented to provide carbon savings of approximately 7.6% in comparison to a baseline building that is fully compliant with the standard set by Part L 2013. The energy efficiency measures include: improved fabric insulation; improved air tightness; LED luminaires with automatic daylight control; high efficiency heating, cooling and ventilation systems; heat recovery on ventilation systems.

The London Heat Map has been utilised to check if the development can connect into an existing distribution network. Currently there are no existing heat distribution networks in the vicinity and the site does not lie within an opportunity area. The site will not be provided with the potential for future connection into a district heating system.

The building will be served by air source heat pumps. A VRF heating and cooling system will extract low-grade heat from the air and use this for space heating. The VRF heat pumps will meet the entire space heating demand of the building and reduce carbon emissions by 0.9 tonnes per year.

The combination of the 'be lean' and 'be green' measures do not achieve the target carbon saving of 35%. The residual carbon saving required to be offset (over the 30 year period specified by the GLA) is 853.4 tonnes.

GLA table 6 show the savings in carbon dioxide achieved by the three steps.

Table 6: Site wide regulated carbon dioxide emissions and savings			
Site Total	Total regulated emissions (Tonnes CO_2/year)	CO_2 Savings(Tonnes CO_2/year)	Percentage Saving
	(Tonnes CO per		(%)
Building Regulations 2013 Part L Baseline	107.0		
After energy demand reduction	98.9	8.1	7.6%
After CHP	98.9	0.0	0.0%
After Low or Zero Carbon Technologies	98.0	0.9	0.9%
Total cumulative savings		**9.0**	**8.4%**
		CO_2 Savings off-set (Tonnes CO_2)	
		853.4	

2 Introduction

This report has been produced by Milieu Consult to provide an Energy Statement to support the planning application for the remodelling and extension of Kingsway House, Kingsway. The site is located in the London Borough of Camden in the Kingsway Conservation area, but the building is not listed.

The building's use is commercial development with retail outlets at ground floor and basement, and seven floors of office space above. The retail units are planning classification A3, Food and Drink, and total 502m² net internal are. The office floors are planning class B1, Offices, and total 2250m² net internal area.

This report assesses different energy strategies for the development to determine the reduction in CO_2 emissions over the target emission rate. It also investigates the effect of improving the building fabric on reducing energy demand and CO_2 emissions.

The structure of this report is based on the Greater London Authority's guidance on preparing energy assessments (March 2016)

2.1 Relevant Policy

2.1.1 The London Plan 2011

2.1.1.1 Policy 5.1 Climate Change Mitigation

The London Plan seeks to achieve an overall reduction in London's carbon emissions by 60% by 2025.

2.1.1.2 Policy 5.2 Minimising Carbon Dioxide Emissions

Developments should try and reduce carbon dioxide emissions to least possible in accordance with the energy hierarchy - Be Lean, Be Clean, Be Green.

Developments are required to achieve a 40% reduction in carbon emissions over 2010 building regulations for both residential and non-domestic buildings. Developments should include a detailed energy assessment to demonstrate how this target will be reached.

2.1.1.3 Policy 5.6 Decentralised Energy In Development Proposals

Developments should select energy systems in accordance with the following hierarchy:

1. Connect to existing heating and cooling networks.

2. Site wide CHP network.

3. Communal heating and cooling.

2.1.1.4 Policy 5.7 Renewable Energy

Developments should seek to reduce carbon emissions by at least 20% through the use of onsite renewable generation where feasible. Technologies applicable include biomass, energy from waste, photovoltaics, solar water heating, wind and heat pumps.

2.1.2 Camden's Development Policy 22 - Promoting sustainable design and construction

The parts of DP22 relevant to this document state that:

The Council will require development to incorporate sustainable design and construction measures. Schemes must:

a) demonstrate how sustainable development principles have been incorporated into the design and proposed implementation; and

b) incorporate green or brown roofs and green walls wherever suitable.

The Council will promote and measure sustainable design and construction by:

e) expecting non-domestic developments of 500sqm of floor space or above to achieve "very good" in BREEAM assessments and "excellent" from 2016 and encouraging zero carbon from 2019.

The Council will require development to be resilient to climate change by ensuring schemes include appropriate climate change adaptation measures, such as:

f) summer shading and planting;

2.1.3 Core Strategy CS13 - Tackling climate change through promoting higher environmental standards *reducing the effects of and adapting to climate change*

Camden's CS13 states that:

The Council will require all development to take measures to minimise the effects of, and adapt to, climate change and encourage all development to meet the highest feasible environmental standards that are financially viable during construction and occupation by:

a) ensuring patterns of land use that minimise the need to travel by car and help support local energy networks;

b) promoting the efficient use of land and buildings;

c) minimising carbon emissions from the redevelopment, construction and occupation of buildings by implementing, in order, all of the elements of the following energy hierarchy:

- ensuring developments use less energy,

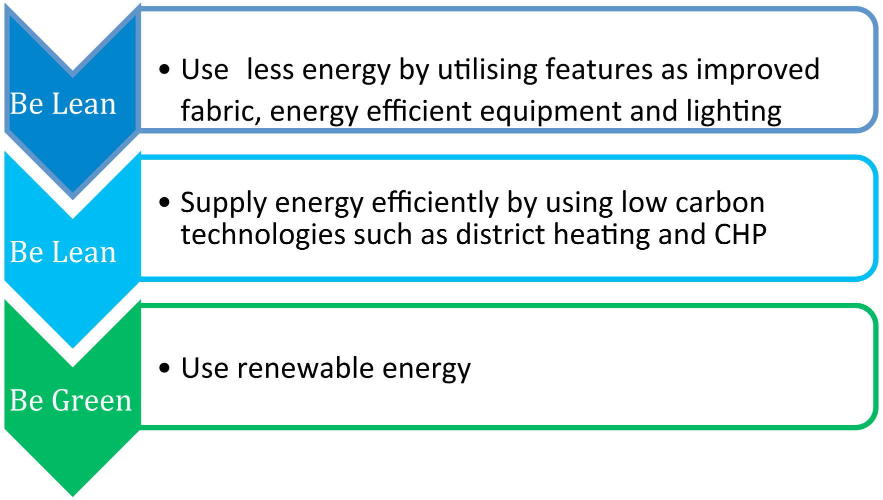
making use of energy from efficient sources, such as the King's Cross, Gower Street, Bloomsbury and proposed Euston Road decentralised energy networks; - generating renewable energy on-site; and

d) ensuring buildings and spaces are designed to cope with, and minimise the effects of, climate change.

The Council will have regard to the cost of installing measures to tackle climate change as well as the cumulative future costs of delaying reductions in carbon dioxide emissions

2.2 Methodology

The methodology used within this report to reduce the energy consumption and CO_2 emissions of the development is based on the energy hierarchy shown below. This is based on the following principles:



2.2.2 Assessment Method

To assess the performance of the non-domestic units a dynamic thermal model has been created in EDSL TAS v9.3.1 to perform Part L2A analysis to calculate the Target Emissions Rating (TER) and Building's Emissions Rating (BER) using the national calculation methodology for defining internal conditions.

2.2.3 Unregulated Energy

The unregulated energy has been calculated using the dynamic thermal model.

3 Baseline

In assessing the reduction in carbon dioxide emissions achieved through the methodology above a baseline building has been produced. The baseline building is defined as a building that is constructed to the standards of Part L (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 heating and domestic hot water are provided by natural gas fired equipment.

The following 'regulated' energy uses are considered in the baseline energy analysis:

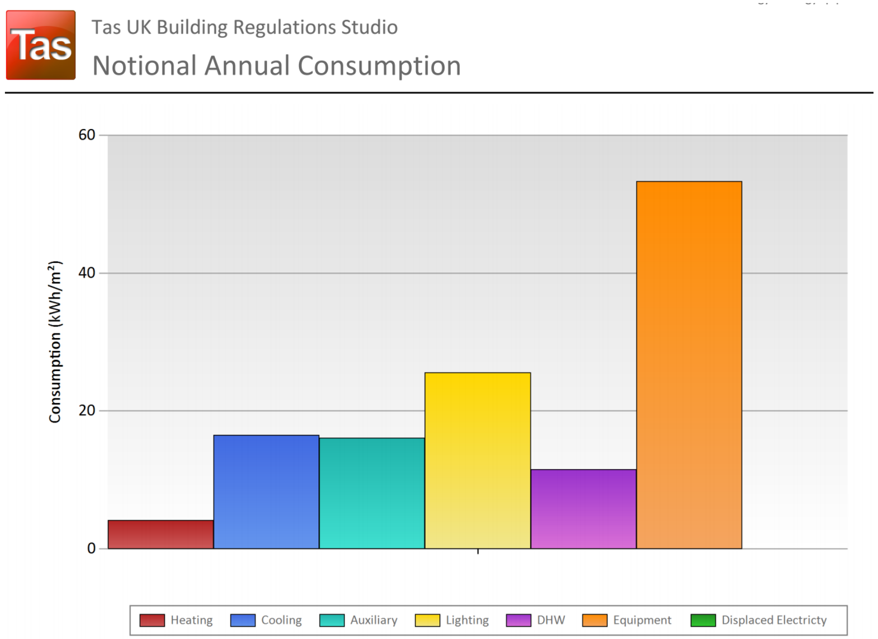
- Space Heating/Cooling
- Water Heating
- Ventilation
- Fans, Pumps and Controls
- Lighting (internal)

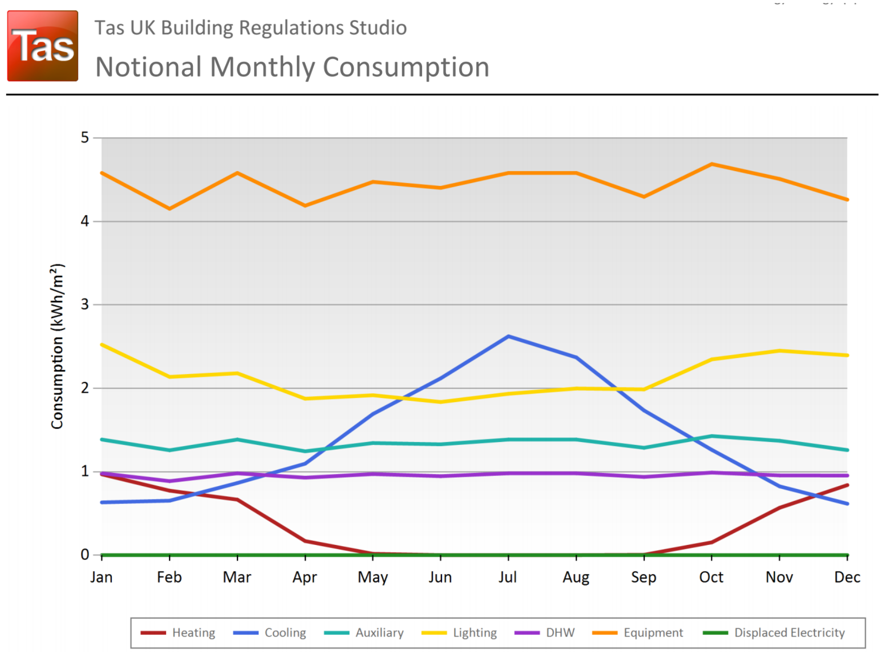
The heating system for the baseline building is defined as being individual gas boilers for each retail unit and a central boiler system serving the offices, as required by the GLA guidance.

The baseline target emission rate for the commercial units has been calculated based on the follow assumptions for the heating and cooling systems:

Heating	Fan coil units in office space and retail units Radiators in circulation and ancillary areas
Cooling	A3 retail units – split air conditioning units Offices – fan coil units with central chiller
Ventilation	A3 retail units - Local supply and extract units with heat recovery. Toilet areas – local extract Office floors – Fresh air supply and extract from central ventilation unit with heat recovery.

Outputs from TAS model showing energy consumption breakdown and annual profile for notional commercial units





4 Be Lean

4.1 Retail Units and Offices

4.1.1 Thermal Fabric

The works include the extensive re-modelling of the building, including the demolition of the existing structural floors and the creation of new structural floors designed to provide increased floor to floor heights more in keeping with current practice. To enable this the existing roof housing the sixth and seventh floors will be removed and replaced with a new double mansard housing the sixth and seventh floors, in addition an eighth floor extension will be added.

The existing stone building façade will be retained. The windows from first to fifth floor will be replaced with new aluminium frame double glazed units, with the exception of the fourth floor windows, which will be retained and provided with secondary glazing. New display windows will be fitted for the A3 units at ground level.

The new mansard roof, double-glazing and insulation provided to the rear of the existing stone façade will result in an energy efficient thermal envelope.

4.1.2 Infiltration

The installation of new windows, new structural floors, a new roof and insulation to the internal face of the stone wall will greatly improve the air permeability of the building and $7m^3/m^2.h$ will be the target leakage rate.

4.1.3 Ventilation

The ground floor/lower ground retail units will require mechanical ventilation, however to reduce energy consumption the mechanical ventilation systems will make use of heat recovery. The mechanical systems will also make use of energy efficient fans to reduce fan powers in line with the non-domestic compliance guide. The maximum specific fan power for mechanical ventilation units will be 0.8W/l/s using local ventilation units. These requirements will be written into the tenant's fit out contract.

The offices will make use of natural ventilation for fresh air supply and extract. The air-handling unit will have a minimum heat recovery efficiency of 75% and a specific fan power of 1.2W/l/s.

4.1.4 Heating and Cooling

The retail units and offices will be provided with mechanical cooling through high efficiency VRF systems with a minimum seasonal coefficient of performance of 4.2.

4.1.5 Lighting

The commercial spaces will also make use of energy efficient lighting throughout and use daylight dimming control in areas benefiting from good daylight.

4.1.6 Summary of Energy Efficiency Measures

Building Fabric	Part L compliant	Be Lean
U Values (W/m2.k)		
External Wall	0.35	0.22
Ground Floor	0.25	0.16
Roof	0.25	0.18
Exposed Floor	0.25	0.22
Glazing	2.2	1.53
Display windows	No limit	5.2
Underground Wall	0.35	0.22
Thermal Bridges		Accredited constructions
Air permeability ($m^3/m^2.h$)	10	7

Building Services	
Heating and cooling systems	Fan coil units in offices and retail units Radiators and natural ventilation in ancillary spaces.
Heating and Cooling Plant	Gas fired boilers, 91% efficient Packaged air cooled chiller, SEER 4.2
Lighting Efficacy (lumens/circuit watt)	<80 in office areas <55 in other areas <40 for display lighting
Lighting Controls	Offices - Automatic daylight Control Retail units – Automatic daylight Control for general lighting.
Ventilation System	Mechanical ventilation with heat recovery in retail units and offices. 75% heat recovery efficiency
Ventilation SFP (W/l/s)	Extract fan - 0.3 Mechanical ventilation with heat recovery – 1.2

Energy consumption Breakdown for Notional and Be Lean Commercial Spaces.

4.1.7 Results

Based on the proposed systems the building emission rate is 7.6% lower than the baseline target emission rate. The vast majority of this benefit is from the high efficiency lighting and the daylight linked dimming control.

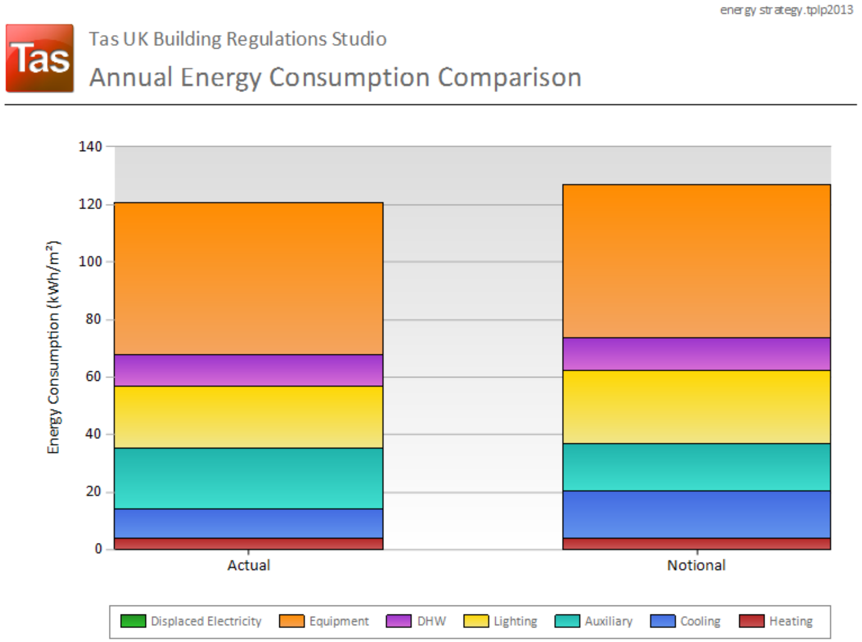
The following tables and graph show the reduction in the building emissions rate due to passive and energy efficient measures.

GLA Table 3: Carbon Dioxide Emissions after each stage of the Energy Hierarchy

Commercial Areas	Carbon dioxide emissions (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Building Regulations 2013 Part L Baseline	107.0	88.0
After energy demand reduction	98.9	88.0

GLA Table 4: Carbon Dioxide Emissions from each stage of the Energy Hierarchy

Commercial Areas	Carbon dioxide savings (Tonnes CO_2 per annum)	Carbon dioxide savings (%)
	Regulated	Regulated
Savings from energy demand reduction	8.1	7.6%



energy strategy.tplp2013
Tas UK Building Regulations Studio
Annual Energy Consumption Comparison
Energy Consumption (kWh/m²)
140
120
100
80
60
40
20
0
Actual
Notional
Displaced Electricity
Equipment
DHW
Lighting
Auxiliary
Cooling
Heating

5 Be Clean

Both the London Plan and local planning guidance state that once demand for energy has been minimised developments must investigate connecting to a district-heating network or using combined heat and power.

5.1 District Heating

The London Heat Map has been utilised to check if the development can connect into an existing distribution network. Currently there are no existing heat distribution networks in the vicinity, and the site does not lie within an opportunity area. The site will not be provided with the potential for future connection into a district heating system.

5.2 Combined Heat & Power

The March 2016 version of the GLA's Guidance on Preparing Energy Assessments includes guidance on the type of developments for which CHP would be appropriate. Paragraph 11.20 of the Guidance lists non-domestic developments such as offices as not being suitable developments. Accordingly, CHP is not considered viable for this development.

5.3 Conclusions

District heating and combined heat and power are not viable for this development.

The tables below show the carbon dioxide emissions and savings after the 'be clean' stage of the hierarchy.

GLA Table 3: Carbon Dioxide Emissions after each stage of the Energy Hierarchy		
Commercial Areas	Carbon dioxide emissions (Tonnes CO_2 per annum)	
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Building Regulations 2013 Part L Baseline	107.0	88.0
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Commercial Areas	Carbon dioxide savings (Tonnes CO_2 per annum)	Carbon dioxide savings (%)
	Regulated	Regulated
Savings from energy demand reduction	8.1	7.6%
Savings from heat network / CHP	0.0	0.0%

6 Cooling and Overheating

6.1 Overview

Policy 5.9 of the London Plan requires that development proposals should reduce potential overheating and reliance on air conditioning systems and demonstrate this in accordance with the following cooling hierarchy.

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 GLA's guidance on preparing energy assessments states that it is expected that dynamic thermal modelling assessing the overheating risk will be undertaken, except in exceptional circumstances where opportunities to reduce cooling demands by passive measures are constrained.

6.2 A3 Retail Area

One of the circumstances listed in the GLA's guidance is the case of small retail food outlets where the doors remain open. The ground floor retail units are likely to be occupied by coffee shops, and it is probable that the doors will be in very frequent use, if not remain open, during the summer for customer access. Therefore, overheating modelling will not be undertaken for the ground floor A3 units.

The retail area cooling will be provided as part of the tenants fit out, and is likely to be high efficiency split cooling units. The tenants guide will provide an indication of the most efficient types of units and give a target efficiency that the tenant should aim for to meet best practice standards.

6.3 Offices

The office element of the development is assessed against the cooling hierarchy as follows:

6.3.1 Minimise internal heat generation

Internal heat generation will be minimised through the use of high efficiency LED luminaires with automatic daylight dimming on the luminaires.

Because the building façade is being retained there is not an opportunity to design a façade that optimises the quantity and quality of the daylight entering the office areas. The daylight factor calculated using an unobstructed sky varies from between 1% and 2% on the existing and replaced floors, with the 8th floor extension achieving a daylight factor of 8%. The lower daylight factors on some of the floors will limit the lighting energy use savings that are available.

The other two major sources of internal heat gains will be the occupants and electrical equipment such as computers and printers. The tenants guide will provide advice on how to reduce the IT gains, but the final choice of equipment will rest with the tenant.

6.3.2 Reduce the amount of heat entering a building

The main source of heat entering the building will be the solar gain. Air infiltration will also contribute some gains, but these will be insignificant relative to the solar gain and other major gains such as lighting and IT equipment.

The use of the existing façade does not allow measures such as providing solar shading, reducing the size of the windows, altering the building's orientation, or designing the orientation of the window openings to reduce solar gains. Where the windows are being replaced the new glazing will be selected to have a good solar performance.

6.3.3 Manage the heat within the building

In order to satisfy the demands of the commercial office market the office floors will be refurbished to contemporary standards, and will include an exposed structural slab. The exposed structure provides the opportunity to use this exposed 'thermal mass' to reduce the cooling demand. In order to utilise this thermal mass the mechanical ventilation system operates during periods of warm weather where the external temperature drops below 16°C overnight.

6.3.4 Passive ventilation

The building is located with all windows facing busy roads, in particular the main easterly elevation faces onto Kingsway and the south elevation faces onto Great Queen Street adjacent a set of traffic lights. The use of passive ventilation through opening windows is not viable is this location.

6.3.5 Mechanical ventilation

The building will be provided with a mechanical ventilation system designed to supply and extract the fresh air requirements of the occupants. The system will be controlled to maximise its potential to provide free cooling by operating with a heating supply air set point of 15°C, ensuring that the air is not provided with heat which then imposes an additional load on the cooling system.

6.3.6 Active cooling systems

The offices will be provided with active cooling systems. Each floor will be provided with an independent high efficiency VRF system. This floor-by-floor approach will be best suited to a building where each floor has the potential to be a separate tenancy.

The space cooling demand has been modelled using the Design Simulation Modelling and the output from the BRUKL document is shown in the table below:

	Area weighted average buidling cooling demand (MJ/m^2)
Actual	141.5
Notional	224.9

This table shows that the space cooling demand of the actual building is 37% lower than the space cooling demand of the notional building. The two major heat gains that the design of the building and the services can affect are the lighting and the solar gain. The total lighting gain in the actual building is 69.6 MWhrs per year, 17% lower than the notional building, and the solar gain during working hours from May to September is 40 MWhrs, 25% lower than the notional building.

7 Be Green

The final step is to use renewable technologies to reduce the energy demand of the building. The following table reviews the technologies and their suitability for the development.

In accordance with the GLA's Guidance an assessment of those technologies not considered suitable for the development is included in Appendix A. A site specific analysis of only those technologies considered viable for the development is included in this section of the report.

7.1 Review of Renewable Technologies

	Technology Appropriate	Comments
Wind	✗	The city centre location of the site means it does not lend itself to wind. Surrounding buildings would create uneven and turbulent wind patterns, which would reduce performance. Added to this are concerns over the visual appearance and noise of wind turbines in an urban environment.
Biomass	✗	Biomass is not thought feasible due to the limited space available for fuel storage and concerns over regular deliveries to the site disturbing the surrounding area.
Solar hot water	✗	Solar hot water has not been considered for this development since there is very little demand.
Ground source heat pumps	✗	Not considered viable due to technical constraints.
Air source heat pumps	✓	The use of a VRF system incorporating heat pump technology to extract heat from ambient air is considered viable for this development.
Photovoltaics	✗	Milieu Consult has assessed the impact of using PV on the roof of the development in consultation with the Architect and other members of the design team. The roof is not suitable for the installation of PV cells due to the limited size of the available roof area.

7.2 Proposed Renewable Energy Technology

The single viable renewable energy technology is air source heat pumps.

7.2.1 Air Source Heat Pumps

The building use and size is ideally suited to the use of a VRF heating and cooling system. A VRF system extracts low-grade heat from the air and converts this into usable heat for use to condition the internal space through the use of heat pump technology. The VRF system has the following performance characteristics:

Operation alongside other heating and cooling	The VRF system is the only form of heating for the building. Its operation alongside the cooling is highly beneficial as the VRF system has a heat recovery operation whereby the heat extracted from parts of the building that require cooling is recycled to provide heat to the building.
COP under test conditions	3.2
ECA compliant	Yes
Seasonal COP	4.5
Estimated heating energy delivered	12.9 MWhrs per annum
CO2 savings realised	0.92 Tonnes per annum

7.3 Be Green Conclusions

The use of the VRF air source heat pump providing space heating will result in a carbon saving of 0.9 Tonnes per annum, and reduce the building's carbon emissions by 0.9%.

The GLA tables summarising the impact of the renewable technologies are below.

GLA Table 3: Carbon Dioxide Emissions after each stage of the Energy Hierarchy		
Commercial Areas	Carbon dioxide emissions (Tonnes CO_2 per annum)	
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GLA Table 4: Carbon Dioxide Emissions from each stage of the Energy Hierarchy		
Commercial Areas	Carbon dioxide savings (Tonnes CO_2 per annum)	Carbon dioxide savings (%)
	Regulated	Regulated
Savings from energy demand reduction	8.1	7.6%
Savings from heat network / CHP	0.0	0.0%
Savings from renewable energy	0.9	0.9%
Total cumulative savings	9.0	8.4%

8 Conclusion

Energy efficiency measures will be implemented to provide carbon savings of approximately 6.7% in comparison to a baseline building that is fully compliant with the standard set by Part L 2013. The energy efficiency measures include: improved fabric insulation; improved air tightness; LED luminaires with automatic daylight control; high efficiency heating, cooling and ventilation systems; heat recovery on ventilation systems.

The London Heat Map has been utilised to check if the development can connect into an existing distribution network. Currently there are no existing heat distribution networks in the vicinity the site is not located adjacent to an opportunity area. The site will not include the potential for future connection into a district heating. Combined heat and power engines are not viable for this development due to its heat demand profile.

The building will be served by air source heat pumps. A VRF heating and cooling system will extract low-grade heat from the air and use this for space heating. The VRF heat pumps will meet the entire space heating demand of the building and reduce carbon emissions by 0.9 tonnes per year.

The combination of the 'be lean' and 'be green measures' does not achieve the target carbon saving of 35%. The residual carbon saving required to be offset (over the 30 year period specified by the GLA) is 853.4 tonnes.

GLA tables 3 to 6 are included to show the carbon savings achieved and the carbon offset required in order to meet the 35% carbon reduction target.

GLA Table 3: Carbon Dioxide Emissions after each stage of the Energy Hierarchy

Commercial Areas	Carbon dioxide emissions (Tonnes CO_2 per annum)	
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Savings from heat network / CHP	0.0	0.0%
Savings from renewable energy	0.9	0.9%
Total cumulative savings	9.0	8.4%

GLA Table 5: Shortfall in regulated carbon dioxide savings

Commercial Areas	Annual Shortfall (Tonnes CO_2)	Cumlative Shortfall (Tonnes CO_2)
Total Target Savings	37.4	
Shortfall	28.4	853.4

Table 6: Site wide regulated carbon dioxide emissions and savings			
Site Total	Total regulated emissions (Tonnes CO_2/year)	CO_2 Savings(Tonnes CO_2/year)	Percentage Saving
	(Tonnes CO per		(%)
Building Regulations 2013 Part L Baseline	107.0		
After energy demand reduction	98.9	8.1	7.6%
After CHP	98.9	0.0	0.0%
After Low or Zero Carbon Technologies	98.0	0.9	0.9%
Total cumulative savings		**9.0**	**8.4%**
		CO_2 Savings off-set (Tonnes CO_2)	
		853.4	

Appendix A - Renewable Energy Technologies

8.1 Biomass

A biomass boiler uses wood pellets, chip or logs as fuel to provide heat and hot water. The biomass fuel is automatically fed from a fuel store into the firebox by an augur that is ignited by an electronic probe. Everything from ignition, timers and temperature is all controlled via a control panel integrated into the boiler.

8.1.1 Planning considerations

Many local authorities in London are concerned about the impact of biomass heating on air quality within the region. Developments are as such required to be at least "air quality neutral" and not lead to any further deterioration of existing poor air quality. It is likely that any biomass proposal would require a detailed air quality assessment to be undertaken. This would include detailed modelling of the biomass flue system. The boiler would need to meet the Clean Air Act 1993.

A biomass boiler for this development is likely to require a substantial flue, which will need to terminate several metres above the ridgeline of the roof. Space would need to be incorporated into the scheme for both the fuel store and 'dead space' for deliveries. Both would require planning consent.

8.1.2 Technical Considerations

The key issues that affect the technical feasibility of the development are space and access of the biomass fuel. An adequately sized plant room with enough space for the biomass boiler, accumulators, backup boilers access for boiler entry/removal would be required. A fuel store would need to be located adjacent to the plant ideally on the same level so as to reduce the complexity of the fuel transfer system. The fuel store would require good approach access for the fuel delivery vehicle. This may require off road parking near the fuel store, which is currently not part of the development.

As with a CHP system, biomass boilers do not modulate as effectively as gas boilers. The biomass system would be sized to provide the base load heat demand for the development with additional gas boilers installed to provide heat during peak periods. A biomass boiler sized at 50% of the peak heating demand could provide around 80% of the total demand.

The source and delivery method of the fuel supply would need to be fully considered. Biomass can only be truly sustainable when sourced locally to the development. When selecting a supplier it is advised they are certified under the Woodsure Scheme. This ensures all products meet EN standards for wood fuel quality. The site will require access for a truck (approximately 12mL x 3.9mH x 2.5mW) with a $20m^2$ turning circle.

Biomass boilers require more maintenance than gas boilers. An annual maintenance program which includes de-ashing would need to be put in place. During these times of maintenance and to cope in periods of high heat demand additional gas backup boilers would be required.

8.1.3 Renewable Heat Incentive

The Renewable Heat Incentive (RHI) is a scheme from the government designed to provide financial support that encourages individuals, communities and businesses to switch from using fossil fuel for heating to renewables such as wood fuel. The RHI pays a price per kWh of heat generated. The current tariffs are show in table 2.

Tariff name	Eligible technology	Eligible sizes	Tariff rate (p/kWh)
Small biomass	Solid biomass; Municipal Solid Waste (incl. CHP)	Less then 200 kWth	*Tier 1:* 8.6
			Tier 2: 2.2
Medium biomass		200 kWth and above; less than 1000 kWth	*Tier 1:* 5.3
			Tier 2: 2.2
Large biomass		1000 kWth and above	1.0
Small ground source	Ground-source heat pumps; Water-source heat pumps; Deep geothermal	Less than 100 kWth	4.8
Large ground source		100 kWth and above	3.5
Solar thermal	Solar thermal	Less than 200 kWth	9.2
Biomethane	Biomethane injection & biogas combustion, except landfill gas	Biomethane all scales; biogas < 200 kWth	7.3

Table 1 Renewable Heat Incentive Tariffs

Advantages	Disadvantages
The cost of wood fuel can be cheaper than traditional fuels if fuel is purchased in advance	Biomass boilers require more space than the gas or oil equivalents. Coupled with this is the need for a fuel store. The size of the store is dependent on the refill interval. The current proposals for the development do not allow for a fuel store
As long as the fuel is sourced locally its carbon emissions are much lower than fossil fuels	Access required to the building for fuel deliveries
Biomass boilers could benefit from the government's Renewable Heat Incentive	The flues for the biomass boiler are likely to be larger than that of a gas boiler and will need to meet the regulations for wood-burning applications.
Other forms of renewable heat generation such as ASHP and GSHP could be integrated into the system to reduce the boiler size.	Requires a backup gas boiler during maintenance and periods of high demand.
	The capital cost of the biomass system will be much higher than a traditional gas system.

8.2 Photovoltaics

Photovoltaics (PV) systems capture the sun's energy using photovoltaic cells and convert it into DC electricity. An inverter is used to connect the PV system to the buildings electrical system. These cells don't need direct sunlight to work and can still generate some electricity on a cloudy day. PV systems can be incorporated into the building in various ways such as sloped roofs or shading devices.

There are three main types of PV panel, each with their own advantages and disadvantages.

Monocrystalline panels are the most efficient but are also the most expensive. They are usually used where there is limited space.

Polycrystalline panels use multiple silicon crystals and due to this are slightly less efficient however they are also cheaper.

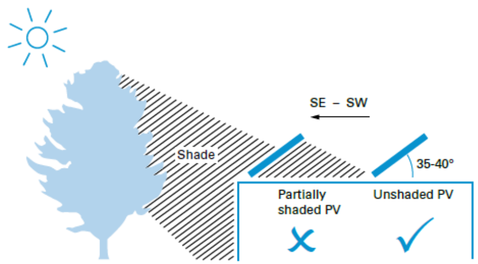
"Thin Film" or amorphous panels are thin and flexible and are commonly used on building integrated photovoltaics because of their many application options. They are cheaper than the other two types however they are also the least efficient.

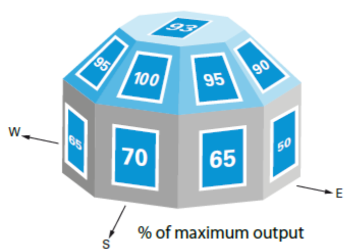
8.2.1 Planning Considerations

The addition of photovoltaic panels to the development is likely to require planning consent.

8.2.2 Technical Considerations

The main consideration for PV systems is a suitably unshaded area to install the panels. Ideally PV arrays should face within 45° of south and be inclined at an angel of 30°. Near horizontal installations are not recommended as the self-cleaning properties of the panels is not reliable under angles of 10°.





PV panels can be mounted in a number of ways however the weight of the modules and any ballast for wind loading needs to be taken in to account in the design of the roof structure.

Conventional PV systems use a central inverter to convert from DC to AC. With a central inverter the solar panels are connected in series. The disadvantage of this is that the overall system performance is defined by the lowest performing panel. This means that if one panel is damaged or dirty the performance of all the others is affected.

The solution is to use micro inverters. These connect to individual or pairs of solar panels. This means the system efficiency is not as affected by shaded or faulty panels. The disadvantage is the increased cost.

Solar shading

Advantages	Disadvantages
PV systems provide clean energy with no greenhouse gas emissions during operation	Additional planning consent could be required
Would benefit from the governments Feed in tariff.	The performance of PV panels worsens slightly as they get older and is low compared to other renewable energy systems.
Low maintenance costs	Solar energy has intermittency issues.
Easy to install as technology is now mature	Require inverter to convert electricity which can reduce efficiency if not sized correctly.
No mechanical parts which would require maintenance	In large developments the area required to meet reduction targets is substantial and often impractical.

8.3 Ground Source Heat Pumps

A ground source heat pump extracts heat from the ground in the same way that a fridge extracts heat from its inside. A ground source heat pump circulates a mixture of water and antifreeze around a loop of pipe buried in the ground. Heat from the ground is absorbed into the fluid and is then passed through the heat pump. The ground temperature in the UK remains at a fairly constant 8 - 11° C throughout the year meaning ground source heat pumps can achieve high coefficients of performance. Ground source heat pumps are able to achieve performance coefficients up to 4 This results in 4kW of heat energy for every 1kW of electrical input.

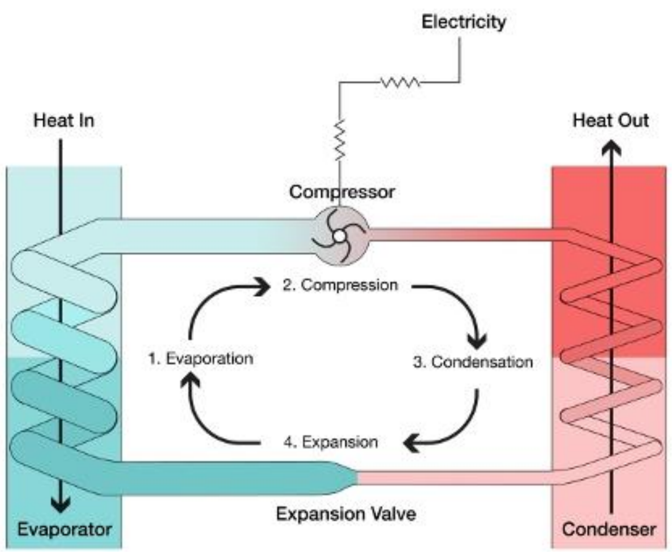


Figure 1 Ground Source Heat Pump Operation

8.3.1 Technical Considerations

The following diagram identifies two types of collectors - horizontal and bore hole. Horizontal collectors would require a substantial amount of land to be able to generate enough heat and so is not applicable for a development of this size. The alternative is to use borehole system. Boreholes are drilled to typically 50 to 100 metres deep with vertical flo and return pipes installed in the boreholes. The disadvantage of using bore hole are that they are considerable more expensive than using a horizontal collector.

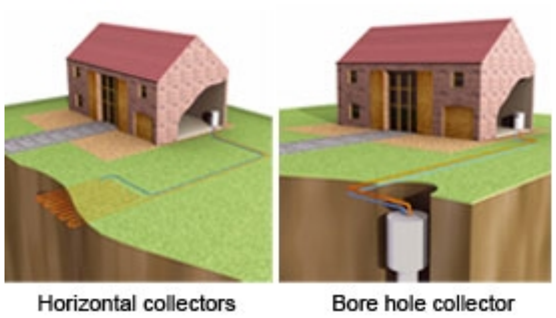


Figure 2 Ground Source Heat Pump Collectors

Ground source heat pumps work best when supplying water at a low temperature, typically 35° to 45°C, which means they are well suited to underfloor heating.

It is likely that the ground source heat pump would be sized to provide the base load heat demand much the same as using a CHP unit.

A backup heat source in the form of gas boilers is likely to be required during exceptionally cold periods and also to perform the pasteurisation cycle in the hot water cylinders to avoid legionella.

8.3.2 Planning Considerations

It is not thought that a ground source heat pump would impact on local planning conditions.

8.3.3 Renewable Heat Incentive

Ground source heat pumps are covered under the renewable heat incentive. Currently the RHI pays 4.8p per kWh of thermal energy generated.

Advantages	Disadvantages
Heat extracted from the ground is constantly renewed naturally	Complicated installation procurement with split contract responsibilities
Ease of installation for refrigerant circuits, contractors are familiar with technology from A/C background.	Design and Build contractor should be engaged prior to any ground works taking place.
Maintenance is minimal and many contractors can top-up refrigerant.	Higher capital cost due to need for bore hole collectors
Exceptional COP coefficient of performance up to 20% greater than air source heat pumps.	Feasibility of ground source loop is dependent on site conditions which are often not discovered until after a contractor has started. Possible abortive costs.
Could benefit from the government's Renewable Heat Incentive	Possible need for backup boiler to perform pasteurisation cycle.

Appendix B - EPC and BRUKL

Energy Performance Certificate
Non-Domestic Building

HM Government

Kingsway
London

Certificate Reference Number:
9182-3074-9463-1602-5505

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

Energy Performance Asset Rating

More energy efficient

A+

Net zero CO_2 emissions

A 0-25

B 26-50

C 51-75

D 76-100

E 101-125

F 126-150

G Over 150

Less energy efficient

31 This is how energy efficient the building is.

Technical information

Main heating fuel: Other
Building environment: Air Conditioning
Total useful floor area (m^2): 3262
Building complexity (NOS level): 5
Building emission rate ($kgCO_2/m^2$): 30.04

Benchmarks

Buildings similar to this one could have ratings as follows:

34 If newly built

100 If typical of the existing stock

Administrative information

This is an Energy Performance Certificate as defined in SI2007:991 as amended

Assessment Software: TAS v9.3.3 using calculation engine TAS v9.3.3

Property Reference: 123456789012

Assessor Name: Barry Redman

Assessor Number: ABCD123456

Accreditation Scheme:

Employer/Trading Name:

Employer/Trading Address:

Issue Date: 24 May 2016

Valid Until: 23 May 2026 (unless superseded by a later certificate)

Related Party Disclosure: Not related to the owner

Recommendations for improving the property are contained in Report Reference Number: 0512-9646-8439-2704-5106

If you have a complaint or wish to confirm that the certificate is genuine

Details of the assessor and the relevant accreditation scheme are on the certificate. You can get contact details of the accreditation scheme from the Government's website at www.communities.gov.uk/epbd, together with details of the procedures for confirming authenticity of a certificate and for making a complaint.

CARBON TRUST

For advice on how to take action and to find out about technical and financial assistance schemes to help make buildings more energy efficient visit **www.carbontrust.co.uk** or call us on **0800 085 2005**

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Kingsway House, Kingsway

As designed

Date: Mon May 23 17:57:11 2016

Administrative information

Building Details

Address: BE GREEN STAGE, London,

Certification tool

Calculation engine: TAS

Calculation engine version: "v9.3.3"

Interface to calculation engine: TAS

Interface to calculation engine version: v9.3.3

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

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name:

Telephone number:

Address: , ,

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	32.6
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	32.6
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	30
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	0.26	0.27	External Wall
Floor	0.25	0.22	0.22	Exposed Floor
Roof	0.25	0.18	0.19	Basement ceiling
Windows***, roof windows, and rooflights	2.2	1.5	2.77	Fourth floor large
Personnel doors	2.2	-	-	No personal doors in project
Vehicle access & similar large doors	1.5	-	-	No vehicle doors in project
High usage entrance doors	3.5	-	-	No high usage entrance doors in project

$U_{a\text{-}Limit}$ = 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	7

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs.
Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	0.9 to 0.95

1- B1_Toilet (13 Zones)

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	-	-	-	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

2- B1_Office (32 Zones)

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	4.5	3.6	-	1.1	0.8
Standard value	0.91*	2.6	N/A	1.5^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

^ Allowed SFP may be increased by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

3- Retail (4 Zones)

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	3	3.6	-	1.1	0.8
Standard value	0.91*	2.6	N/A	1.6^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

^ Allowed SFP may be increased by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

1- New DHW Circuit

	Water heating efficiency	**Storage loss factor [kWh/litre per day]**
This building	0.91	0
Standard value	0.9*	N/A

* Standard shown is for gas boilers >30 kW output. For boilers <=30 kW output, limiting efficiency is 0.73.

2- New DHW Circuit

	Water heating efficiency	**Storage loss factor [kWh/litre per day]**
This building	0.91	0
Standard value	0.9*	N/A

* Standard shown is for gas boilers >30 kW output. For boilers <=30 kW output, limiting efficiency is 0.73.

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
Office reception	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 1	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 2	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 3	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 4	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 5	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 6	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 7	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 8	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 9	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 10	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 11	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 12	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 13	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 14	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 15	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 16	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 17	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 18	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 19	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 20	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 21	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 22	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 23	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 24	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 25	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 26	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 27	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 28	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 29	-	-	-	-	-	-	-	0.7	-	-	N/A
B1_Office 30	-	-	-	-	-	-	-	0.7	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
B1_Office 31	-	-	-	-	-	-	-	0.7	-	-	N/A
Retail 1	-	-	-	-	-	-	-	0.7	-	-	N/A
Retail 2	-	-	-	-	-	-	-	0.7	-	-	N/A
Retail 3	-	-	-	-	-	-	-	0.7	-	-	N/A
Retail 4	-	-	-	-	-	-	-	0.7	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Stairs	-	60	-	614
Basement circulation	-	60	-	126
Plant	60	-	-	127
Showers	-	60	-	152
Basement circ 2	-	60	-	67
Office reception	-	60	22	421
BMS room	60	-	-	44
Grd corridor	-	60	-	105
B1_Office 1	85	-	-	354
B1_Office 2	85	-	-	711
B1_Office 3	85	-	-	450
B1_Office 4	85	-	-	724
B1_Office 5	85	-	-	353
B1_Office 6	85	-	-	705
B1_Office 7	85	-	-	449
B1_Office 8	85	-	-	724
B1_Office 9	85	-	-	375
B1_Office 10	85	-	-	737
B1_Office 11	85	-	-	481
B1_Office 12	85	-	-	724
B1_Office 13	85	-	-	375
B1_Office 14	85	-	-	737
B1_Office 15	85	-	-	481
B1_Office 16	85	-	-	724
B1_Office 17	85	-	-	354
B1_Office 18	85	-	-	710
B1_Office 19	85	-	-	452
B1_Office 20	85	-	-	724
B1_Office 21	85	-	-	324
B1_Office 22	85	-	-	645
B1_Office 23	85	-	-	454
B1_Office 24	85	-	-	724
B1_Office 25	85	-	-	256
B1_Office 26	85	-	-	521

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
B1_Office 27	85	-	-	327
B1_Office 28	85	-	-	724
B1_Office 29	85	-	-	258
B1_Office 30	85	-	-	562
B1_Office 31	85	-	-	280
B1_Toilet 1	-	60	-	100
B1_Toilet 2	-	60	-	99
B1_Toilet 3	-	60	-	99
B1_Toilet 4	-	60	-	99
B1_Toilet 5	-	60	-	99
B1_Toilet 6	-	60	-	199
B1_Toilet 8	-	60	-	86
B1_Toilet 9	-	60	-	65
Retail 1	-	80	45	286
Retail 2	-	80	45	346
Retail 3	-	80	-	1366
Retail 4	-	80	-	1191

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Office reception	N/A	N/A
B1_Office 1	NO (-60%)	NO
B1_Office 2	NO (-48%)	NO
B1_Office 3	NO (-57%)	NO
B1_Office 4	NO (-22%)	NO
B1_Office 5	NO (-72%)	NO
B1_Office 6	NO (-63%)	NO
B1_Office 7	NO (-66%)	NO
B1_Office 8	NO (-48%)	NO
B1_Office 9	NO (-79%)	NO
B1_Office 10	NO (-65%)	NO
B1_Office 11	NO (-74%)	NO
B1_Office 12	NO (-62%)	NO
B1_Office 13	NO (-50%)	NO
B1_Office 14	NO (-33%)	NO
B1_Office 15	NO (-37%)	NO
B1_Office 16	NO (-21%)	NO
B1_Office 17	NO (-75%)	NO
B1_Office 18	NO (-61%)	NO
B1_Office 19	NO (-61%)	NO
B1_Office 20	NO (-47%)	NO
B1_Office 21	NO (-72%)	NO
B1_Office 22	NO (-66%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
B1_Office 23	NO (-71%)	NO
B1_Office 24	NO (-57%)	NO
B1_Office 25	NO (-68%)	NO
B1_Office 26	NO (-84%)	NO
B1_Office 27	NO (-85%)	NO
B1_Office 28	NO (-63%)	NO
B1_Office 29	NO (-15%)	NO
B1_Office 30	YES (+40%)	NO
B1_Office 31	NO (-3%)	NO
Retail 1	N/A	N/A
Retail 2	N/A	N/A
Retail 3	N/A	N/A
Retail 4	N/A	N/A

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	3262	3262
External area [m^2]	3412	3412
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	7	3
Average conductance [W/K]	1548	1841
Average U-value [W/m^{2}K]	0.45	0.54
Alpha value* [%]	23.21	23.21

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
15	**A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways**
85	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Inst.: Hospitals and Care Homes
	C2 Residential Inst.: Residential schools
	C2 Residential Inst.: Universities and colleges
	C2A Secure Residential Inst.
	Residential spaces
	D1 Non-residential Inst.: Community/Day Centre
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
	D1 Non-residential Inst.: Education
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others - Stand alone utility block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	1.92	2.46
Cooling	10.38	16.45
Auxiliary	21.05	16.06
Lighting	21.32	25.57
Hot water	10.92	11.49
Equipment*	53.31	53.31
TOTAL**	**65.59**	**72.04**

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	155.23	236.95
Primary energy* [kWh/m^2]	176.97	192.31
Total emissions [kg/m^2]	30	32.6

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	39.6	0	12.1	0	6.5	0.91	0	0.91	0
	Notional	42.9	0	14.6	0	8.4	0.82	0	----	----
[ST] Fan coil systems, [HS] LTHW boiler, [HFT] Electricity, [CFT] Electricity										
	Actual	11.5	101.3	0.7	7.8	20.1	4.5	3.6	4.5	3.6
	Notional	9	176	1	13.6	14	2.43	3.6	----	----
[ST] Fan coil systems, [HS] LTHW boiler, [HFT] Electricity, [CFT] Electricity										
	Actual	3.2	453.4	0.3	35	44.7	3	3.6	3	3.6
	Notional	1.2	643.4	0.1	49.6	38.1	2.43	3.6	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The BCO can give particular attention to items with specifications that are better than typically expected.

Building fabric

Element	U_{i-Typ}	U_{i-Min}	Surface where the minimum value occurs*
Wall	0.23	0.2	Mansard Wall
Floor	0.2	0.22	Ground Floor
Roof	0.15	0.18	Roof
Windows, roof windows, and rooflights	1.5	0.27	Bay window
Personnel doors	1.5	-	No personal doors in project
Vehicle access & similar large doors	1.5	-	No vehicle doors in project
High usage entrance doors	1.5	-	No high usage entrance doors in project

U_{i-Typ} = Typical individual element U-values [W/(m²K)]
U_{i-Min} = Minimum individual element U-values [W/(m²K)]
* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
$m^3/(h.m^2)$ at 50 Pa	5	7